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Impact of Completed Feed System on Feed Digestibility and Some Blood Biochemical Parameters of Goat Bucks

M. H. Kadhim[1] Jamal A.T. Al-Ani [2] Salam S. Ibrahim[3]
[1.2] Department of Animal Production / College of Agricultural Engineering Sciences / University of Baghdad
[3] Office of Agricultural Research/ Ministry of Agriculture

ABSTRACT

The study looks at the effect of an *ad libitum* complete feed system on feed intake, digestibility, and blood biochemical parameters in goat bucks. There are two experiments with Two roughage-to-concentrate ratios (70:30 and 50:50), each with varying acetate levels (0%, 2%, 3%). The rations involved treated and untreated roughage sources like palm fronds and wheat straw. The first experiment had four treatments (T1,T2,T3 and T4) with the 70:30 ratio and acetate levels. The second experiment used fimilar number of bucks but with a 50:50 ratio, resulting in (T5,T6,T7 and T8) . The design was a 2x4 factorial, completely randomized. The results showed that the 50:50 ratio with urea-treated roughage and 2% acetate (T6, T7) performed best, The dry matter intake in the T6 treatment increased to 1,215 g/day. Similarly, the organic matter intake reached an average of 1,104 g/day, while crude protein consumption was 171 g/day. Ether extract intake amounted to 44 g/day, and crude fiber consumption reached 297 g/day. Additionally, the nitrogen-free extract intake increased to 591 g/day, whereas the metabolizable energy intake averaged 13.18 g/day, improving intake, digestibility, TDN, and blood parameters. The conclusion is that 50% urea-treated roughage with 50% concentrate and 2% acetate enhances feed intake and digestibility, mitigates ammonia issues from urea, and improves rumen efficiency.

Key words: Acetate, Completed feed, Goats, Roughage to concentrate ratio, Urea.

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INTRODUCTION

Feed availability plays a major role in farming systems. Therefore, extensive use of agricultural and industrial byproducts for ruminant feeding is indispensable and important to meet nutritional requirements and maintain environmental sustainability to prevent environmental pollution (Marcos et al., 2020). Selecting concentrate feed rather than roughage, in addition to the inability to provide concentrated feed freely, is preferable to providing complete feed to overcome these problems. Completed feed provides a balanced feed consisting of all nutrients from concentrate and roughage feeds together without separation choice or selection. Cherkashina et al. (2021) stated that completed feed provides necessary elements that enhance an animal's health, reproduction, and performance; this system increases intake (National Research Council [NRC], 2012; Sharma et al., 2006), avoids excluding unpalatable parts of the feed, reduces eating time, rumination, and required energy for digestion and metabolism processes (Afzal et al., 2009; Chaturvedi et al., 2009), controls feed intake, reduces the loss of feeds and feeding costs (Kraidees, 2005; Ministry of Agriculture, Fisheries and Food [MAFF], 1975), and improves and increases the use of agricultural and industrial byproducts and bulky feeds in completed feed (Haloi et al., 2021). Increasing roughage feeding or using 3% concentrate, improving nutrients

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digestibility, feed efficiency and production (Voltolini et al., 2010), completely safe (Defar & Urgie, 2017; Tawfeeq & Al-Attar, 2014), and increases feed intake (Konka et al., 2016). This approach holds broad applicability in ruminant nutrition. Therefore, the present study aimed to investigate the effects of ad libitum complete feed supplemented with or without acetic acid on feed intake, nutrient digestibility, and key blood biochemical parameters in goats.

