Optimum Dietary Crude Protein Level for Fattening Yearling Arsi-Bale Lambs

Getahun Kebede
Ruminant Livestock Research Case Team, Debre Zeit Agricultural Research Center, P.O. Box: 32; Debre Zeit, Ethiopia

Abstract: This study was aimed to determine the optimum dietary crude protein for fattening yearling Arsi-Bale sheep. Thirty-two intact male lambs (live weight=17.53±1.57 kg) were randomly assigned to five iso-caloric (2.12 Mcal/kg DM) dietary treatments(T), varying in crude protein: 9.4% CP (T1), 10.2% CP (T2), 11% CP (T3), 12% CP (T4) and 13.1% CP (T5). Intake and growth trial lasted for 87 days, followed by digestibility trial and carcass analysis. Treatments did not differ\(^{(*)} (P>0.05)\) in DM intake, ranging from 918.29 (T1) to 928.09 g DM/day (T3). Crude protein intake increased \(^{(*)} (P<0.001)\) with increase in dietary CP (T1,86.71 g/day; 120g/day -T5). Intake of fiber fractions was the highest \(^{(*)} (P<0.001)\) with 12% CP diet. Treatments varied in apparent digestibility of DM \(^{(*)} (P<0.05)\), CP \(^{(*)} (P<0.05)\), NDF \(^{(*)} (P<0.001)\) and ADF \(^{(*)} (P<0.001)\). Average final live weight, total gain and daily gain of lambs were increased non-significantly \(^{(*)} (P>0.05)\), from 22.71 to 23.96 kg; 5.37 to 6.35kg; 61.78-73.00 g/day, respectively. Feed conversion ratios were higher \(^{(*)} (P<0.001)\) in lambs fed 12%CP diet (12.61) and 13% CP diet (12.76). Urinary nitrogen and total nitrogen excretion were highest for 13% CP diet (5.02 and 9.19 g/day; \(^{(*)} (P<0.001)\)). Nitrogen balance was peaked (12.70 g/day, \(^{(*)} (P<0.001)\) with 12% CP diet. There was no significant differences \(^{(*)} (P>0.05)\) among treatments in slaughter weight, hot carcass weight, DP, fat and bone proportions. However, hot carcass weight increased from 8.8 to 9.8kg and DP from 39.4 to 42.15, as feed CP raised to 12%. The results of this study indicated that optimum dietary CP for improved growth and feed utilization of yearling Arsi-Bale lambs, growing from 17 to 25 kg is about 12% at the given feed energy. Detail work applying "comparative slaughter technique" is important to support the present findings, including for other indigenous sheep breeds.

Key words: Yearling lambs - Weight gain - Dietary protein

INTRODUCTION

Sheep production plays a crucial role in Ethiopia, majorly serving as a family food (meat) and income source from sale of live sheep. There exist 29.33 million sheep population in Ethiopia [5] that entirely raised under traditional production system- characterized by low input-output. The productivity of sheep is very low as explained by annual off-take rate of 33% and average carcass weight of 10 kg/head [7]. The productivity is hindered by feed deficit (inadequate amount and quality), low genetic potential of sheep and prevalence of disease and parasites. Sheep are raised entirely on grazing pasture and rarely supplemented with concentrates. Feed deficit is aggravated with dry season and drought occurrence, when dry roughages remain major available feed and protein is the most limiting macronutrient. Most sheep are sold to local markets at around yearling age (live weight below 20 kg) often without supplementation (body conditioning) before marketing. However, some farmers traditionally fatten their sheep before marketing, with little concentrate supplementation on top of grazing. However, there is uncertainty that the supplementation could support the nutrient requirement for maximum growth of sheep. Moreover, this system of feeding would sometimes lead to over or under utilization of available feed nutrient that may lead to its wastage and uneconomic feeding.

