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Effect of Low-protein Diet on Haemato-biochemical Parameters and Carcass Traits of Japanese Quails (*Coturnix coturnix japonica*) Raised under Intensive Caged Management

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ABSTRACT

The study, conducted during May-July, 2024 at Department of Animal Nutrition, College of Veterinary Sciences and A.H., CAU (Imphal), Aizawl, Mizoram, assessed effect of low-protein diet on blood haemato-biochemical parameters and carcass traits of Japanese quails. One-day old, 280 quail chicks were randomly distributed into seven homogenous treatments and fed quail starter (up to 3 weeks) and finisher (4 to 6 weeks) rations formulated as per ICAR standard with crude protein level reduced by 0%, 5%, 10%, 15%, 20%, 25% and 30% for treatment 1 to 7, respectively. The rations were isocaloric with other nutrients as per ICAR standard. After 15 days brooding, chicks were reared in cages in well-ventilated house providing feed and water *ad libitum*. For haemato-biochemical parameters, blood was collected on 21st and 42nd day of age from 4 quails of each treatment. Biochemical parameters were analyzed by analytical kit (Fujifilm) and haematological parameters were estimated in automated haematology analyser. At 6th week, four quails from each treatment were slaughtered for carcass characteristics study. The results revealed non-significant effect of low-protein diets on all the blood haematological and biochemical parameters and values were within normal range. There was no significant effect of reduced protein level on dressing percentage and organ weights of Japanese quails, but weights of breast, legs and wings were significantly (p<0.01) reduced. Considering non-significant effect on overall health and metabolism, reduction of dietary crude protein up to 30% of ICAR standard was recommended for growing Japanese quails under intensive caged management.

KEYWORDS: Low-protein diet, biochemical, haematological, carcass traits, quails

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1. INTRODUCTION

Japanese quails (*Coturnix coturnix japonica*) were introduced to India in 1974 from California (Singh, 2023) and since then the population and popularity are growing very fast for uniqueness of its meat and egg and ease of farming with minimum investment. It has the ability to reach adult weight of up to 250 g by 6 weeks of age and to lay 250 eggs $year^{-1}$. Being sturdy, they are less prone to infections than other poultry species. Quail eggs and meat are nutritionally unique with less saturated fats and cholesterol. Quail meat contains 21.65±0.71 % protein, 3.57±0.07 % fat, 2.47±0.11 % ash and 118.73±0.08 Kcal energy $(100g)^{-1}$ and rich in essential amino acids and minerals (Khalifa et al., 2016). Quail eggs are highly nutritious having 4.72% protein, 1.5% fat, 8.5% ash and 19.78 % carbohydrates along with essential minerals and vitamins. Lysozyme, cystatin, ovomucoid, ovoinhibitor and ovomacroglobulin are some of the functional proteins found in Japanese quail eggs beneficial to human health (Mine and D'Silva, 2008). Quail eggs are also known to boost brain activity, improve memory, fortify the immune system, and balance the nervous system (Atefeh et al., 2019). Under Indian agroclimatic condition, Anonymous (2013) feeding standard is followed for Japanese quails and it recommends crude protein requirements as 27.77% for 0–3 week and 23.89% for 3–5 week of age on DM basis for Japanese quails. Feeding cost accounts for nearly 65–70% of total production cost in poultry production including the Japanese quail farming. High protein requirement increases feeding cost as the protein feed ingredients are the costliest ingredients in the ration and reduces the profit margin significantly. Searching alternative strategies to reduce protein ingredients in Japanese quails is important for economic sustainability, and also to optimize performance and health (Hatab et al., 2020, Nogodula and Diaz, 2025, Zadeh et al., 2019). Traditional protein feed ingredients (i.e. soybean meal and fish meal) are expensive and the price is increasing day-by-day for their high demands for human consumption (Mnisi and Mlambo, 2018). In the past, dietary modifications to meet the needs of poultry birds were made with the goal of maximizing production performance rather than considering nutritional excess, particularly in terms of protein and amino acids. Diets with lower protein content can save a significant amount of expenditure (Alagawany et al., 2022). A small decrease in dietary protein has no detrimental effects on the growth or carcass characteristics, but it significantly can lower the feeding cost of Japanese quails (Namroud et al., 2008; Ospina-Rojas et al., 2014). It was also reported that the dietary protein level beyond 22% had no significant effect on growth performance of Japanese quails (Serge-Olivier et al., 2021). Tarasewicz et al. (2007) also observed that lowering the dietary protein level did not affect the slaughter yield, breast yield and leg weight in Japanese quails. Similarly, feeding low-protein diets may also be a valid nutritional strategy not only to reduce feeding cost, but also to mitigate environmental pollutions for ammonia emission and nitrogen excretion during production (Kumari et al., 2016, Wen et al., 2017). Therefore, the present study was conducted to evaluate the effect of low-protein diets on blood biochemical and haematological parameters and carcass traits of Japanese quails raised under intensive caged system of management.