MATERIALS AND METHODS

Chemical treatment and experimental feeds : Crushed wheat straw or palm fronds were treated with urea to prepare 3.3% nitrogen at air temperature (30 °C) and a humidity of 60%. Dissolve 7.17% urea with water to prepare urea solution, adding 60L / 100 kg DM of wheat straw or palm fronds, depending on the dry matter; if roughage has 90% DM, 50L urea solution was added for 90% DM of roughage, which is equivalent to 60% humidity, for 30 days of incubation period. Put the wheat straw or palm fronds on clean nylon and spray prepared urea solution with manual mixing until homogeneity, then wrapped tightly to ensure the ammonia gas that liberated from the decomposed urea does not escape. After 30 days, the nylon was opened and mixed it for drying and volatilization of the remaining ammonia gases, then sampled it for chemical analysis (Table 1) as Association of Official Analytical Chemists [AOAC] (2012) and collect it in bags until it is used. Eight treatments of two levels of roughage: concentrate ratios and acetate (0, 2 and 3%): 70% roughage + 30% concentrate, 70% roughage treated with urea + 30% concentrate, 70% roughage treated with urea + 30% concentrate and 2% acetate, and 70% roughage treated with urea + 30% concentrate and 3% acetate (T1, T2, T3 and T4) and 50% roughage + 50% concentrate, 50% roughage treated with urea + 50% concentrate, 50% roughage treated with urea + 50% concentrate and 2% acetate, and 50% roughage treated with urea + 50% concentrate and 3% acetate (T5, T6, T7 and T8) were used. Acetic acid (2%, and 3%) were prepared (weight: weight) and mixed until homogeneous with the completed feed.

Management of experimental animals

Twenty local goat bucks aged 8-9 months, weighing 20.650 ± 1.52kg, were used in two experiments to study the effect of ad libitum feeding of completed feed on digestibility and biochemical parameters of goats. Individual pens were used with clean water, and ad libitum was used to complete the feed. All animals were given vaccines, preventing foot-and-mouth disease and Co-Baghdad disease, as well as protecting against parasites and administering Ivermectin vaccine to animals under veterinary supervision. Daily residual feeds were recorded to calculate feed intake for 60 days of the experiment, preceded by 7 days as an adaptation period. Daily feeds were collected and weighed for five days to determine the digestibility of nutrients; 5 ml of jugular blood was sampled before morning feeding at the end of each experiment.

Statistical analysis

All data were statistically analyzed using a completely randomized design (CRD), factorial experiment 2 × 4. One-way ANOVA analysis was performed using the statistical program SAS Institute (2012), while Duncan (1955) multiple range test was used to determine the significant differences ($P<0.05$) and ($P<0.01$) among treatments using the following statistical model:

$Y_{ijk} = \mu + A_i + B_j + AB_{(ij)} + e_{ijk}$

mu: Overall mean.

A_i: Effect of roughage: concentrate ratio.

B_j: Effect of treatment with urea and acid.

$AB_{(ij)}$: The interaction-roughage to concentrate ratio and treatment

e_{ijk}: Random error

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Table1. Formulation and chemical composition of completed feeds, wheat straw, and palm fronds on a DM basis (%).

Ingredients %	T1	T2	T3	T4	T5	T6	T7	T8	WS	PF	TWS	TPF
Wheat straw (WS)	35	35	35	35	25	25	25	25				
Palm fronds (PF)	35	35	35	35	25	25	25	25				
Soya bean meal (SBM)	10	10	10	10	10	10	10	10				
Wheat bran (WB)	18	18	18	18	38	38	38	38				
Minerals & Vitamins	2	2	2	2	2	2	2	2				
Dry matter (DM)	89.51	88.45	77.54	76.71	87.12	88.91	84.41	83.37	91.75	90.31	88.32	88.47
Organic matter (OM)	90.79	90.68	90.76	90.51	89.85	90.89	89.52	89.24	91.49	91.57	89.77	90.95
Crude protein (CP)	10.09	12.34	12.34	12.34	12.46	14.07	14.07	14.07	3.93	3.93	6.65	7.65
Ether extract (EE)	2.78	3.15	3.15	3.15	3.37	3.64	3.64	3.64	1.02	2.51	1.85	2.74
Crude fiber (CF)	31.3	27.22	28.12	26.33	30.92	24.51	24.03	24.92	35.85	30.42	38.41	30.61
Nitrogen-free extract (NFE)	46.62	47.97	47.15	48.69	43.10	48.67	47.78	46.61	50.69	54.71	42.86	49.95
Inorganic matter (ash)	9.21	9.32	9.24	9.49	10.15	9.11	10.48	10.76	8.51	8.43	10.23	9.05
*ME (MJ/kg DM)	10.16	10.53	10.46	10.59	10.12	10.86	10.71	10.59	9.67	10.43	9.29	10.29

WS= wheat straw , PF= palm fronds , TWS = Treated wheat straw with urea, TPF = Treated palm fronds with urea, * ME = Metabolic energy (MJ/kg DM) = 0.012 × crude protein + 0.031 × ether extract + 0.005 × crude fiber + 0.014 × nitrogen-free extract…(28).

