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Effect of Feeding Different Dietary Protein Levels with Iso-Caloric Ration on Nutrients Intake and Growth Performances of Dual-Purpose Koekoeck Chicken Breeds

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ABSTRACT

The study was conducted to investigate the effect of feeding different levels of crude protein (CP) but similar levels of energy on nutrients intake and growth performance traits of Koekoeck chickens. Two hundred chicks irrespective of their sexes were randomly assigned to 4 treatment diets (T) containing 16% CP (T1), 18% CP (T2), 20% CP (T3) and 22% CP (T4). Each treatment groups were replicated 4 times with ten chicks per replicate. The feed (offered and refusal) was measured using a digital balance every morning before offering the daily feed. The body weight was assessed on a weekly basis. The results indicated that there was a significant ($P<0.05$) increase in feed consumption as the level of protein increased in the diet. The dry matter intake was ($P<0.05$) higher for chickens receiving T3 and T4 diets. The overall feed consumption was higher among the chickens receiving T3 and T4 diets, while it was the lowest among those receiving T1 diet. The result also indicated that the intake of protein was ($P<0.05$) different and positively associated with the intake of CP. The intake of calcium was higher for chicks fed on T2 diet as compared to those receiving T3 diet. Chickens receiving T1 diet had a significantly lower energy intake when compared to those reared on T4 diet. Whereas chickens reared on diets containing T2 and T3 diets had intermediate value between the two. The results indicated that by increasing in the level of protein in the diets did not influence the overall body weight gain and final live weight of chickens. Though not significantly, the chickens reared on diets containing higher levels of protein (T4) showed poor growth performance, this may be attributed to differences in energy protein ratio among the diets. The Koekoeck chickens reached the highest growth rate at 9th week and followed by 11th and 13th week of the experimental periods. The feed conversion ratio (FCR) showed no significant difference among the dietary treatment groups. However, the FCR improved numerically with increasing levels of protein in the diet. From the current work it can be concluded that 16% dietary CP is optimum for Koekoeck chickens.

Key words: Crude protein levels; feed conversion efficiency; feed intake; growth performances; Koekoeck chickens

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INTRODUCTION

Different livestock species and breeds have an inherent capability of utilizing the nutrients to convert them into economically important components such as meat and eggs. Studies have indicated that both quality and quantity of protein is important particularly for the young, rapidly growing and mature animals. Optimal use of protein is necessary for any feeding system, because protein supplements are usually more expensive than energy feeds, and wasteful usage of the same increases the cost of production. Moreover, when excess protein is included in the ration, there will be increased elimination of nitrogen in feces and urine, which has implication on environmental pollution (Church and Kellems, 2002).

In the tropics, feeding higher than the optimal quantities of proteins to the chickens is not recommended because protein has the highest heat increment value amongst all the nutrients and impairs with the bird's performance (Furlan *et al*., 2004). Reduction in the levels of protein in chicken feeds may present an alternative in minimising the feeding costs (Gardzielewska *et al*., 2005). One of the most important decisions for the poultry nutritionist is to optimize the level of protein in the diet. As the expense of providing sufficient protein to growing chickens especially to broilers, necessitates investigating the possibility of reducing dietary crude protein levels without affecting their growth potential thereby developing a proper energy protein ratio for different breeds and classes within a breed. Results of studies on the effect of different levels of crude protein but iso-caloric diets on chickens metabolism and body composition are differing and more research is necessary in order to understand the response of a breed to different levels of protein in their diet. However, results pertaining to response of different feeding regimes on feed intake and growth traits of imported chicken breeds such as Koekoeck are by large lacking. This study was thus conducted to assess the feed consumption and growth performances of chickens in response to different levels of feeding crude protein diets.

MATERIALS AND METHODS

Experimental site

The experiment lasted for 13 weeks, which were preceded by 2 weeks of diet adaptation. It was carried out using the poultry facility of the School of Animal and Range Sciences, Hawassa University (Ethiopia), which lies geographically between 7° 5′ N latitude and 38° 29′ E longitude at an altitude of 1700 m above the mean sea level. The average rainfall of the area ranges from 800 mm to 1100. The mean minimum and maximum temperatures in the study area are 13.5 °C and 27.6 °C, respectively (NMA, 2012).

