Effect of Dietary Crude Protein Level and Altitudinal Variation on Early Growth Stage of Pen-Raised Ring-Necked Pheasants (*Phasianus colchicus*) in Surkhet, Nepal

Madan Mani Sapakota[1*], Naba Raj Devkota[2], Nirajan Bhattrai[1], Chet Raj Uprety [3] and Shanker Raj Barsila[1]

[1] *Agriculture and Forestry University, Rampur, Chitwan, Nepal*
[2] *Gandaki University, Pokhara, Nepal*
[3] *NARC, Khumaltar, Kathmandu, Nepal*
[*] *Corresponding author: msapkota694@gmail.com*

Abstract

Purpose: *Kalij* meat is recognized as containing high levels of protein and low amounts of fat, which makes it a healthy dietary option. Broiler meat is quite popular in Nepal, along with Sakini and other indigenous local poultry. However, city dwellers and those who enjoy the special taste of indigenous poultry meat are increasingly inclined toward *Kalij* pheasant meat. Ring necked pheasant is called *Kalij* in Nepal. There are 8 different *Kalij* species in Nepal, but Ring-Necked *Kalij* are commercially popular although their growth performance is very poor. The main objective of this research was to assess early growth performance of Ring necked *Kalij* to varying protein levels in their diet by considering altitudinal variation, in Surkhet, Nepal.
Methods: Two altitudes (flat basin, of 658 and 1,498 mean above sea level) of Surkhet district were chosen for this research. Accordingly, four different crude protein (CP) levels, containing 24%, 25%, 26%, and 27% were provided along with required energy and minerals in their diet. Birds were reared under CRD with each treatment replicated four times. Feed intake and growth parameters were measured weekly.
Results: Findings revealed that altitude had a significant effect ($p < 0.001$) to both feed intake and growth resulting in higher growth rate at flat basin (lower altitude), but such effect was not significant ($p < 0.05$) for treatments combination until 3-6 weeks of initial growth stage.
Conclusion: The Early-stage body weight gain of *Kalij* pheasant in flat plain and also to the higher altitude with respect to varying protein content in diet are encouraging, but further detail and in-depth research is required to gauge out the effect of standard diet to the growth of *Kalij* birds that are appropriate from CP content and carcass quality perspective.

Keywords: Altitude; CP content; Diet; Feed intake; Ring-necked *Kalij*

1 Introduction

Poultry production is a vibrant sector of the livestock industry, contributing 3-4% to the national GDP and 8% to agricultural GDP (DLS, 2021). The Ring-necked pheasant (*Phasianus colchicus*), also popurly known as *kalij*, introduced to Nepal in the 18th century, is one of the eight pheasant species recorded in the country. These species, including the Himalayan Monal (*Danphe*) and Cheer Pheasant, play important roles in our biodiversity and culture (Poudyal, 2008; Inskipp et al., 2016).

As the demand for meat and eggs in urban area has increased, commercial poultry production, including pheasant farming, has increased significantly, with a notable increase in demand for *Kalij* pheasant meat due to its high protein and low-calorie content compared with those of chicken (Fetis et al., 2003, Rottenberry et al., 2020). However, the wild population faces challenges from habitat degradation, poaching, and environmental pressures (Nan et al., 2004, Bhattacharya et al., 2007) increasing the scope for enhancing rural and semi urban livelihoods through semi-intensive to intensive rearing of these birds.

Despite the potential economic benefits of pheasant farming, farmers in Nepal face multiple hurdles. These include difficulties in feeding management, bio-security concerns, lack of technical support, and challenges in marketing and branding (Nath, 2021). The rising demand for *Kalij* pheasant meat highlights the need for improved farming practices to meet market needs (Forese et al., 2015). Additionally, the regulatory complexities surrounding pheasant farming, including obtaining permits from the Department of National Parks and Wildlife Conservation, have made it difficult for small-scale farmers to thrive.

This study focused on optimizing the nutritional management and growth performance of *Kalij* pheasants in Karnali Province, Nepal. The dietary crude protein requirements at different growth stages were explored, and the impact of altitudinal variation on productivity was examined.

2 Materials and methods

2.1 Description of study Location

The research was done in two different geographical locations, Birendranagar Municipality i.e. ward no 14 (1480 masl) and ward no 11 (658 masl). The study site having following environmental differences that are described in Table 1.

Table 1: Major climatic parameters in study sites of Surkhet, Nepal.

