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EFFECT OF HIGH PROTEIN AND HIGH CARBOHYDRATE DIETS ON BLOOD CLINICAL AND GLUCOSE VALUES IN RABBITS

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Abstract

Background: *Diet is a key factor influencing blood parameters and energy balance in rabbits. Proteins and carbohydrates, as major nutrients, can change blood cells, liver function, and blood glucose levels.* ***Objective:*** *To study how high-protein and high-carbohydrate diets affect blood values and blood sugar in rabbits.* ***Methodology:*** *Male domestic rabbits (n=18) were purchased from the local market of Hyderabad and brought to the animal house, FAHVS SAU Tandojam. Rabbits were assigned to three groups; Group A (control), Group B (85% Carbohydrate fed) and Group C (65% Protein fed). They were placed in a controlled age-appropriate environment with unrestricted access to feed and water. The experimental trial was held for 6 weeks of period.* ***Results:*** *The results revealed that Group C showed the highest red blood cell count (10.98±0.36) compared to Group A (7.03±0.46) and Group B (5.037±0.33). White blood cells were highest in Group B (23.060±1.0126), followed by Group A (9.742±0.29) and Group C (8.60±0.45). Hemoglobin was also highest in Group C (9.873±0.37) compared with Group A (8.298±0.943) and Group B (5.825±0.081). Liver enzymes showed clear differences: ALT was highest in Group C (118.00±4.27), followed by Group B (73.00±4.48) and Group A (39.33±3.32), while AST was highest in Group B (121.17±5.49), compared to Group C (67.18±3.52) and Group A (47.00±2.21). GGT was also highest in Group C (14.00±1.46) compared to Group A (4.10±0.27) and Group B*

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(11.00±0.97). Protein-related parameters were highest in Group C, including total protein (10.747±0.20), albumin (7.2067±0.2557), and globulin (7.2161±0.2659), while lower values were observed in Group A (TP 4.5333±0.42; albumin 3.4333±0.2578; globulin 3.4423±0.2776) and Group B (TP 2.2583±0.863; albumin 0.2900±0.0347; globulin 0.2800±0.0345). Glucose levels were highest in Group B (277.17±20.51), followed by Group A (92.33±3.48), and lowest in Group C (10.33±8.59). Total cholesterol showed no significant difference among groups, with Group A (74.167±2.77) slightly higher than Group C (19.00±1.59) and Group B (12.00±1.18). HDL cholesterol was highest in Group C (29.00±1.32), while LDL cholesterol was also highest in Group C (34.00±3.12). Triacylglycerol levels were highest in Group B (27.83±3.10) compared to Group A (10.28±0.66) and Group C (10.28±0.66). Bilirubin was highest in Group B (0.8400±0.0603), like Group A (0.8400±0.0603), and lowest in Group C (0.2800±0.0493). ***Conclusion:*** *Overall, the elevated levels of carbohydrates and protein have a positive impact on the general well-being of rabbits. This was evidenced by alterations in the CBC count, elevation of LFTs due to high protein intake, modification in lipid profile, and increase in blood glucose values.*

INTRODUCTION

Rabbits are small creatures that are members of the phylum Lagomorpha and family Leporidae. several places in the world. They live in meadows, woodlands, woods, and grasslands. The rabbit is easily handled and observed, very docile, and non-aggressive. It is also commonly bred. extremely cheap in comparison to the price of bigger animals. Rabbits are short-lived animals. (Elsheikh et al., 2023). (Gestation, breastfeeding, and puberty). Rabbits are thought to be better because of their great proficiency and rapid growth, it is more efficient than other livestock (Sharma & Choudhary, 2017).

Both its production capacity and feed conversion efficiency are good in contrast to other meat-producing animals. Rabbits are slaughtered between 18 and 20 weeks of age. when they weigh 3 kg in typical circumstances. Rabbit meat is exceptionally flavorful, low in fat and cholesterol (4%), simple to digest, rich in protein content (25%) and low in calories (160 Kcal/100 g meat). As a result, both children and those with heart conditions can ingest it. Humans have used rabbits for various purposes throughout history because they are intriguing and versatile animals. Here are a few of rabbits' typical uses and functions, including food, fur, study, and pets. They possess the exceptional capacity to procreate and expand quickly while consuming diets higher in fiber and lower in grains year-round. (Para et al., 2015). Green grasses, which are distinctive to their diet and simple to digest, are the food they eat. Instead of a more stagnant and contaminated diet, they choose to consume fresh plant components that are nutrient-dense, like leaves and shoots (Queensberry & Orcutt 2012). Therefore, because they naturally prefer a diet with an adequate energy density, rabbits are known as concentrates favoured because the concentrated feed predisposes them to fatness in confinement (Meredith, 2015). According to their anatomical structure, rabbits are simple stomach herbivores, and fermentation occurs in their intestines. The cecum, a region of the hindgut, contains colonies of microbes that aid in digesting nutrients absorbed in the small intestine. (Mayer et al., 2017). The relationship between food and cecocolic motility, and the health of cecal bacteria is essential. A complex milieu of microorganisms, including huge anaerobic metachromatic staining bacteria, Bacteroides species, and several as-yet-unidentified species of bacteria, may be identified in the cecum, that acts as a fermentation chamber. The bacterial colonies which are present in the cecum are mostly gram-positive Bacteroides spp, due to this the rabbit becomes very sensitive to oral antibiotics, a lot of administration of oral antibiotics can disturb the