Design of the treatment diets

Day old Koekoek chicks were procured from Debre Zeit Agricultural Research Institute (Ethiopia). The Koekoek is a South African breed of chicken developed in the 1950s at the Potchefstroom Agricultural College in the city of Potchefstroom by cross breeding of Black Australorp, White Leghorn, and Barred Plymouth Rock (Fourie and Grobbelaar, 2003; Grobbelaar *et al*., 2010).). This chicken breed is commonly known as Potchefstroom Koekoek. Two hundred day old chicks were initially raised together for two weeks in a brooding house. At the end of the brooding period, 160 chicks were randomly assigned to 4 treatment diets in completely randomized design. Each group was replicated 4 times with ten chicks per replicate. The treatment diets were T1, T2, T3 and T4 containing 16% crude protein (CP), 18% CP, 20% CP and 22% CP, respectively.

Diet compositions

The major feed ingredients comprised of corn (*Zeamays*), roasted soybean (*Glysine max*), noug cake (*Guizotia abyssinica*) and wheat bran. The ingredients were first ground in a hammer miller; then all ingredients were mixed along with limestone and salt. Roasted soybean, corn, noug seed cake and wheat bran were included at different proportions to obtain the CP levels of treatment diets. The calculated energy, crude fiber, calcium (Ca) and phosphorous (P) contents of the treatment diets were assessed to be closely similar. Vitamin and mineral supplements were added to the final ration before offering the feed and thoroughly mixed with feeds. The proportion of feed ingredients and nutrient composition of the experimental diets are given in Table 1.

Chemical analysis of ingredients

Dry matter (DM) content of maize, soybean, noug cake and wheat bran were determined by overnight drying in the hot air oven at 105°C, while the total nitrogen (N) was determined according to the Kjeldahl method (AOAC, 1990). The ether extract (EE), crude fibre (CF) and total mineral (Ash) were determined by proximate analysis procedures of AOAC (1990). The ash content of the samples were determined by dry ashing the samples in a muffle furnace at 500 ± 50°C for 5 hours. Calcium and total phosphorus were determined by atomic absorption and spectrophotometer, respectively using the procedures recommended by AOAC (1990). The metabolizable energy (ME) was estimated by the formula: ME (Kcal/kg DM) =3951 + 54.4 EE - 88.7 CF - 40.8 Ash (Wiseman, 1987). Nitrogen free extract (NFE) was computed by difference of organic matter and the sum of CF, EE and CP. All analysis was carried out in duplicates in Animal Nutrition Laboratory of Hawassa University.

Table 1: Diet and nutrient compositions of the experimental diets (%, on DM basis)

Diet and nutrient Compositions	Treatments diets T1	T2	T3	T4
Diet composition				
Maize	54.45	48.0	42.0	40.06
Soybean (roasted)	28.0	33.0	40.5	42.0
Noug cake	9.15	7.00	9.50	9.50
Wheat bran	6.40	10.0	6.00	6.44
Salt	0.50	0.50	0.50	0.50
Limestone	1.00	1.00	1.00	1.00
Mineral-vitamin premix	0.50	0.50	0.50	0.50
Total	100	100	100	100
Nutrient compositions				
Ash	11.5	11.4	11.1	11.2
Crude protein	16.1	17.9	19.9	22.2
Ether extract	9.83	9.74	10.6	10.4
Crude fiber	10.7	10.8	11.5	11.3
Non-nitrogen free extract	44.3	43.2	41.2	40.6
Calcium	0.86	0.88	0.89	0.91
Phosphorous	0.54	0.53	0.51	0.53
ME, MJ/kg DM	13.0	13.0	13.0	13.0

T1= iso-caloric diet containing16% crude protein; T2 = iso-caloric diet containing 18% crude protein; T3 = iso-caloric diet containing 20% crude protein; T4 = iso-caloric diet containing 22% crude protein; ME = Metabolizable energy

Management of experimental animals

All chickens were reared according to the recommendation of the authorities from where the chicks were procured. Vaccinations were carried out according to the standard protocols for Marek's disease; Newcastle disease; infectious bursal disease (Gumboro); fowl typhoid and fowl pox. Chicks were kept in a deep litter housing system with wood shavings to a depth of 5 cm. The pens, watering and feeding troughs were cleaned and disinfected using standard protocols. Each pen was divided by mesh-wire and had an area of 1x 1.5 m floor space. All pens were pre-warmed using 100 watt bulb before the transfer of the chicks to the experimental regime. Clean water and feed was provided *ad libitum* throughout the experimental period.