2. MATERIALS AND METHODS

2.1. Location of the study and duration

The study was conducted during May to July, 2024 at the experimental shed of Department of Animal Nutrition, College of Veterinary Sciences and Animal Husbandry, Central Agricultural University (Imphal), Selesih, Aizawl, Mizoram. The study was approved by the Institutional Animal Ethics Committee via approval no: CVSC/CAU/IAEC/23-24/P-4, dated: 21/10/2024.

2.2. Design of the experiment

Two hundred-eighty one-day-old Japanese quail chicks were distributed into seven homogenous treatments (T_1 to T_7) with 40 chicks in each treatment following completely randomized block design (CRD). Each treatment was divided into 4 homogenous replicates with equal numbers of chicks. Quail starter and finisher rations were formulated following Anonymous (2013) standard; but reducing the crude protein percentage by 0%, 5%, 10%, 15%, 20%, 25% and 30% respectively for T_1, T_2, T_3, T_4, T_5, T_6 and T_7, respectively (Table 1). The rations were isocaloric with other nutrients as per Anonymous (2013) standard (Table 2). Quail starter ration was fed up to 3 weeks and thereafter, quail finisher ration was fed up to 6 weeks.

2.3. Feeding and management of japanese quails

Experimental Japanese quails were housed in battery brooder for the initial 15 days for brooding and then transferred into well-ventilated house where each replicate was housed in separate cages providing recommended space. No artificial light was provided. Feeding and watering were done *ad libitum*.

2.4. Collection of blood sample for haemato-biochemical parameters

Blood samples were collected from Japanese quails on 21st and 42nd days of feeding trial. Four quails were selected randomly from each treatment and 2 ml of blood was collected from the jugular vein of each. Blood was promptly put into vacutainer containing clot activator and the serum was separated by centrifugation at 3000 rpm for 10 mins. and stored at -20until analysis. For haematological study, blood was collected into vacutainer containing EDTA. Biochemical parameters (serum glucose, total protein,

Table 1: Ingredient composition (%) of the starter and finisher rations

Ingredient	T_1		T_2		T_3		T_4		T_5		T_6		T_7	
	S	F	S	F	S	F	S	F	S	F	S	F	S	F
YM	44	51	45	52	48	54	50	57	53	59	56	60	59	60
SBM	38	26	34	26	30	25	28	20	26	20	23	22	21	18
GNC	12	13	12	9	12	7	10	8	8	5	7	0	5	0
WB	1	4	3	7	4	8	6	9	7	9	8	11	9	15
VO	3	4	4	4	4	4	4	4	4	5	4	5	4	5
DCP	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
CS	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
LL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
DLM	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
COC*	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
TB**	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
TM***	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
AOX#	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