Climatic parameters	Biendranagar-11	Biendranagar-14
Mean Above Sea Level (masl)	658	1480
Daily average maximum temperature (℃)	29.033	25.02
Daily average minimum temperature (℃)	15.16	6.078
Relative Humidity (	72.18	48
Accumulated Precipitation (mm)	115.73	-
Wind Velocity (km/hr.)	3.23	4.01

2.2 Experimental details and treatments used in experiments

The experiment was carried out in to Completely Randomized Design (CRD) with four replications. The pheasants were reared at two different altitudes, 1480 masl and 658 masl, with four different crude protein (CP) levels: 24 % CP, 25 % CP, 26 % CP and 27 % CP. In total eight treatments were used in the experiment. Each replication consists of four pens, resulting 16 different pens at each location, with each pen consisting of 10 pheasant chicks.

2.3 Feeding practices

Day-old chicks were used in the experiment. During the early stage up to three weeks, all the chicks were fed with a common pre-starter diet based on the recommended dietary level of Nepalese recommendation guidelines in both locations. After three weeks, they were fed with one of four formulated feed containing different levels of crude protein until six weeks of age.

2.4 Data collection and analysis

The body weight of pheasant was measured weekly using weighing balance. The weight of all ten pheasants were recorded and their average weight was considered as the individual weight of a pheasant. Similarly, the feed intake per day was calculated using the formula given formula.

$$\text{Feed intake per day (g)} = \text{Total feed offered in a day} - \text{Total feed refused in a day}$$

2.5 Statistical analysis

The data collected from the experiment were entered into Microsoft Excel 2016 and analyzed by using R-program (version 4.4.3) with Agricola package. All the data collected were statistically analyzed using the analysis of variance (ANOVA) procedure recommended by Gomez & Gomez (1984) for CRD.The Fisher's least significance difference (LSD) test was applied as a mean separation technique applied to identify the most efficient treatment at 0.05 probability level (Obi, 1986).

3 Results

3.1 Effect on feed intake per week

The altitude had a statistically significant effect ($p < 0.05$) on feed intake per week at different time intervals after hatching (Table 2). The altitude 1480 masl recorded the highest feed intake per week across all time intervals, specifically in the 4th week, 5th week and 6th week. The amount of feed intake per week increased over time after hatching, whereas the altitude below 1000 masl resulted the lower feed intake per week across all-time intervals (Figure 1 & Figure 2).

Similarly, CP concentration had significant effect ($p < 0.05$) on feed intake per week at 4th week after hatching (Table 2). The highest feed intake per week was observed with CP 25%, which was statistically similar to CP 24%. Whereas the lowest feed intake per week was recorded for CP 27%. In contrast, crude protein level had a non-significant ($p > 0.05$) effect on feed intake per week during the 5th and 6th week after hatching. Similar trend was observed in the interaction between altitude and crude protein level at 5th week and 6th week. However, at the 4th week after hatching, the interaction between altitude and crude protein levels had significant effect on the feed intake per week (Table 2). The highest feed intake per week was recorded at altitude 1480 masl with the CP 25% which was on par with the altitude 1480 m combined with CP 24% .In contrast, the combination of altitude 1480 masl with the CP 27% recorded the lowest feed intake per week.

Table 2: Effect of altitude and crude protein level on feed intake per week of Ring-necked pheasant in Birendranagar Municipality, Surkhet, Karnali Province, Nepal.

Factors	**Feed intake per chick per week (g)**		
	4^{th} week	**5^{th} week**	**6^{th} week**
Effect of Altitude			
A1 (658 m)	396.67^{b}	424.93^{b}	481.83^{b}
A2 (1480 m)	426.81^{a}	490.57^{a}	527.24^{a}
LSD	24.94	23.36	28.60
P-value	0.02	0.001	0.003
Effect of Crude Protein			
CP 24%	422.55^{a}	461.24	502.75
CP 25%	438.51^{a}	471.24	510.4
CP 26%	409.87^{ab}	468.53	516.58
CP 27%	376.01^{b}	429.99	488.41
LSD	35.27	33.04	40.45
P-value	0.009	0.06	0.51
Treatments combination			
Altitude 658 m with 24% CP	403.41^{bcd}	432.81	492.38
Altitude 658 m with 25% CP	388.75^{cd}	429.65	466.24

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Table 2: Effect of altitude and crude protein level on feed intake per week of Ring-necked pheasant in Birendranagar Municipality, Surkhet, Karnali Province, Nepal. (Continued)

Altitude 658 m with 26% CP	399.86^{bcd}	418.56	494.04
Altitude 658 m with 27% CP	394.64^{bcd}	418.7	474.65
Altitude 1480 m with 24% CP	441.69^{ab}	489.66	513.12
Altitude 1480 m with 25% CP	488.28^{a}	523.92	554.55
Altitude 1480 m with 26% CP	419.88^{bc}	507.4	539.12
Altitude 1480 m with 27% CP	357.38^{d}	441.28	502.15
LSD (0.05)	49.89	33.04	57.21
P-value	0.005	0.09	0.32
CV%	8.23	6.94	7.71
Grand Mean	411.74	457.75	504.53

Note: LSD-Least significant Difference; CV-Coefficient of Variation; means having different superscripts in the same column are significantly different $p < 0.05$.