Data collection on feed intake and growth performance parameters

The daily feed offered was increased by 10% above previous day's offer. Feed refusals were collected, weighed and recorded every morning from each pen prior to give the daily feed. The amounts of feed consumed were assessed on a weekly basis by subtracting the refusal from the total feed offered. The body weight of the birds was obtained using a digital balance, the birds were weighed early in the morning prior to feeding them. Live weight was weighed beginning and then every week during the trial and at the end of the experiment.

Statistical analysis

All data were subjected to one-way ANOVA for a completely randomized designs consisting of 4 treatment diets with 4 replications and analyzed using the General Linear Models Procedure of Statistical Analysis System (SAS, Ver. 9.2, Institute Inc., Cary, NC, USA). When significant differences were observed among treatment means, they were compared using Duncan's Multiple Range Test. Comparisons with statistical level of P<0.05 were considered as significant.

RESULTS

Effect of dietary protein levels on feed consumption and growth performances

The result from Table 2 indicates that there was an increase (P<0.05) in the level of feed consumption as the level of protein supplementation increased in the diet. The results also indicated that the higher feed consumption was observed among chickens receiving T3 and T4 diets while the lowest value was observed among the chickens receiving the T1 diet. The protein intakes were different (P<0.05) and positively associated with the levels of CP in the diets. The results also indicated that the energy intake differed (P<0.05) across all the treatment groups. Accordingly, chickens reared on T1 diet had a significantly lower energy intake when compared to those reared on T4 diet. Whereas chickens reared on diets containing T2 and T3 diets had values intermediate between the two.

The results as presented in Table 2 indicates that increase in the level of protein (in the diets) did not significantly influence the overall body weight gain and final live weight of the chickens. Chickens reared on diets containing higher levels of protein (T4) showed poor growth performance (though not significantly). The results pertaining to the feed conversion ratio (FCR) indicated that chickens showed no significant differences among the dietary treatment groups. There was no significant improvement in FCR values with increasing levels of protein in the diet. The FCR improved slightly (numerically) in the birds receiving 16 and 20% CP, but there was no further improvement as the CP level increased beyond 20%.

Effect of age of birds on feed intake and conversion efficiency

Feed intake of Koekoeck chicks fed on different dietary crude protein levels at various ages is presented in Table 3. The results indicate that feed intake varied across experimental period with difference (P<0.05) across the treatments during most of the experimental periods. In periods (where significant difference was observed) the feed intake was higher among the chickens receiving diets with higher levels of protein (T3 and T4). The results of this study indicated that the dry matter intake of chickens reared on diets containing lower dietary crude protein supplementations (16% CP and 18% CP) increased from 1st to 9th week of experimental period and thereafter it declined during 10th and 11th weeks of the trial period.

The results pertaining to the FCR with the age of the birds across treatment diets are presented in Table 4. The results indicate that FCR did not vary across treatment diets during most of experimental periods. However, the chickens fed diets containing lower crude protein had significantly (P<0.05) poor FCR when compared to those received higher dietary crude protein diets during 1st three successive weeks of experimental period. The results from Table 4 further indicated that in the 6th week of experimental period, Koekoeck chickens reared on a diet containing lower CP level were more efficient in feed conversion than those reared on a diet containing higher CP level.

Effect of age on growth performances

The results pertaining to the mean body weight gain with the age of birds across treatments are presented in Table 5. The results show that the body weight gain varied across the experimental period with significant differences observed during most of the experimental period. The study further indicated that the groups receiving diets with higher crude protein levels (20% and 22%) had mostly higher body weight gain as compared to those received lower crude protein level diets (16% and 18%).