S: Starter ration; F: Finisher ration; YM: Yellow maize, SBM: Soyabean meal; GNC: Ground nut cake; WB: Wheat bran; VO: Vegetable oil; DCP: Dicalcium phosphate; CS: Common salt; LL: L-lysine; DLM: DL-methionine; COC: Coccidiostat; TB: Toxin binder; TM: Trace mineral-vitamin premix; AOX: Anti-oxidant; *: Amproforte (Brand name); **: Toximar (Brand name), #: Vimeral (Brand name); ***: Per kg contains Vitamin A:700,000 IU; Vitamin D3: 70,000 IU; Vitamin E: 250 mg; Calcium: 25.5%; Phosphorous: 12.5%; Sulfur: 0.72%; Zinc: 9600 mg; Magnesium: 6000 mg; Manganese: 1500 mg; Copper: 1200 mg; Iodine: 325 mg; Cobalt: 150 mg; Potassium: 100 mg; Sodium: 5.9 mg

Table 2: Nutritional composition (on DM basis) of starter and finisher rations

Nutrient	T_1		T_2		T_3		T_4		T_5		T_6		T_7	
	S	F	S	F	S	F	S	F	S	F	S	F	S	F
DM (%)	89.31	89.58	89.29	89.68	89.12	89.72	89.36	89.47	89.06	89.30	88.51	89.69	88.54	89.06
CP (%)	27.24	24.24	26.23	22.94	25.13	21.36	23.21	20.38	22.49	18.82	21.00	17.89	19.52	16.29
EE (%)	4.03	4.95	4.29	4.46	4.28	4.97	4.67	5.30	4.12	5.25	4.83	5.15	4.80	4.95
CF (%)	4.96	4.82	4.5	4.65	3.56	4.48	4.43	4.26	4.58	4.00	4.68	3.88	3.75	3.85
TA (%)	6.84	5.56	6.68	5.31	5.20	5.61	6.66	5.35	6.51	4.74	5.54	5.87	6.47	5.02
NFE (%)*	56.91	60.40	58.28	62.62	61.81	63.55	61.00	64.69	62.28	67.17	63.92	67.19	65.44	69.87
Ca (%)	0.85	0.85	0.85	0.85	0.86	0.84	0.85	0.85	0.84	0.85	0.84	0.84	0.85	0.85
P (%)	0.45	0.35	0.46	0.34	0.46	0.34	0.45	0.35	0.45	0.35	0.44	0.35	0.45	0.35
ME (kcal kg^{-1})*	2913	3002	2957	2981	2974	2990	2972	3007	2991	3084	3009	3075	3028	3031
Lysine (%)*	1.45	1.20	1.45	1.20	1.44	1.19	1.44	1.2	1.45	1.19	1.45	1.2	1.45	1.2
Methionine (%)*	0.55	0.5	0.56	0.49	0.56	0.49	0.54	0.5	0.54	0.5	0.55	0.5	0.55	0.5

*Calculated value; S: Starter ration; F: Finisher ration; DM: Dry matter; CP: Crude protein; EE: Ether extract; CF: Crude fibre; TA: Total ash; NFE: Nitrogen free extract; Ca: Calcium; ME: Metabolizable energy; P: Phosphorus

albumin, globulin, total cholesterol, HDL, LDL, AST, and ALT) were estimated using analytical kit (Fujifilm) following standard manufacturer's protocol. Automated haematology analyser (Melet Schloesing Laboratories, France) was used for estimation of haematological parameters (total RBC, Total WBC, Haematocrit and Haemoglobin levels) following standard protocols.

2.5. Evaluation of carcass characteristics

At the end of 6th week of age, twenty-four quails i.e. four

quails from each treatment were slaughtered for carcass characteristics study. 12 hrs of fasting before slaughter was maintained when only drinking water was provided. The live weights of the quails were recorded prior to slaughter. Slaughtering and bleeding of the birds were done in the slaughterhouse of the Department of Livestock Products Technology, College of Veterinary and Animal Sciences and A.H., Selesih, Aizawl, Mizoram. The quails were bled, plucked, scaled, singed, and eviscerated. Weight of the eviscerated organs along with the weights of prime cuts and edible offal such as breast, legs, wings, liver, heart and gizzard were recorded. Dressing percentage was calculated by the following formula:

Dressing percentage (%): (Carcass weight (g)/Live weight (g))×100

2.6. Statistical analysis

The statistical approach outlined by Snedecor and Cochran (1994) was followed for analyzing the data using one-way ANOVA in SPSS. Probability values $p<0.05$ were considered as significant and the values of $0.05> p<0.01$ were considered as trend. When the treatment effect was found to be significant, the Duncan's test was used to evaluate the difference between the treatment means.

