Effect of feeding pellets prepared with different concentrate to wheat straw ratios on productive performance of Awassi lambs

Haider A. M. Al-Husseini[1] Ali A. Saeed [2] , Haitham M. Hussein [3]
haderali@uoqasim.edu.iq Draliameensaeed59@agre.uoqasim.edu.iq haitheamm@agre.uoqasim.edu.iq

, Hayder Atta Abdul-Jabbar Hasan[4] Waleed A. Abd Al-Jabbar[5]
hayder-a.b@uowasit.edu.iq waleedatta.irq@gmail.com

Abstract

This study was carried out to investigate the effect of feeding different ratios of concentrate: wheat straw (C: R) on productive performance of Awassi lambs. Five pellets of total mixed diets containing concentrate and wheat straw at 30:70, 40:60, 50:50, 60:40 and 70:30 ratios were prepared and offered to lambs ad libitum. Twenty Awassi male lambs at 4-6 months of age, with average initial body weight of about 25 kg were used. Lambs were randomly allotted on those five pellet diets. Results showed that lambs fed pellets prepared with C: R ratios of 70:30 and 60:40 gained higher (P<0.05) final weight (39.34 and 39.04 kg) as compared with lambs fed pellets prepared with C: R ratio of 30:70 (35.51 kg). But, the significant (P<0.01) superiority of lambs fed higher C: R ratios in average total (TG) and daily gains (ADG) was extended to include lambs fed pellets prepared with 50:50, 40:60 and 30:70 of C: R ratios. Despite the significant response of lambs to increasing C: R ratio on growth data, they responded mathematically in term of the feed conversion ratio (FCR) calculated on the basis of total or even digestible dry matter and organic matter intakes.

Key words : Awassi , lambs , pallet , concentrate: wheat straw (C: R)

Introduction

It is now well established that the highest economic cost in livestock production projects is attributed to feeding, as it constitutes approximately 80% of the total cost [21]. To reduce this cost, roughages characterized by their lower prices and local availability should be utilized at levels that do not adversely affect the productive performance of animals, thereby compensating for the high cost of concentrate feeds. Moreover, cereals represent one of the primary food sources for humans [2]. Therefore, a total mixed ration (TMR) feeding system may represent a fully appropriate solution to bridge the gap in animals' nutritional requirements [1]. According to the National Research Council [16], growing lambs require diets rich in protein and energy to achieve optimal weight gain.

The quality and quantity of feed are the main factors affecting the productivity of ruminant animals, particularly under hot environmental

ISSN 2072-3857

conditions. Consequently, concentrate feeds are incorporated into rations to increase dietary energy density, which can improve feed utilization efficiency, enhance performance, and promote growth and productivity [26]. However, long-term feeding of diets high in concentrates may lead to digestive disorders due to the accumulation of volatile fatty acids and lactic acid in the rumen, resulting in decreased ruminal pH [7]. [18] indicated the role of roughage in TMR in improving rumen fermentation and digestion, as well as enhancing final body weight (FW) and ADG in lambs [25]. Furthermore, the inclusion of roughage together with concentrates contributes to reduce the cost of production per unit of output, since concentrate feeds are consistently more expensive than roughages [10].

The aim of this study

is to evaluate the effect of feeding Awassi lambs pelleted rations with different concentrate-to-wheat straw ratios on their productive performance. It also aims to determine the optimal concentrate :rough ratio for improving growth and feed conversion efficiency while minimizing feeding costs.

Materials and Methods

Preparation of pellets

The concentrate diet was prepared first by mixing local available ingredients at specific proportion for each based on their chemical composition, together with 0.5% of urea to ensure the required CP content of about 13-14% and the ideal ratio of 1.34 g rumen degradable nitrogen (RDN)/ MJ of metabolisable energy (ME). The wheat straw, which served as the roughage source in the mixed rations, was crushed and ground. Proportion and chemical composition of concentrate diet ingredients and wheat straw are shown table 1. The concentrate diet and ground straw were then transported to the Al-Baraka Feed Mill, where both were mixed together as TMR according to the specified ratios for each treatment. The TMR was then pressed into 6.5 mm diameter pellets using steam as a binder. Chemical composition of TMR pellets diets is shown Table 2.