Feeding sheep based on their nutrient requirement at different production phases is not common practice in Ethiopia. On the other hand, most of the developed feeding standards initially based temperate wool breed sheep [18] and some tropical sheep breeds [11,17] have been used in improved sheep production systems. According to Andrew and Orskov [3], the maximum live
weight gain and nitrogen retention of temperate breed lambs on high plane of nutrition, growing from 15 to 40 kg
were achieved at 17% dietary CP. In addition, NRC [16] recommended a diet containing 14.5% CP for maximum
growth of early weaned lambs. Unlike that for temperate breeds, Kearl [11] and Paul et al. [18] recommended a
lower levels of dietary CP and energy for growing tropical sheep at different growth rates and live weights.

Although nutrient requirement tables developed for tropical sheep are believed to meet the requirements of
indigenous sheep breeds of Ethiopia, it has been accepted with uncertainties and rarely applied. This is because the
recommendations were based on estimates obtained from a specific breed, that may not necessarily represent local
sheep breeds. Also, differences in the quality of feed and utilization efficiency by animal may contribute to this
uncertainty. The differences in nutrient requirement of animals lie on breed, age, physiological status, growth
potential, feed quality and environmental factors, such as temperature, air humidity, solar radiation and wind speed
[16]. However, there is no/little information on nutrient requirements specific to indigenous sheep breeds of
Ethiopia. Therefore, this study was aimed to determine the optimum dietary crude protein for maximum growth and
feed utilization of yearling Arsi-Bale lambs in feedlot.

MATERIALS AND METHODS

Study Area: The experiment was conducted at sheep research station of Debre Zeit Agricultural Research
Centre, located at 45 km South East of Addis Ababa (08°44’N 38°58’E; average altitude of 1900 m a.s.l),
Ethiopia. The area is known for bimodal rainfall pattern with average annual rainfall of 845 mm and annual
minimum and maximum temperature of 10 and 22 °C, respectively. The area is characterized by mixed-crop-
livestock production system, with major crops grown include tef (*Eragrostis tef*), wheat, chick pea and lentil.

Treatments and Feed Composition: The diets were similar in composition, with the exception of noug seed cake and
wheat middling (diet 1) and wheat middling (diet 4) exclusion for the purpose of balancing (Table 1). Maize
grain, wheat bran, noug seed cake, wheat middling, salt and limestone constituted concentrate part that contained
14, 16, 18, 20 and 22% CP in the respective treatments, leading to differences in dietary CP (9.43% CP in T1,
10.26% CP in T2, 11.06% CP in T3; 12.06 % CP in T4 and 13.1% CP in T5). The diets were formulated to be nearly
iso-caloric (2.12 Mcal ME/Kg DM) and meet the energy requirement for growing tropical sheep [11]. The diet
containing 9.4% CP was used as negative control, while 13% CP diet was positive control. All diets were similar in
DM content, but differed in NDF, ADF and ADL.

Animals and Feeding Management: Thirty-two yearling male Arsi-Bale sheep with mean initial live weight of 17.53
±1.57 kg were purchased from local markets and treated against endo-and ecto-parasites and vaccinated for
common viral diseases. All animals were individually penned in a house with concrete floor and adapted to
indoor feeding management for two weeks, before

---

**Table 1: Feed ingredients and chemical composition (%DM).**

|       | T1    | T2    | T3    | T4    | T5    |
|-------|-------|-------|-------|-------|-------|
| Straw | Straw | Straw | Straw | Straw | Straw |
| Straw | Straw | Straw | Straw | Straw | Straw |
| Noug cake | - | 6.0 | 19.9 | 35.0 | 47.2 |
| Wheat bran | 82.3 | 80.8 | 62.9 | 49.9 | 6.0 |
| Maize grain | 15.6 | 3.0 | 7.0 | 12.9 | 16.1 |
| Wheat middling | - | 8.1 | 8.1 | - | 28.6 |
| Limestone | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Salt | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Total | 100 | 100 | 100 | 100 | 100 |