RESULTS AND DISCUSSION

Effect of completed feed on daily intake: The effect of roughage to concentrate ratio indicated an increase ($P < 0.01$) of completed feed intake for a 50:50 ratio of dry matter, organic matter, crude protein, ether extract, ash, nitrogen-free extract, and metabolizable energy (Table 2), while a significant increase P < 0.05) was found for crude fiber intake. Increasing the ratio of concentrate led to more rumen nutrients; it increased the stability of rumen fermentation and digestibility with *ad libitum* feeding. At the same time, roughage needs more rumen digestibility, leading to mechanical satiety (rumen fullness) and low feed intake. Nagi et al. (2012) stated the superiority ($P < 0.01$) of dry matter intake and crude protein for the roughage: concentrate ratio 50:50% completed feed in contrast with a separate feeding system, or 35:65% and 20:80% with buffaloes (Wang et al., 2023). No differences were shown for urea and acetate treatments on the intake of dry matter, nutrients, and metabolizable energy. Alves et al. (2011) revealed no increase in wheat straw intake after being treated with urea, whereas Mudgal et al. (2014) indicated an increase ($P < 0.01$) in dry matter intake using lentil byproduct treated with 4% urea for goat completed feeding. Similarly, Elkholy et al. (2009) found an improvement in dry matter intake for corn cobs treated with urea and molasses. Crude protein intake increased ($P < 0.05$) after treating wheat straw or palm fronds with urea compared with untreated groups. This is due to the improvement of nutritional value by the breakdown of lignocellulosic bonds and a decrease in crude fiber, as well as an increase in the crude protein content (Tawfeeq & Al-Attar, 2014) as a non-protein nitrogen source (Abera et al., 2016; Lailer et al., 2005). Treating hay with urea also led to an increase ($P < 0.05$) in crude protein intake (Resol et al., 2020).The interaction among treatments showed the superiority ($P < 0.01$) of T6 and T7 (50:50) compared to T1 (70:30) for most studied traits. Adapting *ad libitum* feeding for completed feed and treating with urea is a major reason for increasing ($P < 0.01$) daily feed intake and avoiding the exclusion of unpalatable parts of roughage. Datt et al. (2011) and Mudgal et al. (2014) reported an increase in the intake of dry matter (DM) and most nutrients for different ruminant species fed completed feeds.The results showed a non-significant higher crude fiber intake for all treatments compared to the control (T1). Fiber stimulates the growth of beneficial microbes in the rumen, enhancing digestion and fermentation processes. It facilitates the movement of food through the digestive system and prevents issues such as bloating or constipation. In a field experiment conducted by Simonov et al. (2015) to study the

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exclusion of roughage from the diet of weaned lambs, a decrease in daily feed intake and an accumulation of internal fat in the carcass were observed, which affected carcass characteristics. This indicates an improvement in the nutritional value of the treatments, alongside an enhanced rumen environment and better feed efficiency

Table 2. Effect of *ad libitum* completed feed, treated with urea and acetate on daily intake(gm/day); Mean ± SES