ISSN 2072-3857

Table 1- Chemical composition* of ingredients of concentrate diets and wheat straw (%)

Ingredients	DM	% of DM					ME
		OM	CP	CF	EE	NFE	
Barley	96.10	96.66	9.38	5.22	2.92	79.14	1.34
Wheat bran	96.20	95.18	13	9.74	4.64	67.8	1.30
Yellow corn	95	98.96	7.77	1.95	4.83	84.41	1.43
Soybean meal, SBM	96.53	92.81	44.81	5.03	1.86	41.11	1.20
Urea**	-	-	287.5	-	-	-	-
Wheat straw	97.49	91.03	2.58	34.75	2.18	51.52	0.95

*Chemical analysis was performed according to the [4] ; ** 46% nitrogen × 6.25 ME values were estimated according to [13] , with subsequent conversion from MJ/kg DM to MJ/100 g DM in accordance with chemical composition based on percentage determinations: ME (MJ/ kg DM) = 0.012 CP +0.031 EE+0.005 CF +0.014 NFE**.**

Vitamins & minerals and NaCl were added at 1% each.

Experimental animals

Twenty male Awassi lambs at 4-6 months of age and average initial weight of approximately 25 kg were used in this study. Veterinary examinations were conducted to ensure that the lambs were healthy and free from disease. The lambs were then randomly divided into five equal treatments of four lambs each. They were placed in individual pens, equipped with containers for experimental feeds and water, minerals cubes were also suspended close to each lamb. The animals were gradually accustomed to their assigned feeds during a 14-day preliminary period, after which, lambs were weighed again and subjected for ten weeks feeding trial to determine the weight gain and feed conversion ratio (FCR).

, the experiment was conducted in the Al-Siyahi area of Babylon Governorate. For the period from 13/6 to 25/9/ 2025

Table 2- Chemical composition of TMR pellets diets (%)

C: R ratios in pellet diets & treatments		DM	% of DM					ME
			OM	CP	CF	EE	NFE	
T_1	30:70	94.38	89.58	5.90	27.10	2.93	53.65	1.09
T_2	40:60	93.97	90.39	6.78	24.26	3.56	55.79	1.12
T_3	50:50	93.79	90.59	7.59	21.36	5.12	56.52	1.17
T_4	60:40	93.47	92.24	8.03	18.15	5.74	60.32	1.22
T_5	70:30	93.36	92.38	9.31	15.17	6.1	61.8	1.24

Chemical analysis was performed and ME values were estimated as shown in Table 1.

ISSN 2072-3857

analysis to determine the intake of digestible nutrients. The data were statistically analyzed as complete randomized design (CRD) using Statistical Analysis System [23].

Worth mentioning that for the discussion purpose, the intake of concentrate was calculated based on its respective proportions in the five treatments. Where, the concentrate intake equals the TDMI multiplied by 30, 40, 50, 60, and 70%, respectively. The intakes of concentrate across these treatments were then expressed as a percentage of body weight (BW), which represents the average initial and final weight of each lamb. The concentrate intakes of DM as % of BW across the five treatments were increased progressively to approximately 1.5, 2, 2.5, 3 and 3.5%, respectively.

Feed pellets were provided to each animal freely, twice a day, half the expected intake was offered at 8:00 AM and the other half at 4:00 PM, to ensure free feeding and minimize waste as much as possible at the same time. The feed remained from the previous day was weighed for each animal before offering the new feed to calculate daily feed intake. The lambs were weighed at 7:30 AM before feeding at the end of each week.