Comparing body weight gain at 1to 4 weeks of trial period (3 to 6 weeks of age), chickens reared on low protein diet (T1) had lower weight gain (P<0.05) when compared to those receiving diets with higher levels of protein. However, the results further indicate that on 6th week of the experimental period, the chicken's receiving high CP (20% and 22%) diets had significantly low weight gain when compared to those fed on T1 and T2 diets.

The average weekly body weight gain across the treatment groups increased across the experimental period till the 9th week of the study and thereafter the increase slowed down in the last two weeks of the study period. The Koekoeck chickens reached the highest growth rate at 9th week and followed by week 11 and 13 of experimental period (Table 5). The least growth rate was attained during 2nd week of experimental period.

DISCUSSION

The results pertaining to the effects of supplementation of various levels of protein on feed intake of Koekoeck chickens is in agreement with the findings of Urdaneta-Rincón and Leeson (2008), who observed low feed intake among chickens receiving 17% CP in comparison to those reared on feed containing high CP content (19% to 25%). Similarly, Tabeidian *et al*. (2005) reported that lowest feed intake was observed among chickens reared on low energy and low protein diets when compared to higher CP level diets. Similar trend was also reported by Osei and Efaah-Baah (1987) in Cobb-100 broiler chickens reared on iso-caloric diets which consumed high feed according the increment of crude protein level increased. Results as obtained by Sterling *et al*. (2003) indicated that by increasing CP levels during the growing period the feed intake increased linearly. On the other hand, studies by Si *et al*. (2004) and

Table 2: Effect of different levels of crude protein on nutrient intakes and growth performances of Koekoeck chickens (g/day/chicken)

Parameters	Experimental diets				SEM
	T1	T2	T3	T4	
Feed intake	57.7^{a}	58.7^{b}	60.4^{c}	59.8^{c}	0.21
Crude protein intake	6.20^{a}	6.71^{b}	7.52^{c}	8.40^{d}	0.02
Energy intake (ME)	0.56^{a}	0.59^{ab}	0.60^{ab}	0.63^{b}	0.01
Calcium intake	0.37^{ab}	0.39^{b}	0.36^{a}	0.38^{ab}	0.02
Phosphorous intake	0.24	0.23	0.22	0.23	0.01
Final body weight (g/chicken)	1032	1062	1071	1006	29.3
Body weight gain	10.1	10.4	10.8	9.80	0.23
Feed conversion ratio (kg feed/kg gain)	5.71	5.60	5.62	6.03	0.15

^{a,b}Means within the same row with different superscript letters are significantly (P<0.05) different; T1= iso-caloric diet containing16% crude protein; T2 = iso-caloric diet containing 18% crude protein; T3 = iso-caloric diet containing 20% crude protein; T4 = iso-caloric diet containing 22% crude protein; SEM = Standard error of the mean

Table 3: Least square means of feed intake (g/chick/day, on DM basis) of Koekoeck chickens fed on different dietary crude protein levels at various ages of development

Treatment diets	Experimental period (weeks)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
T1	33^{ab}	34^{ab}	39^{a}	48^{a}	58	69^{ab}	65	73^{c}	70^{b}	62	64^{a}	60^{a}	66^{a}
T2	32^{a}	30^{a}	34^{ab}	49^{a}	61	68^{a}	68	69^{b}	71^{b}	63	68^{ab}	64^{ab}	71^{a}
T3	37^{b}	37^{b}	44^{b}	52^{ab}	62	72^{ab}	66	59^{ab}	57^{a}	58	82^{bc}	70^{bc}	82^{b}
T4	34^{ab}	36^{b}	43^{b}	56^{b}	66	78^{b}	66	50^{a}	52^{a}	56	75^{b}	73^{c}	86^{b}
SEM	1.3	1.3	2.2	1.7	3.2	2.6	3.2	3.4	2.9	4.2	2.9	2.9	3.1
P - level	NS	NS	NS	**	NS	**	**	**	**	**	NS	**	**