Tretment	DM	OM	CP	EE	CF	Ash	NFE	ME*
The main effect of roughage: concentrate ratio								
R: C- 70:30	755.16 ± 54.44 B	684.74± 49.33 B	89.45± 7.16 B	23.16± 1.77 B	212.32± 15.05 B	70.37± 5.11 B	367.34± 28.38 B	7.88± 0.57 B
R: C- 50:50	1074.20± 71.31 A	967.03± 65.02 A	146.42± 10.39 A	38.30± 2.63 A	281.84± 20.02 A	107.16± 6.73 A	500.46± 36.01 A	11.35± 0.78 A
Significance level	P<0.01	P<0.01	P<0.01	P<0.01	P<0.05	P<0.01	P<0.01	P<0.01
The main effect of treated with urea and acid								
Without treatment	820.66 ± 135.91	740.49 ± 121.73	94.38 ± 18.32 B	25.69 ± 4.91	255.01± 41.86	80.17 ± 14.27	365.39 ± 57.35	8.31 ± 1.37
Treatment with Urea	1013.50 ± 107.56	920.31 ± 98.01	135.57 ± 17.41 A	34.89 ± 4.56	259.41 ± 23.43	93.17 ± 9.55	490.42 ± 53.20	10.86 ± 1.20
Treatment with Urea, 2% acetate	899 ± 96.87	810.49 ± 85.03	118.51 ± 16.17 AB	30.45 ± 4.25	234.88 ± 18.50	88.49 ± 11.97	426.64 ± 47.16	9.51 ± 1.07
Treatment with Urea, 3% acetate	860.80 ± 98.11	773.97 ± 86.84	113.05 ± 15.20 AB	29.04 ± 3.97	221.07 ± 23.75	86.70 ± 11.57	428.90 ± 47.28	9.10 ± 1.03
Significance level	NS	NS	P<0.05	NS	NS	NS	NS	NS
Interaction								
T1	663.66 ± 152.77 B	602.54 ± 138.69 B	66.95 ± 15.41 D	18.44 ± 4.24 D	207.72 ± 47.81 A	61.12 ± 14 B	309.40 ± 71.22 B	6.74 ± 1.55 C
T2	812.33 ± 129.53AB	736.62 ± 117.46 AB	100.24 ± 15.98 BCD	25.58 ± 4.07 BCD	221.11 ± 35.25 A	75.70 ± 12.07 AB	389.67 ± 62.13 AB	8.55 ± 1.36ABC
T3	768.33 ± 76.39 AB	697.33 ± 69.33 AB	94.81 ± 9.42 CD	24.19 ± 2.40 CD	216.05 ± 21.48 A	70.99 ± 7.05 AB	362.27 ± 36.02 B	8.03 ± 0.79 BC
T4	776.33 ± 114.61AB	702.45 ± 103.69 AB	95.80 ± 14.14 CD	24.44 ± 3.60 CD	204.40 ± 30.17 A	73.67 ± 10.87 AB	407.99 ± 68.74 AB	8.21 ± 1.21 BC
T5	977.66 ± 210.65AB	878.45 ± 189.28AB	121.81 ± 26.25ABCD	32.94 ± 7.09ABCD	302.29 ± 65.13 A	99.23 ± 21.38AB	421.37 ± 90.79AB	9.88 ± 2.13ABC
T6	1214.67 ± 24.55 A	1104 ± 22.32 A	170.90 ± 3.45 A	44.21 ± 0.89 A	297.71 ± 6.01 A	110.65 ± 2.23 A	591.18 ± 11.94 A	13.18 ± 0.26 A
T7	1095 ± 111 AB	980.24 ± 99.36 AB	154.06 ± 15.61 AB	39.85 ± 4.04 AB	263.13 ± 26.67 A	114.75 ± 11.63 A	523.19 ± 53.03 AB	11.72 ± 1.19 AB
T8	987.50 ± 173.50AB	881.25 ± 154.84 AB	138.94 ± 24.41 ABC	35.94 ± 6.31 ABC	246.08 ± 43.23 A	106.25 ± 18.67 AB	460.27 ± 80.86 AB	10.45 ± 1.84ABC
Significance level	P<0.01	P<0.01	P<0.01	P<0.01	NS	P<0.01	P<0.01	P<0.01

Different litters in same column means significant differences; NS = Me*=MJ/ day; T1= 70:30, without treated; T2= 70:30, urea treated; T3= 70:30, urea treated, 2% acetate; T4= 70:30, urea treated, 3% acetate; T5= 50:50, without treated; T6= 50:50, urea treated; T7= 50:50, urea treated, 2% acetate; T8= 50:50, urea treated, 3% acetate.DM= Dry matter,OM= Organic matter,CP= Crude protein,EE= Ether extract,CF= Crude fiber,ASH= Inorganic matter,NFE= Nitrogen-free extract,ME= Metabolic energy.

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Effect of ad libitum completed feed on Nutrient digestibility