At the last week of the study, all lambs were being well adapted to the individual feeding condition. The feces excreted by lambs were collected using handmade bags that are appropriately designed to prevent mixing with urine without impeding the animal's movement. The collected feces were weighed precisely and representative subsamples were taken for chemical

Result and Discussion

Effect of C: R ratio on gain and feed conversion ratio

experimental animals prior to the initiation of the trial, as they were classified according to their live weights into groups of four animals each. Then they were randomly allocated to the experimental units to ensure that their performance would not be influenced by differences in body weight.

the effect of the C: R ratio on Weight gain parameters as affected by feeding pellets containing different C: R ratio were shown in Table 3. As planned, the statistical analysis indicated that increasing the proportion of concentrate to straw in the pellets had no significant effect on the initial weight (IW) of Awassi lambs. This can be attributed to the similarity in live body weights of the

ISSN 2072-3857

Table 3- Effect of C: R ratio on growth performance (mean ± SE)

Growth data	C: R ratio, %					*P*
	30:70	40:60	50:50	60:40	70:30	
Initial weight (IW), kg	26.35 ± 0.63	26.75 ± 1.54	26.80 ± 1.82	27.10 ± 1.27	27.07 ± 0.60	NS
Final weight (FW), kg	35.51^{b} ± 0.69	37.37^{ab} ± 1.45	37.75^{ab} ± 1.36	39.02^{a} ± 1.02	39.34^{a} ± 0.68	*
Total gain (TG) , kg	9.16^{c} ± 0.09	10.62^{b} ± 0.28	10.95^{b} ± 0.48	11.92^{a} ± 0.31	12.26^{a} ± 0.18	**
Average daily gain (ADG), g/day	130.93^{c} ± 1.32	151.82^{b} ± 4.11	156.42^{b} ± 6.89	170.28^{a} ± 4.54	175.21^{a} ± 2.71	**

Means with different letters horizontally differ significantly at the level of * (P<0.05) or **
(P<0.01)

proportion relative to body weight from 1.99% to 3% led to an increase of 1.65 kg in FW. [24] observed a 2.7 kg increase in FW when dietary concentrate level increased from 2.5% to 3.5% BW. The improvement in FW with increasing concentrate proportion may be attributed to enhanced nutrient supply to rumen microorganisms. [24] attributed such improvement to increased availability of energy and protein to rumen microbes. Likewise,. [20] stated that energy-rich diets promote microbial proliferation and increase microbial populations, thereby enhancing the supply of microbial protein and energy to the host animal.

Regarding TG, results showed that lambs fed pellets in the 4th and 5th treatments (60:40 and 70:30, C: R ratios, respectively) recorded significantly higher (P<0.01) values compared with the other treatments.

Despite the absence of significant differences in the FW of lambs fed pellets containing C: R ratios of 40:60, 50:50, 60:40, and 70:30, statistical analysis revealed that those fed pellets containing C: R ratios of 60:40 and 70:30 exhibited significantly higher (P<0.05) FW compared with those fed pellets containing C: R at 30:70 ratio, with differences of 3.51 and 3.83 kg, respectively. These findings are consistent with results reported in lambs study [28].

The differences in FW recorded in the current study for lambs fed pellets containing C: R at 40:60 and 50:50 ratios compared with those fed 30:70 ratio were 1.86 and 2.24 kg, respectively. [11] reported that increasing the proportion of concentrate in diets offered to lambs from 2% to 3% BW resulted in a 2.7 kg increase in FW. In the current study, increasing the concentrate in the 5^{th} treatment. Moreover, lambs in the 2^{nd} and 3^{rd} treatments (40:60 and 50:50, C: R ratios) also exhibited higher (P<0.01) ADG compared with those in the 1^{st} treatment (30:70, C: R ratio), with differences of 20.89 and 25.49 g/day, respectively. The significant improvement in ADG observed in the current study aligns with results reported by [9] and [17].

As with TG, the enhancement in ADG being a direct indicator of body growth resulting from increased concentrate proportion may be attributed to stimulation of rumen microbial activity. [27] reported that feeding concentrate rich pellets with low straw inclusion improved nutrient digestibility, nitrogen retention, and microbial protein synthesis, which positively reflected on final weight gain rates in animals.

It is worth mentioning that although numerous studies agree on the general trend of improved growth performance in ruminants with increasing dietary concentrate levels, the magnitude of improvement is not uniform. Such variation may be related to factors including animal breed, age, initial body weight, and managerial conditions [15].