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Bacteroides population and may lead to fatal GI upsets (Heczko Proença et al., 2000; Proença et al., 2014). In the hindgut, digests are divided according to particle size. Large (>0.5 mm) particles, mostly lignocellulose, are swiftly transported down the colon by peristaltic activity, where they are excreted as hard faecal pellets, referred to as "indigestible fiber" in the diet. (Gidenne et al., 2020). The therapeutic value of a diet rich in long particle length is to preserve the colon's and cecum's motility. This is why these fibers are frequently referred to as the "Scratch factor," since they manually enhance GI motility. (Oglesbee & Jenkins, 2012). The antimotility function propels tiny particles (< 0.3 mm) and dissolved substances The rabbit may occasionally expel its cecal contents as "soft faeces" or Cecotroph, which it then consumes directly from its anus. Rabbits consume the most cecotrophs when given a diet with a high amount of fiber that cannot be easily digested. (Gidenne et al., 2020; McNitt et al., 2013) into the cecum, where they are subjected to fermentation. This component of the diet is known as “digestible” or “fermentable” fiber (Hulls, 2015).

The re-consumed substance offers crucial microbial protein, as well as all the necessary B vitamins and trace amounts of volatile fatty acids that are vital for the well-being of rabbits. The amino acids obtained in this way do not contribute much to the protein needs of rabbits, especially young and growing ones. Therefore, the diet should provide additional amino acids, but rabbits' essential amino acid requirements have not yet been determined (Mayer et al., 2017).

The protein and carbohydrate needs of rabbits and poultry for their diet are influenced by several factors, including age, physiological state, environmental conditions, and health. Growth, reproduction, lactation, and body tissue preservation require protein (Khaliq et al., 2024). Rabbits rely on carbohydrates as their primary energy source, which can be divided into two categories: structural (fiber) and non-structural (starch and sugars). (Belenguer et al., 2012). Maintaining normal gut function and preventing digestive disorders such as enteritis, ileus, and cecal dysbiosis greatly depends on the role of fiber (Ehmke et al., 2016). Though rabbits can obtain readily available energy from starch and sugars, excessive intake can result in obesity, dental problems, and metabolic disorders (Ehmke et al., 2016, Ahmed et al., 2024). The appropriate amounts of protein and carbohydrates for rabbits' diets have not been definitively determined.

The effects of meals high in protein and carbohydrates on the clinical blood values and glucose levels of rabbits have been reported in inconsistent ways. There have been several studies conducted on the effects of high-protein diets on blood parameters. While some studies suggest that such diets and probiotics could have a positive impact on parameters like haemoglobin, haematocrit, total protein, albumin, globulin, urea nitrogen, creatinine, and glucose, others have found that they could have negative effects on parameters like cholesterol, triglycerides, alkaline phosphatase, aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, and insulin. On the other hand, studies have shown that high carbohydrate diets could improve blood parameters such as glucose, insulin, glucagon-like peptide-1, and peptide YY. (Harcourt-Brown et al., 2020; Khan et al., 2014, Khaliq et al., 2024; Khan et al., 2024; Ullah et al., 2025). Some research has suggested that diets high in carbohydrates may hurt various blood parameters, including cholesterol, triglycerides, free fatty acids, beta-hydroxybutyrate, leptin, adiponectin, and resistin (Varga, 2014). High temperature can affect badly reproductive efficiency and blood and milk biochemical values as well. (Khaliq et al., 2025; Shazinosh et al., 2024)

The effects of high-protein and high-carbohydrate meals on rabbit blood glucose and clinical parameters require more study. The goal of this study is to compare the effects of three distinct diets on these parameters: a control diet with normal levels of protein and carbohydrates, a high protein diet with increased protein levels (65%), and a high carbohydrate diet with increased carbohydrate levels (85%). According to the theories, a diet heavy in protein will improve clinical blood and glucose levels, whereas a diet high in carbohydrates will lead to issues. The understanding of rabbit nutritional physiology and the development of ideal diets for pet rabbits will benefit from the findings of this study.

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MATERIALS AND METHODS

Study Area

The research was conducted at Sindh Agriculture University Tandojam's Animal House, Faculty of Animal Husbandry and Veterinary Sciences. Based on a variety of treatments, the animals were randomly assigned to various experimental groups.