**Chemical composition (% DM):**

|       | T1    | T2    | T3    | T4    | T5    |
|-------|-------|-------|-------|-------|-------|
| DM    | 91.46 | 91.55 | 91.53 | 91.84 | 92.30 |
| CP    | 9.43  | 10.26 | 11.06 | 12.06 | 13.10 |
| Ash   | 12.25 | 12.69 | 12.91 | 10.67 | 9.71  |
| NDF   | 48.66 | 52.86 | 55.79 | 56.77 | 54.80 |
| ADF   | 26.71 | 26.43 | 28.15 | 31.65 | 29.18 |
| ADL   | 5.65  | 5.75  | 6.33  | 7.61  | 7.20  |
| ME (Mcal Kg<sup>-1</sup>) | 2.14 | 2.13 | 2.12 | 2.11 | 2.11 |

ME = Metabolizable energy; calculated according to Kearl [11]. * DM of concentrate mix. Ratio of straw to concentrate offered was 65:35, on as fed basis.
commencing the experiment. Then, they were randomly assigned to five dietary treatments in completely randomised design.

Feed was provided twice daily at 8:30 a.m and 2:00 p.m ensuring 15% refusal for each animal. The amount of straw and concentrate offered were adjusted daily based on previous day intake, where straw to concentrate ratio was 65:35, on as fed basis. Water was provided in a bucket free of choice. Feed offered and refusals were measured daily and feed intake was calculated as the difference between the two measurements. Representative feed samples were taken daily and sub-sampled every 15 days. All animals were weighed biweekly after overnight (~16 hours) deprivation of feeds and water.

At the end of the feeding period (87 days), three lambs were selected per treatment and transferred to metabolic crate with slotted floor, individually. The animals were adapted to the attached fecal bags and urine funnels for three days followed by collection of fecal and urine for seven days. All animals were with unlimited access to water. Urine was directly poured into a glass bottle containing drops of sulfuric acid to prevent ammonia loss. The amount of feces and urine produced per animal/day was measured and recorded. About 10% of the daily fecal and urine outputs were sampled per animal and stored in a deep freezer (-20 °C) until sub-sampled for laboratory analysis. Moreover, three animals were randomly selected per treatment and slaughtered for carcass analysis. The animals were slaughtered after 24 hour of feed deprivation. Measurements were taken for slaughter weight, hot carcass weight (HCW) and carcass components (bone, fat and lean, trimmings). Dressing percentage (DP) was calculated as: (HCW/SW)*100. Moreover, lean to bone ratio and lean to fat ratios of a carcass were calculated.

Sample Chemical Analysis: Feed and fecal dry matter (DM), crude protein (CP) and Ash were determined according to the procedures of AOAC [4], while neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to Van Soest et al. [22].

Statistical Analysis: Data was analyzed using the General Linear Model (GLM) procedure of SAS [19]. Treatment means of the parameters were separated using Duncan Multiple Range Test. The statistical model used for feed intake, live weight change, digestibility, feed conversion ratio, carcass parameters and nitrogen utilization was:

\[ Y_{ij} = \mu + \alpha_i + \epsilon_{ij} \]

Where, \( \mu \) = Grand mean; \( \alpha_i \) = Effect of treatment feeds; and \( \epsilon_{ij} \) = Experimental error. Data on average daily gain (ADG) for each lamb was computed by regressing the live weight incurred in two weeks interval over the number of days elapsed.

RESULTS AND DISCUSSION

Nutrient Intake and Digestibility: The effect of treatments was not significant on dry matter intake \((P>0.05)\), ranging from 918.3 (T1) to 928.1 g/day per lamb (T3). The DM intake observed in the present study is comparable with previous studies for Arsi-Bale lambs maintained on roughage and concentrate [6,8]. Studies have shown that a non-significant feed intake with sheep fed diets containing 9% to 13% CP [2], in Saanen kids fed14% to16% CP diets [20] and Korean black goats consumed 14-20% CP diet [10]. In the present study, intake of crude protein linearly increased \((P<0.001)\) with increase in dietary CP, where lambs on 13% CP diet consumed 120g CP/day. Also, intake of fiber fractions increased with increase in dietary CP, the highest value obtained with 12% CP diet. Although change in the apparent digestibility of nutrients was non-linear with change in dietary CP, there was variation in digestibility of DM \((P<0.05)\), CP \((P<0.05)\), NDF \((P<0.001)\) and ADF \((P<0.001)\). The apparent digestibility of nutrients was greater with T2 and T4 diets and lowest with T3 diet.