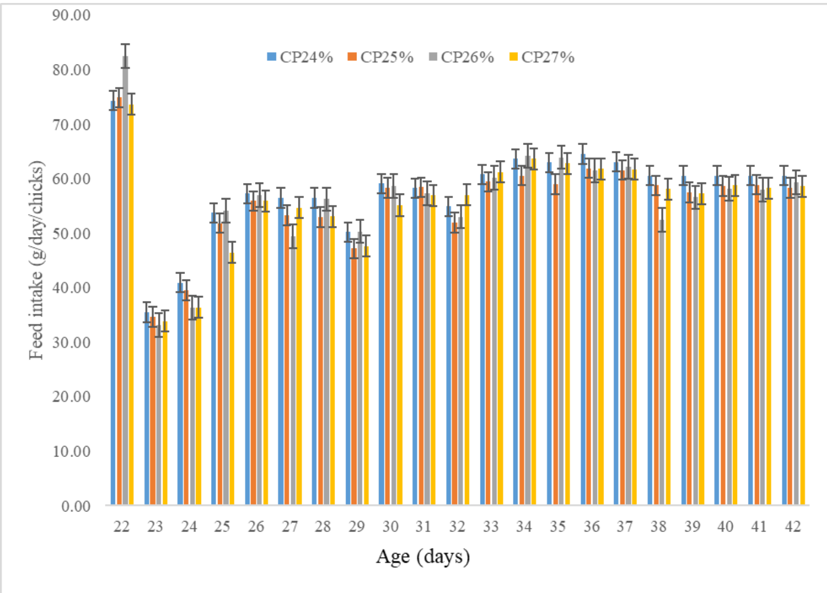

Figure 1: Daily feed intake of a Kalij pheasant during 22-42 days of age at altitude 658 masl), Surkhet, Nepal.

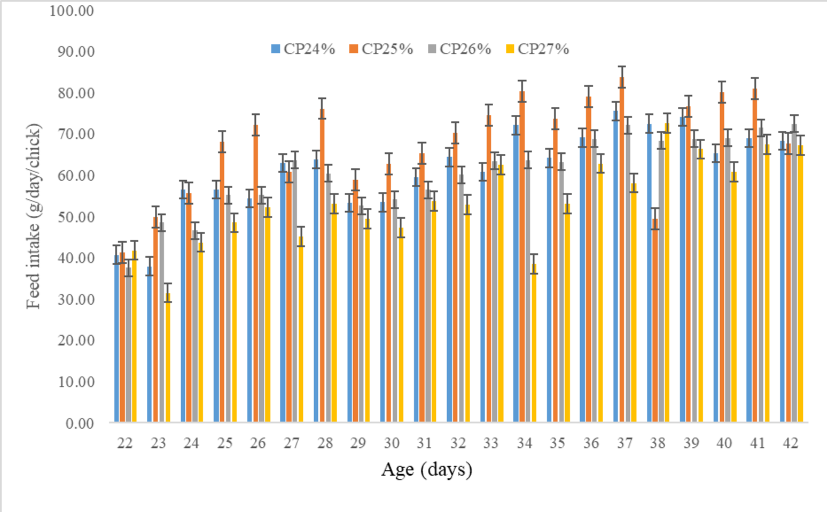

Figure 2: Daily feed intake of a Kalij pheasant during 22-42 days of age at altitude of 1498 masl, Surkhet, Nepal.

3.2 Effect on growth performance (body weight)

The altitude had a statistically significant effect ($p < 0.05$) on body weight at different stages of growth (Table 3). The altitude 658 masl recorded the highest body weight specifically during, 4th, 5th and 6th week. (Table 3, figure 3 and figure 4). The body weight is increasing with successive stages of growth after hatching. Whereas the altitude 1480 masl resulted in the lower body weight as compared to altitude 658 masl.
In contrast, the concentration of crude protein (CP) had a non-significant effect ($p > 0.05$) on body weight of ring-necked pheasant across all time intervals (Table 3). Similar types of result were observed for the combination of treatments on the body weight of ring-necked pheasant across all time intervals (Table 3). Although the crude protein has non-significant effect on body weight, numerically the CP 25% had highest body weight at 4th week, 5th week and the CP 26% at 6th week.