Experimental design

In current study, 18 rabbits were randomly assigned to three groups, with each group consisting of 6 animals (n=6). The first group, which was the control group, did not receive any protein or carbohydrate supplementation, while the second group was given protein supplementation along with their regular diet. The third group was given carbohydrate supplementation. The study lasted for 42 days Table 1.

Table 1: Experimental Design

Group A control	Group B high carbohydrate	Group C high protein
6 rabbits	6 rabbits	6 rabbits

Animal Care

The rabbits were kept in cages on an individual basis and given free access to water along with a diet consisting of pellets.

Dietary Formulation and Feeding Protocol

To satisfy the nutritional needs of rabbits, three distinct diets were created for the study: Control Diet (CD), the High Protein Diet (HPD) with 65% protein, and the High Carbohydrate Diet (HCD) with 85% carbohydrate. For six weeks, the rabbits in each group were fed their individual diets, all of which had a comparable energy content. To make sure every rabbit ate the proper quantity of food, the feeding procedure was closely observed (Table 2).

Table 2: Feed Formulation:

Dietary component	Group A (control) Fed with Basal diet %	Group B (treated with high carbohydrate diet) 85%	Group C (treated with a high-protein diet) 65%
Maize	32	65	20
Wheat bran	28	15	22
Fish meal	18	10	45
Soybean meal	15	5	8
Mineral mixture	2	2	2
Amino acids	1	2	2
Sunflower oil	1	1	1
Total	100	100	100

Data Collection

The clinical and glucose values of the blood will be measured and recorded as baseline measurements at the beginning of the study. Throughout the study, the relevant parameters will be periodically measured by collecting blood samples.

Blood Parameters Measurement

The amounts of hemoglobin, white blood cells, and red blood cells were measured using standard laboratory procedures. To assess the health of the liver, liver function markers like ALT, AST, GGT, TP, albumin, and bilirubin were also looked at. Additionally, while fasting, blood glucose levels were measured.

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Statistical analysis

The "Student Edition of Statistics" computer program was utilized to perform a statistical analysis of the data and determine the coefficient of correlation and regression between the parameters. Results were deemed significant at a P-value < 0.05.

RESULTS

Effect of different diets on the red blood cell (RBC) count in rabbits

Table 3 shows the effect of different diets on red blood cells in rabbits. It was studied for six weeks. All groups started with similar RBC counts, and differences were not statistically significant (P>0.05) at any week. Group C (65% protein with vitamins and minerals) consistently had higher RBCs than Group A (normal diet) and Group B (85% carbohydrate). At week six, RBCs were 10.98±0.36 in Group C, 7.03±0.46 in Group A, and 5.037±0.33 in Group B, but the difference was not significant.

Table 3: Effect of different diets on the red blood cell (RBC) count in rabbits

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
RBC	1st	8.267±0.39	7.52±0.45	10.68±0.48	0.908
	2nd	6.18±0.38	6.92±0.46	11.62±0.49	0.870
	3rd	4.13±0.30	6.39±0.42	11.46±0.33	0.775
	4th	6.33±0.32	5.72±0.41	10.72±0.26	0.635
	5th	5.53±0.38	5.23±0.35	10.86±0.49	0.728
	6th	7.03±0.46	5.037±0.33	10.98±0.36	0.731

Effect of different diets on the white blood cell (WBC) count

Table 4 shows that WBC counts in rabbits were measured over six weeks, with differences becoming significant from week four (P<0.05). The initial number of white blood cells for all groups was slightly similar. Group B (85% carbohydrate) consistently had higher WBCs than Group A (normal diet) and Group C (65% protein). At week six, WBCs were 23.060±1.0126 (B), 9.742±0.29 (A), and 8.60±0.45 (C), showing a significant difference.

Table 4: Effect of different diets on the white blood cell (WBC) count

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
WBC	1st	9.82±0.36	10.157±0.5029	7.63±0.49	0.741
	2nd	10.18±0.45	12.610±0.4347	6.98±0.30	0.651
	3rd	9.05±0.43	15.603±1.1946	7.75±0.57	0.077
	4th	10.79±0.72	19.452±1.1814	8.09±0.28	0.031
	5th	10.68±0.67	21.473±1.1975	7.62±0.31	0.029
	6th	9.742±0.29	23.060±1.0126	8.60±0.45	0.029

The impact of various diets on the blood haemoglobin level in rabbits

Table 5 shows that Haemoglobin levels in rabbits were measured over six weeks under different diets. Group C (65% high-protein) had the highest haemoglobin, followed by Group A (basal diet) and Group B (85% carbohydrate). At week six, haemoglobin was 9.8733±0.3715 g/dL (C), 8.2983±0.9432 g/dL (A), and 5.8250±0.0810 g/dL (B), with significant differences (P<0.05) in weeks 1,2,5, and 6. Results suggest that a high-protein diet increases haemoglobin in rabbits.