3. RESULTS AND DISCUSSION

3.1. Effect of low-protein diet on blood biochemical parameters

Routine assessment of biochemical parameters was a non-invasive method for gaining critical insights into avian physiology and pathology. Analysis of blood biochemical parameters provided rapid assessment of overall health status of birds. The values were also indicative of nutritional status, physiological condition and functions of organs like liver and kidneys. Glucose level in blood, the prime energy source of the body, indicated the energy supply status and its higher or lower values might be indicative of metabolic disorder or stress. Similarly, blood total protein value reflected protein utilization from the diet, cholesterol levels were related to energy metabolism and increased serum AST and ALT were indicatives of liver disease or muscle damage. The estimations of blood biochemical parameters, therefore, were vital for determining prognosis and severity of illnesses, if any. In the present experiment, assessment of blood biochemical parameters (i.e. serum glucose, total protein, albumin, and globulin levels) of Japanese quails fed low-protein diets indicated that all the parameters were within the normal ranges and were non-significant between the treatment groups (Figure 1–4). Similar trends were also observed for other biochemical parameters, namely the serum total cholesterol (mg dl^{-1}), LDL cholesterol (mg dl^{-1}) and HDL cholesterol (mg dl^{-1}) and serum AST (U l^{-1}), ALT (U l^{-1}) levels in blood. The findings might be the

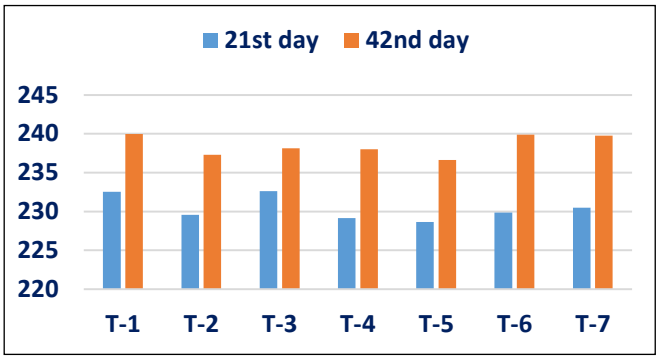

Figure 1: Glucose (mg dl^{-1})

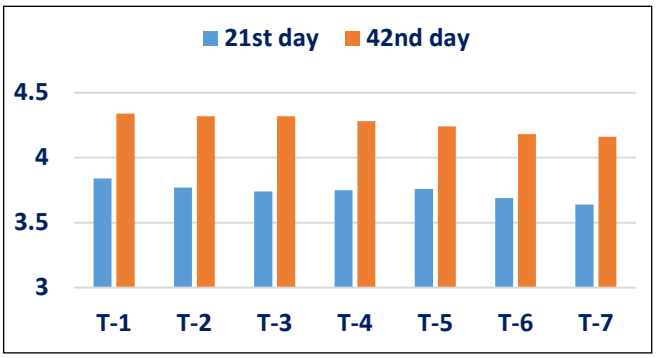

Figure 2: Total protein (g dl^{-1})

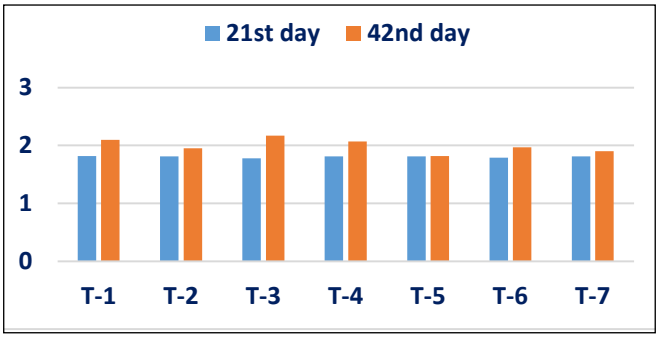

Figure 3: Albumin (g dl^{-1})