Table 3: Effect of altitude and crude protein content on the early body weight of ring-necked pheasant in Surkhet, Nepal.

Factors	**Average Body weight (g/chick)**		
	4th week	**5th week**	**6th week**
Effect of Altitude			
A1 (658 m)	485.97^{a}	534.09^{a}	581.85^{a}
A2 (1480 m)	38375^{b}	442.10^{b}	490.49^{b}
LSD	55.00	53.54	49.4
P-value	0.001	0.001	0.001
Effect of Crude Protein			
CP 24%	453.54	494.62	536.87
CP 25%	455.54	502.37	536.62
CP 26%	421.37	486.03	540.88
CP 27%	408.99	469.37	530.32
LSD (0.05)	77.79	75.72	69.9
P-value	0.52	0.82	0.99
Treatments combination			

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Table 3: Effect of altitude and crude protein content on the early body weight of ring-necked pheasant in Surkhet, Nepal. (Continued)

Altitude 658 m with 24% CP	501.25	536.25	569.16
Altitude 658 m with 25% CP	504.66	519.75	557.61
Altitude 658 m with 26% CP	469.17	545.81	602.5
Altitude 658 m with 27% CP	468.82	534.58	598.15
Altitude 1480 m with 24% CP	405.83	452.99	504.58
Altitude 1480 m with 25% CP	406.41	484.99	515.63
Altitude 1480 m with 26% CP	373.58	426.24	479.27
Altitude 1480 m with 27% CP	349.16	404.16	462.49
LSD (0.05)	110.01	107.09	98.86
P-value	0.98	0.56	0.45
CV%	17.2	14.92	12.53
Grand Mean	411.74	488.1	536.18

Note: LSD-Least significant Difference; CV-Coefficient of Variation; means having different superscripts in the same column are significantly different $p < 0.05$.

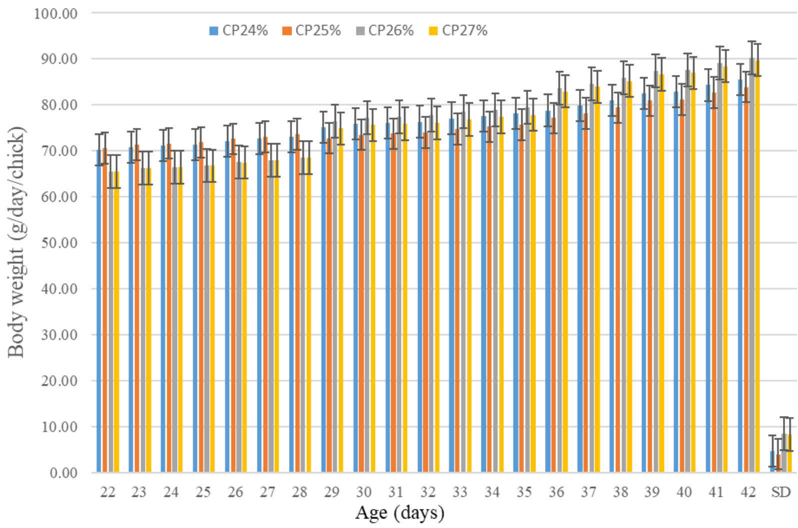

Figure 3: Daily weight gain of a Kalij pheasant during 22-42 days of age at altitude of 658 masl, Surkhet, Nepal.