Live Weight Change and Feed Conversion Ratio (FCR): Although non-significant \((P>0.05)\), an improve in the average final live weight (22.71 vs. 23.96 kg), total gain (5.37 vs 6.35kg) and average daily gain (61.78 vs 73.00 g/day) were observed with increase in dietary CP. The observed changes in growth performance with higher CP diet probably resulted from increase in feed intake. In agreement with the present results, Paul et al. [18] recommended 9.7%CP to 12.1% CP) diet for tropical sheep, growing from 15 kg to 25 kg. However, improved growth performances was reported at higher (16 to 18%) than lower (10-14%) dietary crude protein for Awassi lambs [9,21] and Kivircik lambs [12]. Similarly, Hwangbo et al. [10] reported the highest gain for growing Korean black goats at higher (18%CP) than lower level of dietary CP. The present study has also shown that changes in live weights of lambs were incremental throughout feeding period (Fig 1). There was differences in FCR \((P<0.001)\): the highest FCR were observed in lambs fed
Fig. 1: Trend of body weight changes in experimental lambs

Table 2: Effect of dietary crude protein level on intake and apparent digestibility of nutrients

| Treatments | Parameter | T1  | T2  | T3  | T4  | T5  | SE  | P value |
|------------|-----------|-----|-----|-----|-----|-----|-----|---------|
|            | DM (g/day)| 920.26<sup>a</sup> | 918.29<sup>b</sup> | 928.09<sup>a</sup> | 920.33<sup>a</sup> | 922.23<sup>b</sup> | 3.17 | 0.2262  |
|            | CP        | 86.71<sup>a</sup>   | 94.13<sup>b</sup>   | 102.61<sup>c</sup> | 110.87<sup>d</sup> | 120.63<sup>e</sup> | 0.37 | <0.001  |
|            | ME        | 1.97<sup>a</sup>    | 1.95<sup>b</sup>    | 1.96<sup>c</sup>   | 1.94<sup>d</sup>   | 1.95<sup>e</sup>   | 0.01 | <0.001  |
|            | Ash       | 112.71<sup>a</sup>  | 116.61<sup>b</sup>  | 119.81<sup>c</sup> | 98.22<sup>d</sup>  | 89.51<sup>e</sup>  | 0.39 | <0.001  |
|            | NDF       | 447.81<sup>a</sup>  | 485.39<sup>b</sup>  | 517.68<sup>c</sup> | 522.41<sup>d</sup> | 505.52<sup>e</sup> | 1.74 | <0.001  |
|            | ADF       | 245.86<sup>a</sup>  | 242.83<sup>b</sup>  | 261.25<sup>c</sup> | 290.93<sup>d</sup> | 269.31<sup>e</sup> | 0.94 | <0.001  |
|            | ADL       | 52.05<sup>a</sup>   | 52.85<sup>b</sup>   | 58.72<sup>c</sup>  | 70.05<sup>d</sup>  | 66.41<sup>e</sup>  | 0.22 | <0.001  |
| Intake     | DM (%)    | 55.59<sup>a</sup>   | 61.56<sup>b</sup>   | 54.66<sup>c</sup>  | 64.30<sup>d</sup>  | 60.92<sup>e</sup>  | 2.18 | 0.0393  |
|            | CP (%)    | 59.91<sup>a</sup>   | 59.55<sup>b</sup>   | 58.55<sup>c</sup>  | 65.49<sup>d</sup>  | 66.54<sup>e</sup>  | 2.32 | 0.0477  |
|            | NDF (%)   | 64.88<sup>a</sup>   | 74.79<sup>b</sup>   | 63.00<sup>c</sup>  | 67.11<sup>d</sup>  | 60.41<sup>e</sup>  | 2.07 | <0.001  |
|            | ADF (%)   | 62.24<sup>a</sup>   | 71.75<sup>b</sup>   | 49.58<sup>c</sup>  | 66.60<sup>d</sup>  | 53.4<sup>e</sup>   | 2.65 | <0.001  |