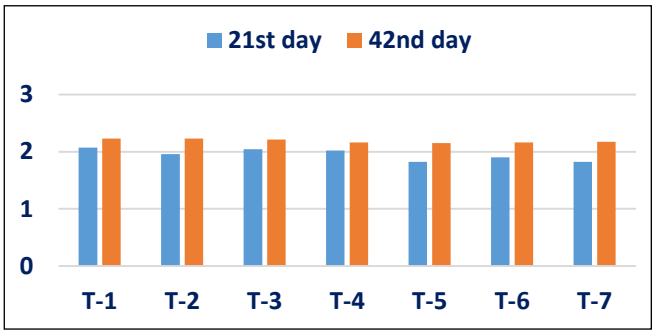

Figure 4: Globulin (g dl^{-1})

indication that reduced dietary crude protein level up to 30% of Anonymous (2013) standard did not have any significant effect on blood biochemical parameters of Japanese quails. The serum total cholesterol (mg dl^{-1}), LDL cholesterol (mg

dl^{-1}), and HDL cholesterol (mg dl^{-1}) level estimated on 21st and 42nd day of age ranged from 142.51± 2.89 145.56±2.63 and 146.66± 0.76 – 149.56± 2.20; 30.59± 5.72 32.66±6.38 and 39.72± 1.02 42.54± 1.72; 108.66± 1.96 –113.56±3.64 and 107.59± 0.69113.14± 0.69, respectively. The statistically insignificant differences (p>0.05) of serum AST (U l^{-1}) and ALT (U l^{-1}) levels between treatments also confirmed that lowering dietary protein level up to 30% of Anonymous (2013) recommendation did not have deleterious effects on the functioning of liver and hence vital functions of the body (Table 3). Our observations also confirmed that the overall health of the Japanese quails was not affected on low-protein diet under intensive rearing in cages. Similar observations were also reported by El-Katcha et al. (2015) and Serge-Oliver et al. (2021) in growing Japanese quails that dietary crude protein level did not have any significant effect on blood glucose, protein, cholesterol, bilirubin, calcium, phosphorus and liver enzyme activities. Mnisi and Mlambo (2018) also observed that, except alkaline phosphatase, all biochemical parameters were not (p>0.05) influenced by dietary protein level. These observations could be due to protein sparring effect that available protein in the body used for essential biological activities.

3.2. *Haematological parameters*

The blood haematological parameters were diagnostic

Table 3: Serum AST (U l^{-1}) and ALT (U l^{-1}) level in Japanese quails at low-protein diets

Day	Treatment							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	p-value
Serum AST (U l^{-1})								
21st day	372.42 ±3.27	368.38±7.18	366.25± 8.89	370.22±7.46	368.77±2.30	372.07±1.99	368.6±3.52	0.98
42nd day	375.18± 0.50	373.92±0.88	373.88± 0.91	373.32±0.74	372.82±0.69	372.57±0.51	371.82±0.60	0.07
Serum ALT (U l^{-1})								
21st day	10.51± 0.07	10.48±0.14	10.49±0.08	10.41±0.14	10.40±0.08	10.29±0.06	10.30±0.07	0.06
42nd day	10.77± 0.07	10.71±0.07	10.65±0.08	10.61±0.06	10.58±0.06	10.55±0.05	10.50±0.05	0.98