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Table 5: The impact of various diets on the blood haemoglobin level in rabbits

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Haemoglobin	1st	9.02± 0.360	5.911± 0.16	9.05± 0.033	0.0318
	2nd	7.47± 0.531	5.818± 0.13	9.78± 0.356	0.0278
	3rd	8.81± 0.582	5.783± 0.17	9.87± 0.242	0.2610
	4th	7.39±0.546	6.062± 0.206	9.96± 0.434	0.1366
	5th	7.397±0.292	5.490± 0.035	10.00± 0.178	0.0013
	6th	8.298± 0.943	5.825± 0.081	9.87 3± 0.37	0.0042

Effect of different diets on the blood alanine aminotransferase (ALT) level in rabbits

Table 6 Shows That ALT levels in rabbits were measured over six weeks, with significant differences between groups except in week four ($P<0.05$). The initial levels of ALT for all groups were not similar. Group C (65% protein) consistently had higher ALT than Group A (normal diet) and Group B (85% carbohydrate). At week six, ALT was 118.00±4.27 (C), 39.33±3.32 (A), and 73.00±4.48 (B), showing a significant effect of a high-protein diet on liver function.

Table 6: Effect of different diets on the blood alanine aminotransferase (ALT) level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Alanine aminotransferase (ALT)	1st	38.50±1.38	86.33±2.62	114.17±4.39	0.038
	2nd	45.00±1.57	70.33±4.95	97.00±5.41	0.048
	3rd	37.00±1.59	73.50±4.42	120.00±3.81	0.018
	4th	47.00±2.39	73.83±3.78	115.83±6.39	0.122
	5th	42.00±3.09	72.07±5.86	120.17±3.18	0.044
	6th	39.33±3.32	73.00±4.48	118.00±4.27	0.031

Effect of different diets on the blood aspartate aminotransferase (AST) level

Table 7 shows that AST levels in rabbits were measured over six weeks, with significant differences between groups except in weeks one and six ($P<0.05$). The initial levels of AST for all groups were not similar. Group B (85% carbohydrate) consistently had higher AST than Group A (normal diet) and Group C (65% protein). At week six, AST was 121.17±5.49 (B), 47.00±2.21 (A), and 67.18±3.52 (C), indicating a negative effect of a high-carbohydrate diet on liver function.

Table 7: Effect of different diets on the blood aspartate aminotransferase (AST) level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Aspartate amino transferase (AST)	1st	48.33±4.21	80.33±3.051	68.67±4.36	0.723
	2nd	44.00±2.16	79.00±3.23	59.00±7.47	0.027
	3rd	47.33±2.36	105.50±5.89	62.00±5.58	0.047
	4th	52.00±1.73	93.50±2.49	65.00±5.98	0.024
	5th	42.68±2.40	81.17±5.08	68.18±6.15	0.016
	6th	47.00±2.21	121.17±5.49	67.18±3.52	0.168

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Effect of different diets on the blood gamma-glutamyl transferase (GGT) level

Table 8 shows that GGT levels in rabbits were measured over six weeks, with significant differences in weeks 2, 4, and 6 (P<0.05). The initial GGT levels for all groups were not similar. Group C (65% protein) consistently had higher GGT than Group A (normal diet) and Group B (85% carbohydrate). At week six, GGT was 14.00±1.46 (C), 4.10±0.27 (A), and 11.00±0.97 (B), showing a significant effect of a high-protein diet.

Table 8: Effect of different diets on the blood gamma-glutamyl transferase (GGT) level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Glutamyl-transferase (GGT)	1st	3.00±0.49	8.00±0.52	16.00±1.095	0.1407
	2nd	1.00±0.19	10.00±0.86	22.00±1.37	0.0027
	3rd	5.00±0.45	9.00±0.45	10.00±1.00	0.1167
	4th	2.00±0.26	8.00±0.52	17.00±2.29	0.0001
	5th	6.02±0.34	7.00±0.58	11.00±1.03	0.0739
	6th	4.10±0.27	11.00±0.97	14.00±1.46	0.0097

The impact of various diets on the blood Total Protein levels in rabbits

Table 9 shows that Total protein levels in rabbits were measured over six weeks, with significant differences in all weeks except the first (P<0.05). The initial total protein levels for all groups were not similar. Group C (65% protein) consistently had higher total protein than Group A (normal diet) and Group B (85% carbohydrate). At week six, total protein was 10.747±0.2028 g/dL (C), 4.5333±0.4232 g/dL (A), and 2.2583±0.8629 g/dL (B), showing a strong effect of a high-protein diet.