The effect of roughage to concentrate ratios on the digestibility of crude protein, ether extract, and ash showed a highly significant increase ($P < 0.01$) with the 50:50 ratio compared to the 70:30 ratio (Table 3). Also, the digestibility of dry matter, organic matter, metabolizable energy, and total digestible nutrients (TDN) significantly increased ($P < 0.05$) . The reason for increasing digestibility is the synchronization between energy and protein sources to produce microbial protein or any other animal production, because digestibility refers to the retained nutrients inside the animal's body. Mir et al. (2010) observed an increase in *in vitro* dry matter digestibility (IVDMD) and organic matter digestibility (IVOMD) when adding 2–3% of different herbs to completed goat feed.Conversely, increasing the roughage ratio or providing it alone affects microbial protein production due to the insufficient availability of protein and energy for the host animal or rumen bacteria (Abedo et al., 2013). On the other hand, increasing the concentrate level negatively affects the rumen environment due to the decrease in rumination and saliva secretion, which leads to a reduction in rumen pH and a negative change in the rumen ecosystem (Claffey et al., 2018). Therefore, completed rations are highly suitable to meet the animals' maintenance and production needs. Numerically, there was a superiority in the main effect of urea, though without statistical significance. The interaction among treatments indicated a significant increase ($P < 0.01$) in the digestibility of crude protein, ether extract, ash, and total digestible nutrients (TDN) for the 50:50% ratio compared to the 70:30% ratio after treatment with urea and acetate (T6). This improvement is attributed to the urea treatment, which works to provide an easy and readily rumen-degraded protein (RDP) source used by rumen microorganisms as a nitrogen source for growth and microbial protein synthesis.Another reason for increasing digestibility is that *ad libitum* feeding of complete feeds prevents animals from excluding the unpalatable or undesirable parts of the feed and encourages them to consume the feed continuously, which provides a steady supply of nutrients for rumen microorganisms (Afzal et al., 2009; Chaturvedi et al., 2009). These conditions are similar to a high frequency of feeding, which is known to cause increased digestibility (Tawfeeq & Al-Attar, 2014). Hussein et al. (2024) noticed improved nutrient digestibility for complete feed when using roughage treated with 2% urea. They concluded that using roughage treated with urea for growing lamb feeds is important to improve performance and economic efficiency without any negative effects. Urea breaks down lignocellulosic and hemicellulosic bonds and fixes ammonia on the cellulose wall (Wahyono et al., 2022). Furthermore, treating roughage with urea combined with acetate or organic acids provides a suitable rumen environment for the growth and reproduction of microorganisms, which increases roughage degradability and its rate of passage through the rumen, thereby providing more space to increase roughage intake (Pearlin et al., 2020).

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Table 3. Effect of roughage to concentrate ratio, treated with urea and acetate on completed feed digestibility of dry matter, nutrients and metabolizable energy (%) (Mean ± SE)

Tretment	DM	OM	CP	EE	CF	Ash	NFE	Me	TDN
Main effect of roughage: concentrate ratio									
R:C 70:30	67.26± 2.69 B	70.87± 2.44 B	87.40 ± 1.66 B	66.93± 3.15 B	57.02 ± 4.09	32.07 ± 5.30 B	75.15 ± 2.11	73.64 ± 2.13 B	66.83 ± 2.30 B
R:C 50:50	77.08± 2.53 A	79.09± 2.36 A	93.96 ± 0.85 A	95.94± 0.75 A	69.04 ± 3.38	59.07 ± 4.14 A	79.01 ± 2.71	81.89 ± 2.13 A	75.45 ± 2.24 A
Significance level	P<0.05	P<0.05	P<0.01	P<0.01	NS	P<0.01	NS	P<0.05	P<0.05
Main effect of treated with urea and acid									
Without treat.	71.04± 3.84	73.66± 3.54	88.14 ± 2.50	79.95± 6.60	64.63 ± 5.73	46.19 ± 7.51	75.74 ± 2.82	76.20 ± 3.17	69.63 ± 3.35
Urea treat.	77.48± 5.33	79.90± 4.73	92.60 ± 2.53	84.03± 7.46	67.35 ± 7.56	53.78 ± 11.20	82.90 ± 3.72	82.60 ± 4.18	76.15 ± 4.60
Urea treat., 2% acetate	68.71± 3.79	72.28± 3.25	89.63± 2.41	79.78± 7.75	60.65 ± 3.85	34.98 ± 9.61 A	73.49 ± 3.23	74.91 ± 3.32	68.58 ± 3.13
Urea treat., 3% acetate	68.64± 3.02	71.74± 2.84	91.17 ± 2.26	75.98± 8.93	55.89 ± 5.60	40.18 ± 6.47	74.52 ± 2.82	75.03 ± 2.26	67.79 ± 2.63
Significance level	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction									
T1	65.52± 5.59	68.90± 5.40	84.81 ± 4.05 A	65.86± 4.15 B	57.72 ± 10.46	32.21 ± 7.57AB	73.15± 3.28	71.55 ± 4.04 A	64.84 ± 4.92AB
T2	72.63± 9.44	75.71± 8.41	89.39 ± 4.48AB	70.57± 9.84 B	61.12 ± 13.77	42.66 ± 19.49AB	80.82± 6.39	78.53 ± 7.33AB	71.44 ± 8.01AB
T3	63.37± 2.34	67.67± 2.07	86.71± 2.94AB	68.63± 6.52 B	55.88± 2.84	21.41± 5.01 B	69.67± 3.43	70.13± 2.17 B	64.13± 1.98 B
T4	67.51± 3.24	71.20± 2.93	88.71± 3.08 A	62.68± 6.69 A	53.36± 6.78	32.30± 6.29AB	76.96± 0.79	74.36± 2.16AB	66.91± 2.83AB
T5	76.56± 3.50	78.41± 3.32	91.48± 1.96AB	94.04± 1.52 A	71.55± 2.70	60.18± 5.40A	78.33± 4.72	80.86± 3.53AB	74.41± 3.04AB
T6	82.34± 5.43	84.08± 4.86	95.80± 1.36 A	97.48± 0.71 A	73.60± 7.58	64.91± 11.15A	84.98± 4.95	86.67± 4.14 A	80.86± 4.42A
T7	76.73± 4.53	79.18± 3.72	94.01± 0.59AB	96.50± 2.61 A	67.82± 6.26	55.76± 11.41AB	79.21± 3.80	82.09± 3.26AB	75.27± 3.45AB
T8	70.34± 7.43	72.55± 7.34	94.86± 0.32AB	95.93± 1.00 A	59.70± 12.31	51.99± 8.21AB	70.86± 7.44	76.05± 5.98AB	69.11± 6.50AB
Significance level	NS	NS	P<0.01	P<0.01	NS	P<0.01	NS	P<0.05	P<0.01