tools for assessing bird's overall health, nutritional status and stress level. It was known that low levels of RBCs and haemoglobin might indicate nutritional deficiencies or parasitic infections, whereas high levels could be indicative of dehydration. The measure of haematocrit was indicative of anaemia or dehydration. High WBCs level indicated infection or inflammation or tissue damage and lower value indicated severe infections or viral diseases. In the present experiment, blood haematological parameters, namely RBC (g dl^{-1}), Hematocrit (g dl^{-1}), Hemoglobin (g dl^{-1}) and WBC (g dl^{-1}) were non-significant between the treatments and within the normal ranges (Figure 5 –8). This might be the indication that the dietary crude protein of JQ did not influence blood haematological parameters and hence could be reduced up to 30% of Anonymous (2013) standard without compromising overall health and growth performance. Nazar et al. (2015) also did not observe any significant differences in haematological parameters of Japanese quails fed rations with different dietary protein levels. Mohamed et al. (2012) also reported that there was no significant effect of dietary protein level on blood PCV values in Japanese quails.

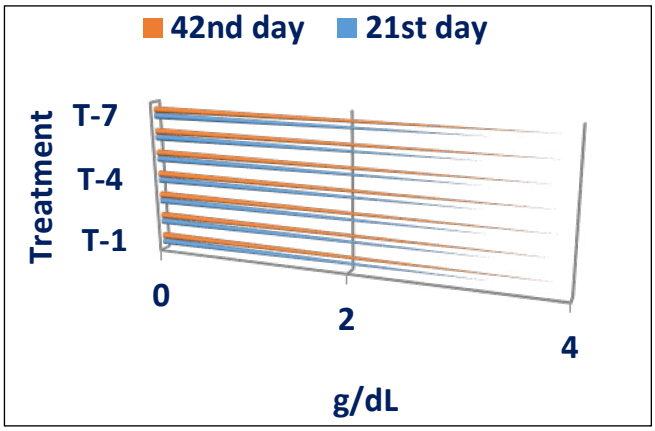

Figure 5: RBC (g dl^{-1})

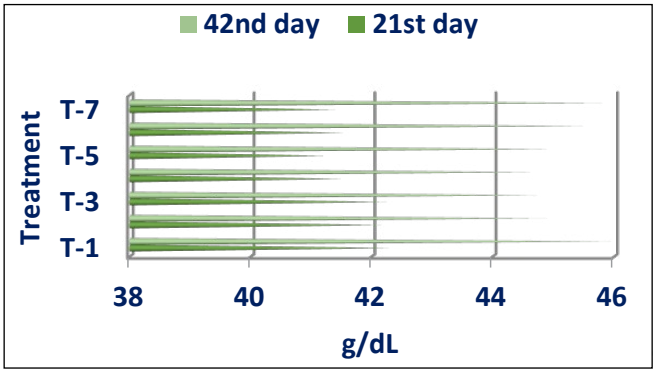

Figure 6: Hematocrit (g dl^{-1})

3.3. *Carcass traits of japanese quails fed low-protein diets*

Protein plays an important role in muscle tissue development. Reduction of crude protein could be negatively impacted the development of breast and leg muscle. In the present study, weights of breast, legs and wings were found to be

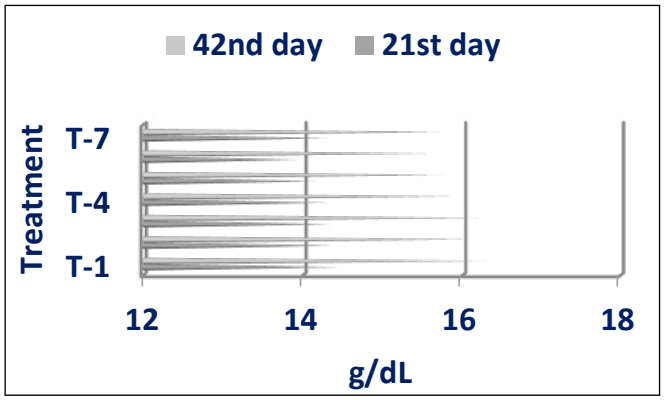

Figure 7: Hemoglobin (g dl^{-1})