Values with different superscripts within same row are significantly different; DM=dry matter intake; CPI=crude protein intake; Ash=ash intake; NDFI=neutral detergent fiber intake; ADFI=acid detergent fiber intake; ADLI=acid detergent intake

Table 3: Effect of dietary crude protein on live weight change and feed conversion ratio (FCR)

| Treatments | Parameter | T1(n=6) | T2(n=6) | T3(n=6) | T4(n=7) | T5(n=7) | SEM | P value |
|------------|-----------|---------|---------|---------|---------|---------|-----|---------|
|            | Initial wt, kg | 17.33   | 17.41   | 17.83   | 17.53   | 17.57   | 0.68 | 0.9886  |
|            | Final wt, kg   | 22.71   | 23.25   | 23.96   | 23.88   | 23.86   | 0.81 | 0.7814  |
|            | Total gain, kg | 5.37    | 5.83    | 6.12    | 6.35    | 6.28    | 0.70 | 0.8673  |
|            | ADG, g         | 61.78   | 67.05   | 70.40   | 73.00   | 72.25   | 8.12 | 0.8673  |
|            | FCR            | 14.90   | 13.70   | 13.18   | 12.61   | 12.76   | 0.24 | <0.001  |

Values with different superscripts within same rows are significantly different; n=number of animals; FCR=feed conversion ratio(g DMI/g gain); ADG=average daily gain

Table 4: Nitrogen utilization (g/day) in lambs fed the experimental diets

| Treatments | Parameter | T1 | T2 | T3 | T4 | T5 | SE  | P value |
|------------|-----------|----|----|----|----|----|-----|---------|
|            | NI        | 15.03<sup>a</sup> | 1.52c | 3.76 | 5.29d | 9.74d | <0.001 |<0.001  |
|            | UN        | 16.21<sup>a</sup> | 4.12ab | 4.20 | 8.32c | 7.89e | 0.68 | 0.9886  |
|            | FN        | 17.72<sup>a</sup> | 2.43c | 4.68 | 7.11c | 10.61cd | <0.001 |<0.001  |
|            | TN        | 19.57<sup>a</sup> | 3.06bc | 3.81 | 6.87dc | 12.70ab | 0.68 | 0.9886  |
|            | NB        | 21.08<sup>a</sup> | 5.02a | 4.18 | 9.19a | 11.89eb | 0.68 | 0.9886  |

Values with different superscripts within same column are significantly different; UN=urine nitrogen, g/d; FN=fecal N; NI= N intake; TN= total N excreted; NB= nitrogen balance; SEM= standard error of mean
Table 5: Effect of dietary crude protein level on carcass parameters of experimental lambs

| Parameter  | T1(n=3) | T2(n=3) | T3(n=3) | T4(n=3) | T5(n=3) | SEM  | P-value |
|------------|---------|---------|---------|---------|---------|------|---------|
| SW (kg)    | 22.50   | 23.75   | 23.83   | 23.33   | 23.83   | 1.46 | 0.9580  |
| HCW(kg)    | 8.87    | 9.07    | 9.73    | 9.80    | 9.83    | 0.63 | 0.7177  |
| DP (%)     | 39.39   | 38.21   | 40.77   | 42.15   | 41.34   | 1.60 | 0.4684  |
| Lean(kg)   | 4.95b   | 5.18b   | 5.58ab  | 5.96ab  | 5.62a   | 0.45 | 0.0148  |
| Fat(kg)    | 1.26    | 0.90    | 1.35    | 1.14    | 1.01    | 0.19 | 0.4987  |
| Bone(kg)   | 2.26    | 2.65    | 2.43    | 2.24    | 2.10    | 0.18 | 0.2980  |
| Trimming, g| 393.3a  | 339.1ab | 365.0ab | 460.3a  | 201.5b  | 56.18| 0.0794  |
| LBR        | 2.19b   | 1.98b   | 2.35b   | 2.68ab  | 3.12a   | 0.24 | 0.0524  |
| LFR        | 3.96b   | 6.05ab  | 4.41ab  | 5.47ab  | 6.89a   | 0.87 | 0.1868  |