Different litters in same column means significant differences; NS = non-significant; TDN= Total digestible nutrients; T1= 70:30, without treated; T2= 70:30, urea treated; T3= 70:30, urea treated, 2% acetate; T4= 70:30, urea treated, 3% acetate; T5= 50:50, without treated; T6= 50:50, urea treated; T7= 50:50, urea treated, 2% acetate; T8= 50:50, urea treated, 3% acetate. DM= Dry matter,OM= Organic matter,CP= Crude protein,EE= Ether extract,CF= Crude fiber,ASH= Inorganic matter,NFE= Nitrogen-free extract,ME= Metabolic energy,TDN=Total Digestible Nutrients.

Effect of ad libitum completed feed on some biochemical parameters of goat bucks:

The impact of roughage to concentrate ratios (70:30% and 50:50%) indicated a highly significant increase (P < 0.01) in blood urea and glucose with increasing concentrate levels in the completed feed (Table 4). Conversely, the liver enzyme aspartate aminotransferase (AST) increased with an increasing roughage ratio (70:30). Blood glucose levels were within the normal physiological range of 40–80 mg/100ml (Bhattacharyya et al., 2018). The increase in blood glucose associated with a higher concentrate feed intake is due to the elevated production of rumen propionate and soluble carbohydrates, which enhances blood glucose synthesis and stabilizes the physiological features of body cells. Giger-Reverdin (2018) observed similar results, reporting an increase in blood glucose when the ratio of concentrate to roughage feeds was elevated.Although blood urea levels remained within the normal range, the addition of acetate led to a decrease in blood urea. This reduction indicates an increase in rumen urea utilization efficiency, achieving optimal synchronization between urea and acetate to promote the growth and reproduction of rumen bacteria as microbial protein for the host animal. Furthermore, this synchronization helps in reducing potential urea toxicity and prevents an excessive increase in blood urea concentration. Al-Samaraie et al. (2020) confirmed that providing a completed, balanced feed maintains the homeostasis of blood characteristics.The results of the