Additionally, lambs in the 2^{nd} and 3^{rd} treatments (40:60 and 50:50, C: R ratios, respectively) exhibited significantly higher (P<0.05) TG than that achieved by lambs in the 1^{st} treatment (30:70, C:R ratio). The TG means across the five treatments were, 9.16, 10.62, 10.95, 11.92, and 12.26 kg, respectively. These results are in agreement with findings reported in studies on sheep[5,19].

The response of lambs in the current study to increasing concentrate proportion in the pellets can be explained by improvements in the rumen fermentation patterns and enhanced utilization of dietary energy. According to. [14], feeding grain-rich diets such as barley to sheep and cattle improves growth rates by reducing methane production, increasing propionate production, decreasing energy losses, and enhancing overall utilization efficiency of dietary energy toward body weight gain.

Statistical analysis further showed that lambs fed pellets containing C: R ratios of 60:40 and 70:30 (4^{th} and 5^{th} treatments) achieved higher (P<0.01) ADG compared with those in the 1^{st}, 2^{nd} and 3^{rd} treatments. The differences were 39.35, 18.46, and 13.86 g/day, respectively, for lambs in the 4^{th} treatment, and 18.70, 23.82, and 44.19 g/day, respectively, for lambs

Feed conversion ratio (FCR)

The effect of feeding pellets differed in concentrate to straw ratio on FCR is shown in table 4. The results indicated no significant effect on FCR calculated on the basis of TDMI, despite a mathematical

ISSN 2072-3857

TDMI/ g ADG as a result of increasing the C: R ratio in the diet offered to lambs from 30:70 in the 1st treatment, where the concentrate constituted about 1.5% BW, to 50:50 in the 3rd treatment, where concentrate proportions reached to about 2.5% of BW.

improvement from 11.32 to 10.54, 10.27, 9.74, and 9.41 g TDMI/ g ADG with increasing C: R ratios. Similar findings have been reported in many studies conducted on lambs [28, 12, 5]. In the current study, a comparable improvement was recorded, with FCR was slightly decreased from 11.32 to 10.27 g

Table 3- Effect of concentrate to roughage ratio on feed conversion data (mean ± SE)

Food conversion data g intake/ g ADG	Concentrate to roughage ratio, %					*P*
	30:70	40:60	50:50	60:40	70:30	
Total DMI / ADG	11.32 0.19±	10.54 0.64±	10.27 0.95±	9.74 0.52±	9.41 0.33±	NS
TDDMI / ADG	7.76 0.25±	7.68 0.53±	7.57 0.78±	7.61 0.48±	7.33 0.20±	NS
TOMI / ADG	10.14 0.17±	9.53 0.58±	9.30 0.86±	8.98 0.48±	8.70 0.30±	NS
TDOMI / ADG	7.02 0.22±	7.03 0.48±	6.96 0.71±	7.12 0.43±	6.89 0.18±	NS

TDMI, total dry matter intake; TDDMI, total digestible DMI; TOMI, total organic matter intake; TDOMI, total digestible OMI.

R ratios on FCR calculated on basis of TDMI, with a clear numerical trend toward such improvement as the concentrate proportion was increased at the expense of straw. Values of FCR were lower when calculated on basis of TDMI (7.76, 7.68, 7.57, 7.61 and 7.33) and TDOMI (7.02, 7.03, 6.96, 7.12, and 6.89) compared with those calculated on basis of TDMI (11.32, 10.54, 10.27, 9.74, and 9.41) and TOMI (10.14, 9.53, 9.30, 8.98, 8.70) for diets with C: R ratios of 30:70, 40:60, 50:50, 60:40 and 70:30,

The improvement in FCR achieved by lambs fed pellets containing progressively higher proportions of concentrate may be associated with enhanced total tract digestibility of the diet. [8] reported that increasing the grain proportion in the diet improves digestibility due to lower crude fiber content, which can positively affect feed conversion efficiency.

The FCR calculated on basis of TOMI, TDDMI and TDOMI followed a similar pattern, though insignificant effect of increasing C:

ISSN 2072-3857

lambs different C: R ratios solely based on this economic criterion is insufficient, despite its importance. The overall profitability of a production system should consider the best possible animal performance at the lowest cost.

respectively. This can be explained by the decrease in the mean TDDMI and TDOMI (the numerator in FCR calculations) while the denominator (mean ADG) remained constant.