Values with different superscripts within same row are significantly different; SW = slaughter weight; HCW= hot carcass weight; DP= dressing percent (HCW/SW*100); LBR= lean to bone ratio; LFR=lean to fat ratio; n= no. of slaughtered animals

12% CP diet (12.61 DMI/g gain) and 13% CP diet (12.76 g DMI/g gain), while the lowest (14.9) was in lambs fed 9.4% CP diet, suggesting a higher nutrient availability at given feed protein and energy contents. Previous studies by Abebe et al. [1] and Ermias [6] have indicated an improve in feed utilization and growth performances of Arsi-Bale lambs at higher than lower level of protein source concentrates.

Nitrogen Utilization: Nitrogen intake(NI), urinary nitrogen(UN) and total nitrogen excretion (TN) increased \(^{<0.001}\) with increase in dietary CP (Table 4). The highest NI(21.08), UN(5.02) and TN excretion (9.19 g/day) were observed in 13% CP diet. Treatments did not vary \(^{>0.05}\) in the level of fecal nitrogen excretion. An increase \(^{<0.001}\) in nitrogen balance (NB) was seen with increased dietary CP, being the highest (12.70 g/day) in12% CP diet. Osuagwu and Akinsoyinu [17] reported an increase in NI, UN, FN and N retention for West African dwarf goats, as the level of crude protein in the supplement increased from 5% to 25% DM. However, there was no significant difference \(^{>0.05}\) in nitrogen balance between lambs fed 12% and 13% CP diets. The result shows that the higher nitrogen balance, the better the growth performances of lambs.

Carcass Analysis: There was no real difference \(^{>0.05}\) among treatments in SW,HCW, DP, fat and bone yields (Table 5). However, the magnitude of HCW increased by about 10% (8.88 vs. 9.8kg) and that of DP increased by 6.5% (39.38 vs. 42.15kg), as feed CP increased from 9.4% to 12%. Studies have shown that DP increases as SW increases[13,15]. However, the fact that no remarkable change in DP in the present study might have resulted from the lower SW of sample animals. In this study, lean meat yield increased \(^{<0.05}\) with increase in feed CP%, where the highest value (6.52kg) was observed with 13% CP diet. Similarly, lean to bone and lean to fat ratios were highest for 13% CP diet compared to 9.4% CP diet. There was no significant change in the proportion of fat, bone and meat for Korean Black goat kept on 14% to 20% CP diet [10].

CONCLUSION

Based on the results of this experiment, the optimum dietary CP for improved performance and feed utilization of yearling Arsi-Bale lambs, growing from 17 to 25 kg, is about 12%, which synchronizes with 2.11 Mj/kg DM feed energy. However, detail studies, using "comparative slaughter techniques", is required to support the present findings. Moreover, applying the same work for other indigenous sheep breeds is equally important.

ACKNOWLEDGEMENTS

The author acknowledged Ethiopian Institute of Agricultural Research for funding this research and availing research inputs. The efforts of technical assistance-Mr Solomon Abiy and animal attendants: Mrs Workiyu Shibru; Mrs Asrat Endale and Mrs Topiya Mugiye is well appreciated. Also, a useful help given by veterinary technician- Mrs Kasech Melese is acknowledged.

REFERENCES

1. Abebe Tafa and Solomon Melaku and Kurt J. Peters, 2010. Supplementation with linseed (Linum usitatissimum) cake and/or wheat bran on feed utilization and carcass characteristics of Arsi-Bale sheep. Trop Anim Health Prod, 42: 677-685.
2. Ahn, B.H. and Y.H. Moon, 1985. Effect of dietary protein and calcium levels on nutrition in sheep I. Effect of dietary protein and calcium levels on digestibility, nitrogen balance and some mineral retention in sheep. Kor. J. Anim. Sci., 27: 507-514.

3. Andrews, R.P. and E.R. Orskov, 1970. The nutrition of early weaned lamb. I. The influence of protein concentration and feeding level on rate of gain in body weight. J. Agric. Sci.(Camb.), 75: 11-18.