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interaction among treatments revealed a highly significant decrease (P < 0.01) in blood urea after utilizing acetate in combination with urea treatments. In contrast, blood glucose increased significantly with high-concentrate treatments, where T5 and T7 exhibited a superior increase (P < 0.01). Simultaneously, highly significant decreases (P < 0.01) were observed for the liver enzymes AST and alanine aminotransferase (ALT) in the high-concentrate treatments.Feeding roughages treated with urea generally leads to an increase in rumen ammonia-nitrogen. This enhancement increases the amount of ammonia escaping from the rumen into the bloodstream, which is subsequently converted back to urea in the liver and excreted through the kidneys as urine. When urea is added to the feed, it is rapidly converted into ammonia in the rumen by microbial urease. If the generated ammonia exceeds the liver's metabolic capacity to convert it into safe urea, ammonia may accumulate in the blood, leading to toxicity that affects hepatic tissues. This can cause liver cell damage, resulting in elevated AST levels leaking into the blood.Mokhtarpour and Jahantigh (2018) reported increased blood urea when sugarcane was treated with 2% urea, suggesting that urea levels should not exceed 2% when combined with concentrated feeds (SAS Institute, 2012). Chen et al. (2021) also observed increased blood urea levels associated with rising rumen ammonia concentrations. In addition to using urea as a chemical treatment to improve the nutritional value of roughages and provide a non-protein nitrogen (NPN) source in the rumen, the addition of acetic acid to the feed led to the neutralization of rumen ammonia and the elimination of high blood urea, as ammonium acetate salt is produced when ammonia reacts with acetic acid.The highly significant decrease (P < 0.01) in liver enzymes (AST and ALT) observed for the 50:50% roughage to concentrate ratio indicates a healthy status of the animals. This demonstrates that the experimental animals consumed a completed, well-balanced feed containing all the nutrients required for growth and maintenance, which may also be attributed to the inclusion of organic acids that enhance liver functions (Pearlin et al., 2020).

Table 4. Effect of roughage to concentrate ratio, treatment with urea and acetate on some blood parameters (Mean ± SE)

Tretment	Urea (mg/dl)	Glucose (mg/ dl)	AST (U/L)	ALT (U/L)
Main effect of roughage: concentrate ratio				
R:C- 70:30	60.41± 1.50 B	46.95± 1.77 B	100.90± 4.22	37.80± 2.0 A
R:C- 50:50	69.85± 2.52 A	71.30± 2.24 A	91.55± 6.83	29.75± 1.76 B
Significance level	P<0.01	P<0.01	NS	P<0.01
Main effect of treated with urea and acid				
Without treat.	60.10± 2.51 B	63± 5.0 AB	117.30± 9.22 A	32.80± 1.97
Urea treat.	74.77± 3.26 A	50.20± 4.51 C	83.90± 5.99 B	32.20± 2.93
Urea treat., 2% acetate	64.32± 2.71 B	65.10± 5.50 A	95.30± 6.70 B	38.20± 3.96
Urea treat., 3% acetate	61.34± 2.68 B	58.20± 3.17 B	88.40± 6.57 B	31.90± 2.46
Significance level	P<0.01	P<0.01	P<0.01	NS
Interaction				
T1	56.40± 1.86 D	49± 2.44 C	121.20± 8.90 A	31.20± 1.59 BC
T2	67.54± 2.34 BC	38.40± 3.14 D	87.40± 2.54 B	39.80± 2.51 AB
T3	58.24± 1.13 CD	50.80± 3.44 C	103.60± 8.36 AB	45.20± 4.30 A
T4	59.48± 3.18 CD	49.60± 2.67 C	91.40± 3.18 AB	35± 4.62ABC
T5	63.80± 4.25BCD	77± 2.93 A	113.40± 17.20 AB	34.40± 3.69 BC
T6	82± 4.03 A	62± 3.52 B	80.40± 12.21 B	24.60± 1.91 C
T7	70.40± 3.66 B	79.40± 4.69 A	87± 9.89 B	31.20± 5.26 BC
T8	63.20± 4.01BCD	66.80± 1.15 B	85.40± 13.41 B	28.80± 1.11 BC
Significance level	P<0.01	P<0.01	P<0.01	P<0.01

Different litters in same column means significant differences; ** Significant at level 0.01; NS = non-significant; T1= 70:30, without treated; T2= 70:30, urea treated; T3= 70:30, urea treated, 2% acetate; T4= 70:30, urea treated, 3% acetate; T5= 50:50, without treated; T6= 50:50, urea treated; T7= 50:50, urea treated, 2% acetate; T8= 50:50, urea treated, 3% acetate