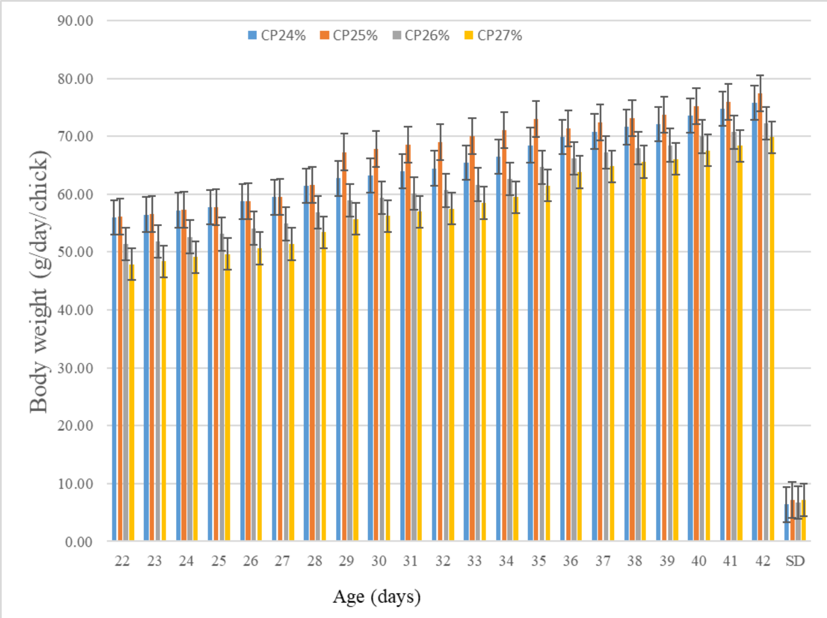

Figure 4: Daily weight gain of a Kalij pheasant during 22-42 days of age at altitude of 1498 masl Surkhet, Nepal.

4 Discussion

The experiment evaluated the effect of altitude and different levels of CP on body growth and feed intake. The results indicated that altitude significantly impacts the body weight, with higher altitudes associated with lower body weight. This is likely because animals inhabiting at higher altitude require more energy to adapt to the cold environments (Storz, 2007; Storz et al., 2010). Similar patterns have been observed in other avian species, where high-altitude environments necessitate greater energy expenditure for thermoregulation and physiological adaptation (Lan et al., 2018). Body weight of ring-necked pheasant consistently increased with age, but those reared at altitude 1480 masl had lower body weights throughout the study period. These results align with the previous findings indicating a negative correlation between altitude and body mass, likely due to increased energy demands and environmental stress at higher elevations (Zheng et al., 2014). In contrast, crude protein (CP) concentration had a non significant effect on body weight across all time invervals. However, numerically, birds fed with 25% CP exhibited the highest body weight at the 4th and 5th week, while tohose on 26% CP diet had the highest body weight at the 6th week. These findings suggest that, the CP levels may influence the body growth, other factors such as altitude may have a more dominant role in shaping body weight.
Altitude also had a significant effect on feed intake per week at different time intervals after hatching. Birds reared at altitudes 1480 masl consumed more feed per week across all intervals, Feed intake increased over time, but those at lower altitudes consumed less feed per week, potentially due to lower metabolic demands associated with milder climatic conditions (Robb et al., 2008). High-altitude environments generally necessitate higher feed consumption to meet increased energy expenditures required for thermoregulation (Swanson & Bozinovic, 2011). Crude protein concentration had a significant effect on feed intake per week at the 4th week after hatching, with the highest intake recorded for birds fed 25% CP. However, CP levels had a non-significant effect on feed intake at the 5th and 6th weeks, suggesting that protein requirements might be more critical at earlier growth stages (Hill et al., 2016).
The interaction between altitude and CP levels significantly affected feed intake per week at the 4th week after hatching. The highest intake was recorded at altitudes 1480 masl with 25%, which was on par with birds at the same altitude fed 24% CP. Conversely, the lowest intake was recorded at altitudes 1480 masl with 27% CP (357.38 g). This suggests that dietary protein levels interact with environmental conditions, influencing feed intake dynamics in ring-necked pheasants (Noy & Sklan, 2002). Overall, the results highlight the importance of considering altitude as a critical environmental factor affecting pheasant growth and development.

5 Conclusion

This study highlights the significant impact of altitude on both body weight and feed intake in ring-necked pheasants. Birds reared at altitudes 658 masl exhibited higher body weights, whereas those at altitude 1480 masl had greater feed intake, likely due to increased metabolic demands for thermoregulation. In contrast, crude protein concentration had no significant effect on body weight across all time intervals but did influence feed intake at the 4th week after hatching, suggesting that protein requirements are more critical during early growth stages.
The interaction between altitude and CP levels further underscores the role of environmental factors in shaping feed consumption patterns. Moreover, while the combination of altitude and CP levels did not significantly affect body weight, numerical variations suggest that other environmental factors may exert a stronger influence on growth performance.
These findings offer valuable insights for optimizing nutritional and habitat management strategies for ring-necked pheasants, particularly in captive breeding and conservation programs aimed at enhancing growth performance under different environmental conditions. Future research should focus on the long-term effects of altitude and dietary modifications on overall survival, reproductive success, and adaptation mechanisms in pheasants across diverse ecological settings.

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Author's contribution

The author is responsible for the overall write up and preparation of manuscript starting from research designing, data generation, analysis and interpretation. Second and third authors contributed to data analysis, formatting and preliminary editing of the manuscript. The remaining authors contributed to literature review and table as well as figure construction and shaping the manuscript.

Conflict of interest

There is no conflict of interest among the authors in preparing and publishing this research work.

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