Worth mentioning that evaluating the efficiency of feeding

Conclusions:

1

. Increasing the proportion of concentrate in the prepared pellets improved nutrient digestibility and increased energy and protein utilization.

2. Energy- and protein-rich grains enhanced rumen microbial activity, leading to increased microbial protein production and available energy for the animal.

3. Hay-rich rations reduced overall digestibility compared to pellets with a higher concentrate content.

4. Optimal use of concentrate and hay mixtures (especially 60:40 and 70:30) resulted in good digestibility and improved animal growth.

References

[1]
Abdelrahman, M. M., I. Alhidary, A. H. Alyemni, R. U. Khan, A. R. S. Bello, M. Y. Al-Saiady and R. A. Amran (2017a). Effect of alfalfa hay on rumen fermentation patterns and serum biochemical profile of growing Naemi lambs with ad libitum access to total mixed rations. Pakistan J. Zoology, 49 (4): 1519-1522.

[2] Al-Jobbery, H. R. A. and A. I. Noaman (2021). Effect of drench with flaxseed oil with different ratio of concentrate to roughage on economic efficiency and some growth characteristics of Iraqi Awassi lambs. J. Genetic Environ. Res. Cons., 9 (3):138-142.

[3] Al-Jobbery, H. R. A. and A. I. Noaman (2021). Effect of drench with flaxseed oil with different ratio of concentrate to roughage on economic efficiency and some growth characteristics of Iraqi Awassi lambs. J. Genetic Environ. Res. Cons., 9 (3):138-142.

[4] AOAC (2005). Official methods of analysis, Association of Official Analytical Chemists, Washington, D.C.

[5] Al-Shemary, H. F. H. and A. A. Saeed (2020). Effect of level of concentrate feeding and addition of monensin on rumen fermentation characteristics in Awassi lambs. Euphrates J. Agric. Sci.,12 (1): 164-174.

[6] Can, A., N. Denek and M. Şeker (2008). Effect of harsh environmental conditions on nutrient utilization and blood parameters of Awassi sheep and Kilis goat fed different levels of concentrate feed. J. Appl. Anim. Res., 33 (1): 39-43.

[7] Chen, Y., M. Oba and L. L. Guan (2012). Variation of bacterial communities and expression of toll-like receptor genes in the rumen of steers differing in susceptibility to subacute ruminal acidosis. Vet. Microbiology, 159 (3-4): 451-459.

[8] Denek, N., A. Can, S. Tufenk, K. Yazgan, H. Ipek and M. Iriadam (2006). The effect of heat load on nutrient utilization and blood parameters of Awassi ram lambs fed different types and levels of forages. Small. Rumi. Res., 63 (1-2): 156-161.

[9] Gizachew, A. (2012). Comparative feedlot performance of Washera and Horro sheep fed different roughage to concentrate ratio. PhD Thesis, Haramaya University.

[10] González, L. A., X. Manteca, S. Calsamiglia, K. S. Schwartzkopf-Genswein and A. Ferret (2012). Ruminal acidosis in feedlot cattle: Interplay between feed ingredients, Rumen Function and feeding behavior (A review). Anim. Feed Sci. Technol., 172 (1-2): 66–79.

[11] Hein, D. C. (2009). The effect of intake level of a soy hull diet on digestibility in ram lambs and mature non-lactating ewes. MSc. Thesis.
Cornell University, USA.

[12] the effect of different ratios of forage to concentrate on performance and carcass traits of Zel fattening lambs. DOI: https://doi.org/10.21203/rs.3.rs-575001/v1

[13] MAFF (1975). Ministry of Agriculture, Fisheries and Food Department, ofAgriculture and fisheries of Scotland. Energy allowances and feed systems for ruminants. Technical Bulletin, 33.