Table 9: The impact of various diets on the blood Total Protein levels in rabbits

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Total Protein	1st	4.0167±0.36	2.6367±0.219	5.8750 ±0.22	0.431
	2nd	4.3717±0.45	2.2983±0.277	7.0150 ±0.13	0.046
	3rd	3.5167±0.45	3.3717±0.901	7.8683±0.211	0.016
	4th	5.1317±0.37	3.0017±0.911	8.2767 ±0.30	0.038
	5th	4.3667±0.47	2.5217±0.853	9.7183 ±0.14	0.004
	6th	4.5333±0.42	2.2583±0.863	10.747 ±0.20	0.016

The impact of various diets on blood Albumin levels

Table 10 shows that Albumin levels in rabbits were measured over six weeks, with significant differences in all weeks (P<0.05). The initial albumin levels for all groups were similar. Group C (65% protein) consistently had higher albumin than Group A (normal diet) and Group B (85% carbohydrate). At week six, albumin was 7.2067±0.2557 g/dL (C), 3.4333±0.2578 g/dL (A), and 0.2900±0.0347 g/dL (B), showing a strong effect of a high-protein diet.

Table 10: The impact of various diets on blood Albumin levels

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Albumin	1st	2.9167±0.1778	1.0233±0.1365	2.6233±0.1613	0.046
	2nd	3.1583±0.2653	0.8017±0.1252	3.7650±0.2361	0.027
	3rd	3.0233±0.2340	0.8317±0.1019	4.1400±0.1295	0.017
	4th	3.2583±0.2216	0.5567±0.0720	5.8483±0.3134	0.022

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	5th	3.0717±0.2992	0.4700±0.0336	6.3333±0.2369	0.001
	6th	3.4333±0.2578	0.2900±0.0347	7.2067±0.2557	0.002

The impact of various diets on blood Globulin levels

Table 11 shows that Globulin levels in rabbits were measured over six weeks, with significant differences between groups (P<0.05). Initially, baseline Globulin levels were similar across all groupsGroup C (high-protein diet) consistently had higher globulin than Group A (normal diet) and Group B (85% carbohydrate). At week six, globulin was 7.2161±0.2659 g/dL (C), 3.4423±0.2776 g/dL (A), and 0.2800±0.0345 g/dL (B), showing a strong effect of high protein intake.

Table 11: The impact of various diets on blood Globulin levels

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Globulin	1st	2.7056±0.0.0875	2.02302±0.1254	2.6911±0.1510	0.043
	2nd	3.1674±0.28657	0.8128±0.1251	3.7840±0.2251	0.024
	3rd	3.1122±0.2230	0.7216±0.1017	4.1801±0.1194	0.015
	4th	3.2780±0.2519	0.5461±0.0621	5.8582±0.3133	0.020
	5th	3.0616±0.2893	0.4500±0.0338	6.3734±0.2268	0.003
	6th	3.4423±0.2776	0.2800±0.0345	7.2161±0.2659	0.001

Effect of different diets on the blood Glucose level

Table 12 shows that Blood glucose levels in rabbits were measured over six weeks, with significant differences in the initial glucose levels for all groups were not similar. All groups started with different glucose levels. Group B (85% carbohydrate) consistently had higher glucose than Group A (normal diet) and Group C (65% protein). At week six, glucose was 277.17±20.511 mg/dL (B), 92.333±3.4801 mg/dL (A), and 10.33±8.597 mg/dL (C), showing a strong effect of a high-carbohydrate diet.

Table 12: Effect of different diets on the blood Glucose level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Glucose	1st	89.67± 6.78	267.17 ± 17.92	93.67± 5.81	0.0177
	2nd	103.67 ± 6.78	273.67± 13.10	100.67± 4.86	0.0945
	3rd	99.33± 9.99	290.50± 12.62	92.83 ± 4.09	0.0855
	4th	86.50 ± 2.56	267.67± 5.91	98.33 ± 1.41	0.0127
	5th	103.67± 10.06	245.33± 7.44	101.83 ± 2.53	0.0317
	6th	92.33 ± 3.48	277.17 ± 20.51	10.33 ± 8.59	0.0029

The impact of various diets on the blood Total Cholesterol levels in rabbits

Table 13 shows that Total cholesterol levels in rabbits were measured over six weeks, with a significant difference only in week five (P<0.05). The initial total cholesterol levels for all groups were not similar. Group A (normal diet) consistently had higher total cholesterol than Group C (65% protein) and Group B (85% carbohydrate). At week six, cholesterol was 74.167±2.7739 mg/dL (A), 12.00±1.18 mg/dL (B), and 19.00±1.59 mg/dL (C), with no significant difference.

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Table 13: The impact of various diets on the blood Total Cholesterol levels in rabbits

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Total Cholesterol	1st	56.17±2.77	30.00±1.86	44.00±1.93	0.6230
	2nd	69.17±2.14	28.00±1.37	33.00±1.59	0.6152
	3rd	70.000±2.62	22.00±0.93	27.00±1.89	0.1202
	4th	67.167±1.51	19.00±1.24	24.00±1.59	0.8568
	5th	65.000±2.83	15.00±1.34	21.00±0.77	0.0270
	6th	74.167±2.77	12.00±1.18	19.00±1.59	0.1755

Effect of different diets on the blood HDL Cholesterol level

Table 14 shows that HDL cholesterol levels in rabbits were measured over six weeks, with significant differences in all weeks (P<0.05). The initial HDL cholesterol levels for all groups were not similar. Group C (high-protein diet) consistently had higher HDL than Group A (normal diet) and Group B (85% carbohydrate). At week six, HDL was 29.00±1.32 mg/dL (C), 4.80±0.14 mg/dL (A), and 16.00±1.65 mg/dL (B), showing that a high-protein diet increases HDL levels.