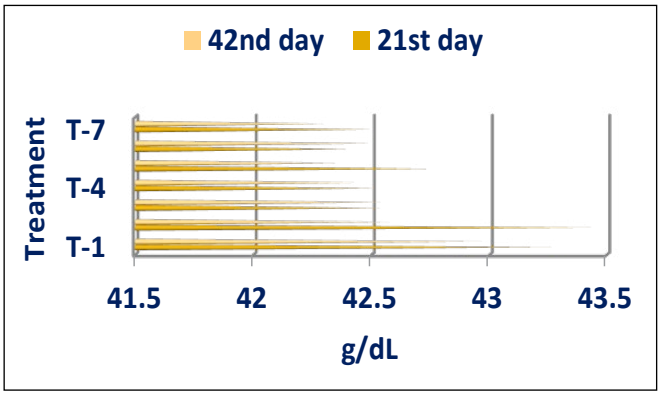

Figure 8: WBC (g dl^{-1})

significantly (p<0.01) reduced for reducing the dietary crude protein levels (Table 4). However, the dressing percentage and visceral organ weights were not affected for reducing the dietary protein level. Similar to the present findings, El-Katcha et al. (2015) also reported that higher dietary protein level with standard calcium content did not have significant (p≥0.05) effect on dressing (%), gizzard and heart weight of growing Japanese quails than those fed diet with lower protein level with the standard level of calcium. Dowarah et al. (2014) could not find any significance difference in the eviscerated weight or dressing % of Japanese quails with different dietary crude protein levels. Wen et al. (2017) also reported that carcass yields of quails at 42 days of age were not influenced by reducing dietary CP from 25.32 to 17.61% (p>0.05) and without any effect on carcass yields. However, lowest carcass yields (i.e. breast, legs and backbone) were reported by Siyadati et al. (2011) in Japanese quails fed diets containing low crude protein level.

Table 4: Carcass traits of Japanese quails at different dietary crude protein levels

Attribute	T_1	T_2	T_3	T_4	T_5	T_6	T_7	p-value
Dressing %	68.46±0.81	68.23±1.03	68.22± 0.25	67.38±0.81	66.67±0.44	67.24±0.80	66.97±0.84	0.85
Leg (g)	28.49^{a}±0.11	28.18^{ab}±0.34	27.43^{abc}±0.30	27.24^{bcd}±0.34	26.74^{cd}±0.26	26.44^{d}±0.39	26.24^{cd}±0.56	<0.01**
Wing (g)	10.60^{a}±0.37	10.20^{a}±0.20	10.50^{ab}±0.25	9.58^{bc}±0.41	9.40^{bc}±0.12	9.22^{c}±0.20	9.1^{c}±0.21	<0.01**
Breast (g)	50.40^{a}±0.80	49.95^{a}±0.58	48.95^{ab}±0.80	47.95^{bc}±0.58	47.45^{bc}±0.33	46.95^{c}±0.33	46.70^{c}±0.25	<0.01**
Heart (g)	1.18±0.03	1.11±0.09	1.10±0.09	1.05±0.02	1.07±0.03	1.07±0.04	1.07±0.05	0.78
Liver (g)	3.87±0.20	3.63± 0.08	3.80±0.24	3.63±0.09	3.74±0.22	3.63±0.12	3.56±0.12	0.85
Gizzard (g)	3.40±0.53	2.87±0.43	2.96±0.41	3.15±0.55	3.46±0.53	3.40±0.48	3.40±0.41	0.95

Means bearing different superscripts (a, b, c, d) in a row differ significantly; NS: Non-significant; **: means (p<0.01)

4. CONCLUSION

Reduced dietary crude protein level had significant effect on carcass yields of growing Japanese quails, but without any adverse effect of blood biochemical and haematological parameters. Therefore, it could be opined that if carcass yield was compromised, dietary crude protein level could be reduced up to 30% of recommended level of Indian Council of Agricultural Research without any adverse effect on overall health and metabolism of growing Japanese quails under intensive management.

5. ACKNOWLEDGEMENT

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