[14] McDonald, P., R. A. Edward, J. F. Greenhalgh, C. A. Morgan, L. A.Sinclair, R. G. Wilkinson (2010). Animal Nutrition. 7th edition. (Prentice Hall: Pearson, UK)

[15] Nair, P. V., A. K. Verma, R. S. Dass and U. R. Mehra (2004). Growth and nutrient utilization in buffalo calves fed ammoniated wheat straw supplemented with sodium sulphate. Asian-Australasian J. Anim. Sci., 17 (3): 325-329.

ISSN 2072-3857

[16] NRC (2007). Nutrient requirements of small ruminants: Sheep, goats, cervids, and new world camelids. Natl. Acad. Press, Washington, DC.

[17] Parente, H. N., M. D. O. M. Parente, R. M. D. S. Gomes, W. D. J. D. S. Sodré, M. A. Moreira Filho, R. C. Rodrigues and J. D. S. Araújo (2016). Increasing levels of concentrate digestibility, performance and ingestive behavior in lambs. Revista Brasileira de saúde e produção Anim., 17 (2): 186-194.

[18] Phesatcha, K., B. Phesatcha, M. Wanapat and A. Cherdthong (2020). Roughage to concentrate ratio and Saccharomyces cerevisiae inclusion could modulate feed digestion and in vitro ruminal fermentation. Vet. Sci., 7 (4):151-164.

[19] Sadq, S. M. (2018). A comparison study between barley and concentrate feeding on the growth and digestibility of Karadi male lambs. J. Zankoy Sulaimani (Special Issue): 663-671.

[20] Safari, J. G., D. E. Mushi, L. A. Mtenga, G. C. Kifaro and L. O. Eik (2011). Growth, carcass yield and meat quality attributes of red Maasai sheep fed wheat straw-based diets, Trop. Anim. Health Prod., 43 (1): 89-97.

[21] Sakab, A. M. and Mohammed, Rafid Fattah (2017). Financial evaluation of lamb breeding projects in Dhi Qar Governorate. Al-Kut J. Economic Sci., 25 (1): 146-152.

[22] Sakab, Anwar Mohsen and Mohammed, Rafid Fattah (2017). Financial evaluation of lamb breeding projects in Dhi Qar Governorate. Al-Kut Journal of Economic Sciences, 25 (1): 146-152.

[23] SAS (2010). SAS/STAT User´s Guide for Personal Computers. Release 6.08. SAS Inst. Inc. Carg, No. USA

[24] Shirima, E. J., L. A. Mtenga, A. E. Kimambo, G. H. Laswai, D. M. Mgheni, D. E. Mushi and J. G. Safari (2014). Influence of age at entry and level of concentrate feeding on growth and carcass characteristics of feedlot-finished Tanzanian long-fat-tailed sheep. Trop. Anim. Health Prod., 46(5): 815-822.

[25] Silva Moura, C. M., G. G. L. Araújo, B. Y. S. Oliveira, J. A. G. Azevêdo, E. C. Pimenta Filho, P. S. Azevedo and E. M. Santos (2019). Different roughage: concentrate ratios and water supplies to feedlot lambs: carcass characteristics and meat chemical composition. The J. Agric. Sci., 157(7-8): 643-649.

[26] Tripathi, M. K., O. H. Chaturvedi, S. A. Karim, V. K. Singh and S. L. Sisodiya (2007). Effect of different levels of concentrate allowances on rumen fluid pH, nutrient digestion, nitrogen

retention and growth performance of weaner lambs. Small Rumin. Res., 72 (2-3): 178-186.

[27] Van Ackeren, C., H. Steingaß, K. Hartung, R. Funk and W. Drochner (2009). Effect of roughage level in a total mixed ration on feed intake, ruminal fermentation patterns and chewing activity of early-weaned calves with ad libitum access to grass hay. Anim. Feed Sci. Tech., 153(1-2): 48-59.

[28] Zhang, J., K. Shi, Y. Wang, S. Li, H. Zhang, Z. Cao and K. Yang (2017c). Effects of limit-feeding diets with different forage- to- concentrate ratios on nutrient intake, rumination, ruminal fermentation, digestibility, blood parameters and growth in Holstein heifers. Anim. Sci. J., 89 (3): 527-536.

ISSN 2072-3857