^{a,b} Means within the same column with different superscripts letter are significantly (P<0.05) different; T1= iso-caloric diet containing16% crude protein; T2 = iso-caloric diet containing 18% crude protein; T3 = iso-caloric diet containing 20% crude protein; T4 = iso-caloric diet containing 22% crude protein; SEM= Standard error of the mean

Table 4: Feed conversion ratio of Koekoeck chickens fed on different levels of dietary crude protein at various ages of development

Treatment diets	Experimental period (weeks)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
T1	5.60	6.2^{b}	5.7^{b}	7.1	6.9	7.3^{ab}	6.4	7.1^{b}	6.1^{b}	6.5	5.5	6.1	6.5
T2	5.51	5.8^{ab}	4.2^{a}	6.0	7.7	6.2^{a}	5.8	6.1^{ab}	5.5^{b}	5.2	6.6	5.8	7.1
T3	4.82	5.0^{ab}	4.7^{ab}	5.5	6.5	8.3^{ab}	6.9	5.0^{a}	4.8^{a}	4.3	6.2	5.9	6.2
T4	6.01	4.4^{a}	4.8^{ab}	6.2	7.4	8.9^{b}	7.7	4.6^{a}	3.8^{a}	4.3	6.0	6.6	7.4
SEM	0.5	0.5	0.6	0.7	0.7	0.9	0.8	0.7	0.7	0.8	0.5	0.5	0.6
P-level	NS	NS	NS	**	NS	**	**	**	**	**	NS	**	**

^{a,b} Means within the same column with different superscripts letter are significantly different (P<0.05); T1= iso-caloric diet containing16% crude protein; T2 = iso-caloric diet containing 18% crude protein; T3 = iso-caloric diet containing 20% crude protein; T4 = iso-caloric diet containing 22% crude protein; SEM= Standard error of the mean

Table 5: Least square means of body weight gain (g/chick/week) of Koekoeck chickens fed different crude protein levels at various ages of development

Treatment diets	Experimental period (weeks)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
T1	42.8^{a}	40.0^{a}	49.0^{a}	49.4^{a}	59.2	67.7^{b}	72.8^{ab}	72.6	80.1	70.9^{a}	83^{ab}	74	76^{ab}
T2	42.1^{a}	40.2^{a}	57^{ab}	59.7^{ab}	57.9	78.5^{b}	81.7^{b}	79.6	91.3	94.5^{b}	74^{a}	77.9	69.9^{a}
T3	55^{b}	46^{ab}	65.3^{b}	67.2^{b}	66.7	58^{a1}	67.6^{a}	83.6	85.1	93.4^{b}	92^{b}	83.8	94^{b}
T4	39.7^{a}	55.2^{b}	63.4^{b}	64.8^{b}	62.5	56.2^{a}	63.3^{a}	76.6	96.1	90.6^{b}	88^{ab}	78.4	82^{ab}
SEM	3.7	4.3	4.4	4.5	4.2	6.1	4.5	4.5	5.6	5.7	5.3	5.5	6.4
P-level	**	**	**	**	NS	**	**	NS	NS	**	**	NS	**

^{a,b} Means within the same columns with different superscripts letter are significantly different (P<0.05); T1= iso-caloric diet containing16% crude protein; T2 = iso-caloric diet containing 18% crude protein; T3 = iso-caloric diet containing 20% crude protein; T4 = iso-caloric diet containing 22% crude protein; SEM = Standard error of the mean

Jiang *et al*. (2005) have shown a reduction in feed intake among broilers reared on low CP diets. However, results of studies by Yung *et al*. (2001) and Wu *et al*. (2005) and Shawangizaw *et al*. (2011) indicated that there was no significant differences in feed intake of chickens reared on high and low levels of dietary protein supplementations. On the other hand, the observations by Kamran *et al*. (2008) indicated that the feed intake increased with decrease in dietary protein levels.

The results as obtained from the current study are in accordance with the observation of Xi *et al*. (2007) who observed that Chinese color-feathered chicks reared on lower levels of protein had lower feed intake than those receiving higher levels of protein. This may be attributed to the fact that low protein results in comparatively higher levels of energy (due to high energy protein ratio) when compared to the level of protein, when the levels of energy are higher than the protein intake the energy helps in metabolism resulting in poor muscle mass but higher abdominal fat deposition. The results as obtained in the study differed from the observations of Kamran *et al*. (2008) who indicated that broilers fed on low dietary protein had low feed intake when compared to those fed on high dietary protein diets at 1 to 26 days of age.