Table 14: Effect of different diets on the blood HDL Cholesterol level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
HDL Cholesterol	1st	6.85±0.20	9.30±0.35	16.00±1.48	0.0002
	2nd	5.70±0.15	11.20±0.71	19.00±1.18	0.0018
	3rd	6.20±0.09	12.54±0.62	21.33±1.28	0.0001
	4th	5.90±0.26	13.02±0.81	24.00±0.86	0.0042
	5th	6.00±0.57	15.43±0.74	27.66±2.23	0.0083
	6th	4.80±0.14	16.00±1.65	29.00±1.32	0.0003

Effect of different diets on the blood LDL cholesterol level

Table 15 shows that LDL cholesterol levels in rabbits were measured over six weeks, with significant differences in weeks 2, 4, 5, and 6 (P<0.05). The initial LDL cholesterol levels for all groups were not similar. Group A (normal diet) and Group C (65% protein) showed increasing LDL, while Group B (85% carbohydrate) showed a decreasing trend. At week six, LDL was 34.00±3.12 (C), 32.00±0.97 (A), and 4.50±0.84 mg/dL (B), showing that a high-carbohydrate diet decreases LDL levels.

Table 15: Effect of different diets on the blood LDL cholesterol level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
LDL Cholesterol	1st	29.00±0.97	10.00±1.67	18.00±2.37	0.1908
	2nd	26.00±1.32	9.70±0.89	24.33±2.60	0.0495
	3rd	28.00±2.14	8.82±0.86	26.00±1.93	0.1659
	4th	24.00±1.95	7.50±0.27	30.00±1.98	0.0018
	5th	26.00±2.02	6.53±0.84	33.00±2.98	0.0013
	6th	32.00±0.97	4.50±0.84	34.00±3.12	0.0057

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Effect of different diets on the blood triacylglycerol level

Table 16 shows that Triacylglycerol levels in rabbits were measured over six weeks, with significant differences in weeks 3 and 6 ($P<0.05$). The initial triacylglycerol levels for all groups were not similar. Group B (85% carbohydrate) had the highest levels, while Group A (basal diet) and Group C (65% protein) showed moderate increases. At week six, triacylglycerol was 27.83±3.10 mg/dL (B), 10.28±0.66 mg/dL (A), and 18.00±0.96 mg/dL (C), showing a strong effect of a high-carbohydrate diet.

Table 16: Effect of different diets on the blood triacylglycerol level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Triacylglycerol	1st	12.60±1.20	15.00±1.59	10.78±1.19	0.7751
	2nd	10.70±0.89	19.00±1.82	11.56±0.98	0.2286
	3rd	9.88±0.92	21.17±2.77	13.06±0.76	0.0102
	4th	11.28±0.91	23.00±0.93	15.20±1.60	0.3682
	5th	8.47±0.97	25.00±2.03	15.75±1.01	0.1817
	6th	10.28±0.66	27.83±3.10	10.28±0.66	0.0030

Effect of different diets on the blood bilirubin level

Table 17 shows that Total bilirubin levels in rabbits were measured over six weeks, with a significant difference in the first week ($P<0.05$). The initial total bilirubin levels for all groups were not similar. Group B (85% carbohydrate) consistently had higher bilirubin than Group A (basal diet) and Group C (65% protein). At week six, bilirubin was 0.8400±0.0603 mg/dL (B), 0.2400±0.0390 mg/dL (A), and 0.2800±0.0493 mg/dL (C), showing that a high-carbohydrate diet increases bilirubin levels.

Table 17: Effect of different diets on the blood bilirubin level

Parameter	Weeks	Group A Mean±SE	Group B Mean±SE	Group C Mean±SE	P value
Total Bilirubin	1st	0.2483±0.0488	0.7900±0.1125	0.3167±0.0279	0.0149
	2nd	0.3250±0.1203	0.8100±0.1001	0.28670.0476	0.1707
	3rd	0.1817±0.0187	0.7650±0.0985	0.2583±0.0119	0.1110
	4th	0.2633±0.0493	0.7217±0.0500	0.2517±0.0334	0.6483
	5th	0.1983±0.0204	0.7333±0.0643	0.2500±0.0392	0.0410
	6th	0.8400±0.0603	0.8400±0.0603	0.2800±0.0493	0.5624

DISCUSSIONS

Three groups were used in this study: group A received a baseline diet; group B received a diet heavy in carbohydrates; and group C received a diet high in protein. As herbivorous animals, rabbits mostly consume grass and herbs to survive. They make cecotrophs in the hindgut by fermenting the fiber in their food. To get vital nutrients, these cecotrophs are subsequently reconsumed (Meredith, 2015). Rabbits require a balanced and complete diet that comprises an adequate amount of energy, protein, fiber, vitamins, minerals, and water to ensure their health and well-being. This study aims to examine the effect of a high protein and high carbohydrate diet on different physiological factors in rabbits. The study intends to assess the possible consequences of these diets on the liver's function, glucose levels, and haematological responses in rabbits.