4. AOAC (Association of Official Analytical Chemists), 1990. Official method of analysis. 15th ed. AOAC Inc., Arlington, Virginia, USA, pp: 12-98.

5. CSA (Central Statistic Authority) of Ethiopia, 2014. Agricultural sample survey 2014. Vol. II. Report on livestock and livestock characteristics (Private peasant holdings). pp: 194.

6. Ermias Tekletsadik, 2008. The Effect of Supplementation with barely bran, linseed meal and their mixtures on the performance of Arsi-Bale sheep fed a basal diet of faba bean haulms. MSc Thesis. Haramaya University, Ethiopia.

7. FAO (Food and Agricultural Organization of the United Nations), 2004. FAOSTAT data. http://www.fao.org/faostat/collections?subset=agriculture.

8. Getahun Kebede and Kassahun Melese, 2010. Evaluation of poultry litter as substitute of urea in urea molasses block on growth and carcass characteristics of finished lamb. Ethiopian Journal of Animal Production (EJAP), 10: 19-31.

9. Haddad, S.G., R.E. Nasr and M.M. Muwalla, 2001. Optimum dietary crude protein level for finishing Awassi lambs. Small Ruminant Research, 39: 41-46.

10. Hwangbo Soon, Sun Ho Choi, Sang Woo Kim, Dong Soo Son, Ho Sung Park, Sung Hoon Lee and Ik Hwan Jo, 2009. Effects of Crude Protein Levels in Total Mixed Rations on Growth. Performance and Meat Quality in Growing Korean Black Goats. Asian-Aust. J. Anim. Sci., 22(8): 1133-1139.

11. Kearl, L.C., 1982. Nutrient Requirements of Ruminants in Developing countries. International Feedstuffs Institute, Utah State University, Logan, Utah 84322, USA.

12. Keser, O., T. Bilal and H. Cankutay, 2008. The effect of different dietary crude protein level on performance and serum immunoglobulin g in male Kivircik lambs. Bulgarian Journal of Veterinary Medicine, 11(1): 49-54.

13. Marinova, P., Y. Banskalieva, S. Alexandrov, V. Tzvetkova and H. Stanchev, 2001. Carcass composition and meat quality of kids fed sunflower oil supplemented diet. Small Ruminant Res., 42: 217-225.

14. Mohammad Sharifi, Moslem Bashtani, Abbas Ali Naserian and Hamid Khorasani, 2013. Effect of dietary crude protein level on the performance and apparent digestibility of Iranian Saanen kids. African Journal of Biotechnology, 12(26): 4202-4205.

15. Mourad, M., G. Gbanamou and L.B. Balde, 2001. Carcass characteristics of West African dwarf goats under extensivesystem. Small Rumin. Res., 42: 81-85.

16. NRC (National Research Council), 1985. Nutrient Requirements of Sheep. Sixth Revised Edition. Washington, D.C; National Academic Press.

17. Osuagwu, A.I.A. and A.O. Akinsoyiun, 1990. Efficiency of nitrogen utilization by pregnant West African dwarf goats fed various levels of crude protein in the diet. Small Ruminant Research, 3(4): 363-371.

18. Paul, S.S., A.B. Mandal, G.P. Mandal, A. Kannan and N.N. Pathak, 2003. Deriving nutrient requirements of growing Indian sheep under tropical conditions using performance and intake data emanated from feeding trials conducted in different research institutes. Small Rumin. Res., 50: 97-107.

19. SAS (Statistical Analysis System), 2003. SAS Institute. Inc., Cary, NC, USA.

20. Sharifi Mohammad, Moslem Bashtani, Abbas Ali Naserian and Hamid Khorasani, 2013. Effect of dietary crude protein level on the performance and apparent digestibility of Iranian Saanen kids. African Journal of Biotechnology, 12(26): 4202-4205.

21. Titi, H.H., M.J. Tabbaa, M.G. Amasheh, F. Barakeh and B. Daqamseh, 2000. Comparative performance of Awassi lambs and black goat kids on different crude protein levels in Jordan. Small Ruminant Research, 37: 131-135.

22. Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.