Yonemochi *et al*. (2003) reported that broiler chicks reared on low CP diet had similar growth performance when compared to those fed on higher CP diet which is consistent with our observations. Similar observations were also reported by Yung *et al.* (2001) and Wu *et al.* (2005) who indicated that a non-significant difference in weight gain with increasing level of protein in commercial breeder pullet diets at growing phase. Similarly, Ndegwa *et al*. (2001) reported that indigenous chickens reared on different dietary CP had similar growth rates, suggesting that a 17 % CP diet was sufficient for these chickens. Results as reported by Folorunso and Onibi (2012) for broiler chickens too are in accordance with the present study. Similar results were also reported by Nguyen and Bunchasak (2005) on Betong chicks fed on different levels of CP and they concluded that energy had no significant difference on body weight gain.

On the other hand, results observed by Sklan and Plavnik (2002) and Kamran *et al*. (2008) were not in accordance with the present observations, who reported that the final body weight and body weight gain of broilers were significantly influenced by dietary CP levels where those fed on higher dietary levels of CP had higher body weight. This differences as observed by several authors may be fallout of differences in breed, management and levels of protein and energy in the diet of the experimental chickens.

Results of studies by Hussein *et al*. (2001) are in good agreement with the findings of the study, who reported that the body weight gain of chicks fed on diet with low CP content was significantly lower when compared to the pullets fed on high CP diet at early ages. Similar observations were also reported by Kamran *et al*. (2008) who indicated that chickens fed on a diet containing lower CP had lower body weight gain when compared to those fed higher CP supplemented diets.

The results pertaining to FCR indicated that it improved in birds reared on T1, T2 and T3 diets, but there was no further improvement when the CP level increased from 20% CP in the diets. The results of studies by Yung *et al*. (2001), Wu *et al*. (2005) and Folorunso and Onibi (2012) too are in agreement with the observation of this study. They reported that the chickens fed varying dietary crude protein level diets had no significant effect on the FCR. Results of study by Osei and Effah-Baah (1987) too followed the same trend where Cobb-100 broiler chicks fed different dietary crude protein with iso-caloric diets had no significant effect on FCR. However, the results obtained by Pfeffer *et al*. (2000) and Shawangizaw *et al*. (2011) differed from the present study, who reported that the varying crude protein levels in diets significantly affected FCR. This difference could be due to both genetic and non genetic factors of experimental animals used.

The results as obtained in this study (from 1st to 3rd weeks of trial periods) are in accordance with findings of Nguyen and Bunchasak (2005) who fed Betong chicks with diets containing different levels of dietary crude protein and energy; and the chicks fed with lower crude protein supplementation had poorer FCR when compared to those received diets containing higher protein supplementations. The present finding indicated that in the 6th week of experimental period, Koekoeck chickens reared on a diet containing lower CP level were more efficient in FCR as compared to those raised on a diet containing higher CP level and are in good agreement with the findings of Kamran *et al*. (2008) who reported that the FCR increased linearly with the reduction in dietary CP at 6th week of age of broilers. In the 8th week of the experimental period, chickens reared on diets containing higher crude protein had significantly ($P<0.05$) better FCR which is consistent with the findings of Muhammad *et al*. (2002) who reported that the FCR at 8th week was better in those chicks fed on higher CP level when compared to those fed on lower CP diets.

Conclusion

Feed intake and growth performances of chicks were found to be variable between treatment diets with varying crude protein levels. The dry matter intake was much better in T2 compared to other treatment diets. The different crude protein level had no significant effect on final live weight and body weight gain of Koekoeck chickens. It can be thus recommended that 16% dietary crude protein is optimum for dual-purpose Koekoeck chickens reared under semi intensive management in Southern Ethiopia. Further investigation is recommended to assess the effect of different level of energy with high and low protein levels on egg production and egg quality parameters of Koekoeck chickens.

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