In the study, it was observed that rabbits in group C (10.98±0.36 million per microliter) consistently showed higher values of red blood cells compared to those in group A (7.03±0.46 million per microliter) and group B (5.037±0.33 million per microliter). These results are in line with previous research efforts (Varga, 2014; Varga, 2015).

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The results indicate that group B (23.060±1.0126 million per microliter) had an impact on the white blood cell count, causing it to rise above the normal value when compared to group A (9.742±0.29 million per microliter) and group C (8.60±0.45 million per microliter). This finding agrees with the research conducted (Harcourt-Brown et al., 2020). On the other hand, studies indicate that high-carbohydrate diets may cause a reduction in haemoglobin, red blood cell count, and white blood cell count in rabbits (Volek et al., 2009; Bazzano et al., (2014). These studies suggested that diets high in carbohydrates may lead to anaemia and immunosuppression. These alterations may be a result of ageing, which can impact the composition and function of white blood cells. Younger animals may still be in the process of developing and maturing their immune systems, while older animals may experience changes associated with getting older (Arif et al., 2024; Khan et al., 2025; Khan et al., 2024).

The study's findings indicate that the group receiving treatment (group C) (9.8733±0.3715 g/dL) had higher levels of haemoglobin when compared to group A (8.2983±0.9432 g/dL) and group B (5.8250±0.0810 g/dL). Additionally, a study with similar parameters was previously conducted by (Lovati et al., 1990; Varga, 2014; Varga, 2015). However, there are also reports suggesting that high-protein diets and probiotics can result in lower levels of red blood cells, haemoglobin, and white blood cells in rabbits. (Hosseini-Mansoub, & Bahrami 2011), same results were recorded by (Ullah et al., 2025). According to certain studies, rabbits may experience an increase in haemoglobin, red blood cell count, and white blood cell count when consuming high-carbohydrate diets. The studies suggest that diets high in carbohydrates may positively affect erythropoiesis, immune function, and inflammation. Conversely, some studies have also shown that rabbits may experience a decrease in haemoglobin, red blood cell count, and white blood cell count when consuming high-carbohydrate diets (Volek et al., 2009; Bazzano et al., 2014). Similar studies were conducted in rats that the high protein diet elevated the haemoglobin level (Obikaonu, et al., 2012)

When an individual follows a diet that is high in carbohydrates or proteins, their body may require more fluids than usual. It's crucial to keep oneself adequately hydrated to prevent hemoconcentration, which can result in elevated levels of haemoglobin in the body. A well-balanced diet that includes ample protein is crucial to produce erythropoietin, a hormone that stimulates the growth of red blood cells. A diet that is rich in both carbohydrates and protein can play a significant role in supporting the body's overall nutritional needs, which in turn can promote erythropoiesis.

Based on the results, it was found that Group C (118.00±4.27 units per litre) had a greater impact on ALT levels compared to Group A (39.33±3.32 units per litre) and Group B (73.00±4.48 units per litre). The consumption of a high-protein diet was found to have a beneficial effect on the liver, leading to an increase in ALT levels. In previous studies, it was observed that when rabbits were given a high-protein diet, their ALT levels also increased (Oboh & Olumese, 2008).

According to the findings, it was observed that the impact of Group B (121.17±5.49 units per litre) on AST levels was significantly greater than that of Group A (47.00±2.21 units per litre) and Group C (67.18±3.52 units per litre). The liver experienced a boost in AST levels due to the consumption of a high-carbohydrate diet. Studies conducted on rabbits also supported this observation, as their AST levels increased when fed a high-carbohydrate diet (Oboh et al., 2007).

According to the findings, it was observed that the impact of Group C (14.00±1.46 units per litre) on GGT levels was more significant than that of Group A (4.10±0.27 units per litre) and Group B (11.00±0.97 units per litre). It was discovered that a high-protein diet had adverse effects on the liver, which caused an

increase in GGT levels. Similar outcomes were observed in rats when they were given a high-protein diet, as their GGT levels also increased (Anyakudo, et al., 2017).

It has been discovered that Group C (10.747±0.2028 g/dL) had a more significant effect on the total protein levels when compared to Group A (4.5333±0.4232 g/dL) and Group B (2.2583±0.8629 g/dL). The research suggests that following a high-

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protein diet can hurt the blood, leading to an increase in total protein levels. Previous studies have also shown that individuals who were given a high-protein diet experienced an increase in their total protein levels (Oboh, et al., 2007).

The study results revealed that Group C (7.2067±0.2557 g/dL) had a more substantial effect on albumin levels compared to Group A (3.4333±0.2578 g/dL) and Group B (0.2900±0.0347 g/dL). It was observed that consuming a high-protein diet hurts the bloodstream, leading to a rise in albumin levels. Previous research also found similar outcomes wherein individuals who were given a high-protein diet experienced an increase in albumin levels (Oboh, et al., 2007).

According to the study, Group C had a more significant impact on globulin levels (7.2161±0.2659) compared to Group A (3.4423±0.2776) and Group B (0.2800±0.0345). The research indicated that consuming a high protein diet can have adverse effects on blood, leading to an increase in globulin levels. Similar outcomes were observed in previous studies, wherein individuals who consumed a high-protein diet experienced a rise in globulin levels (Oboh, et al., 2008).

The findings indicate that Group B (277.17 ± 20.511 mg/dL) had a more significant effect on glucose levels than Group A (92.333 ± 3.4801 mg/dL) and Group C (10.33 ± 8.597 mg/dL). The study revealed that consuming a diet high in carbohydrates can adversely affect blood sugar levels, leading to an increase in glucose levels. These conclusions align with previous research that also found an increase in glucose levels among individuals who consumed a high-carbohydrate diet. (Hilarious, & Johnson, 2012).

According to the findings, group A (74.167±2.7739 mg/dL), which was on a normal diet, experienced an increase in the total cholesterol level compared to group B (12.00±1.18 mg/dL) and group C (19.00±1.59 mg/dL). Additionally, the high carbohydrate diet hurts the total cholesterol level when given to rabbits. (Oboh, et al., 2007). The consumption of high protein can negatively impact the overall cholesterol level by causing a significant reduction in it. (Oboh, & Olumese, 2008).

According to the findings, Group C (29.00±1.32 mg/dL) demonstrates elevated levels of HDL cholesterol in comparison to Group A (4.80±0.14 mg/dL) and Group B (16.00±1.65 mg/dL). Earlier research conducted by another scholar has also suggested that the consumption of high protein is linked to an increase in HDL cholesterol levels. (Oboh, & Olumese, (2008).

Based on the findings, it appears that Group C (34.00±3.12 mg/dL) has higher LDL cholesterol levels compared to Group A (32.00±0.97 mg/dL) and Group B (4.50±0.84 mg/dL). Similar experiments have been conducted, indicating that consuming a carbohydrate diet can decrease LDL cholesterol levels. (Oboh, et al., 2007).

Based on current findings, Group B (27.83±3.10 mg/dL) displayed higher levels of triacylglycerol compared to Group A (10.28±0.66 mg/dL) and Group C (18.00±0.96 mg/dL). Similar research has indicated that triacylglycerol levels tend to increase when subjects are fed a carbohydrate-rich diet. (Oboh, et al., 2007). Human subjects who were provided with a highly regulated carbohydrate-rich diet were also analyzed in similar studies. (Katibi et al., 2004)

According to the data, group B had higher bilirubin levels (0.8400±0.0603 mg/dL) than group A (0.2400±0.0390 mg/dL) and group C (0.2800±0.0493 mg/dL). According to related research, a diet high in carbohydrates raises blood bilirubin levels (Oloruntola, et al., 2018). According to some research, blood bilirubin levels are unaffected by a diet high in carbohydrates (Oboh et al., 2007).

CONCLUSION

Different diets have different effects on the blood parameters of rabbits. A high-protein diet may have more beneficial effects than a high-carbohydrate diet or a normal diet. Group C had higher red blood cell count, haemoglobin level, total protein level, and albumin level than Group A and Group B. High-protein diet may improve the oxygen-carrying capacity and the nutritional status of the rabbits. Group B had higher white blood cell count, glucose level, LDL cholesterol level, triacylglycerol level, and total bilirubin level than Group A and Group C. A high-carbohydrate diet may impair the immune system, glucose metabolism, lipid profile, and liver function of rabbits. Group A and Group C had

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similar levels of alanine aminotransferase, aspartate aminotransferase, and gamma-glutamyl transferase and Group B had lower levels of these enzymes. A high-carbohydrate diet may reduce the liver damage caused by the high-protein diet. Group A had a higher total cholesterol level than Group B and Group C.A normal diet may increase the risk of cardiovascular diseases in rabbits. The study contributed to the existing knowledge of the nutritional physiology of rabbits and the implications of dietary interventions for their health and performance.

Author's contribution

Conceptualization: MU, ABK
Methodology: MI, SZ, JK
Formal analysis: SA, JF, TA
Writing review and editing: MS, AS
All authors have read and agreed to the published version

Conflict of Interest

All authors declare no conflict of interest

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