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CONCLUSION

In conclusion, utilizing an *ad libitum* completed feed with a 50:50 roughage-to-concentrate ratio significantly increases feed intake and nutrient digestibility in goats compared to a 70:30 ratio. Treating agricultural byproducts with urea effectively upgrades their nutritional value as an economical non-protein nitrogen (NPN) source. Crucially, supplementing the complete ration with 2% or 3% acetic acid successfully neutralizes excess rumen ammonia, thereby lowering blood urea levels and preventing hepatic toxicity, as evidenced by the optimal levels of liver enzymes (AST and ALT). Consequently, this dietary strategy offers a safe, sustainable, and cost-effective approach to improve ruminant nutrition and performance.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

REFERENCES

Abedo, A. A., Hafez, Y. H., Khalifa, E. I., Mohamed, B., & El-Zolaky, O. A. (2013). Milk yield and composition of dairy Zaraibi goats fed microbial inoculated corn silage. Egyptian Journal of Sheep & Goat Sciences, 8(1), 1–12. https://doi.org/10.21608/ejsgs.2013.26780

Abera, F., Urge, M., & Animut, G. (2016). Effect of urea or urea-molasses treated maize stover on body weight change and carcass parameter on Hararghe highland sheep, eastern Ethiopia. Journal of Biology, Agriculture and Healthcare, 6(13), 76–83. https://doi.org/10.14202/jbagh.2016.76-83

Afzal, Y., Mattoo, F. A., Ganai, A. M., & Ahmad, H. A. (2009). Complete feed block technology: A boon to sheep farming. Livestock International, 13(1), 4–7. https://doi.org/10.14202/vetworld.2017.424-437

Alsamaraie, A. A., Noaman, A. I., & Al-Abbasy, E. G. (2023, December). The effect of different levels of wild reeds (Saccharum spontaneum) with concentrated fodder on some physical and biochemical blood parameters of local Iraqi lambs. IOP Conference Series: Earth and Environmental Science, 1262(7), Article 072015. https://doi.org/10.1088/1755-1315/1262/7/072015

Alves, N. G., Torres, C. A. A., Guimarães, J. D., Moraes, E. A., Rodrigues, M. T., Cecon, P. R., & Amorim, L. D. S. (2011). Effect of urea in the diet on ovarian follicular dynamics and plasma progesterone concentration in Alpine goats. Revista Brasileira de Zootecnia, 40(7), 1512–1518. https://doi.org/10.1590/S1516-35982011000700016

Association of Official Analytical Chemists. (2012). Official methods of analysis (19th ed.). AOAC International.

Bishnoi, S. K., Dariya, S., Mathur, M., Dadhich, H., Mehra, M., Asopa, S., & Desai, J. K. (2020). Estimation of serum enzymes (AST, ALT, GGT, and ALP) level in goat (Capra hircus) in various hepatic lesions. Journal of Pharmacognosy and Phytochemistry, 8(1), 95–99. https://www.biochemjournal.com/articles/459/8-1-45-991.pdf

Chaturvedi, O. H., Kumar, S., Mishra, A. K., Arora, A. L., & Karim, S. A. (2009). Effect of complete feed or grazing and supplementation of lambs on performance, nutrient utilization, and feed cost of production. The Indian Journal of Animal Sciences, 79(9), 917–920. https://doi.org/10.22267/ijans.79.9.2687

Chen, G. J., Song, D. S., Wang, B. X., Zhang, Z. F., Peng, Z. L., Guo, C. H., Zhong, J. C., & Wang, Y. (2015). Effects of forage: concentrate ratio on growth performance, ruminal fermentation, and blood metabolites in housing-feeding yaks. Asian-Australasian Journal of Animal Sciences, 28(12), 1736–1744. https://doi.org/10.5713/ajas.15.0419

Cherkashina, A. G., Stepanova, S. V., Spiridonova, A. V., & Kalininsky, R. G. (2021). Increase of animal products using complete feed provision. IOP Conference Series: Earth and Environmental Science, 720(1), Article 012118. https://doi.org/10.1088/1755-1315/720/1/012118

Claffey, N. A., Fahey, A. G., Gkarane, V., Moloney, A. P., Monahan, F. J., & Diskin, M. G. (2018). Effect of forage to concentrate ratio

Iraqi Journal of Agricultural Sciences –2026:57(6):1731-1741
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/ckfz5k26

and duration of feeding on growth and feed conversion efficiency of male lambs. Translational Animal Science, 2(4), 419–427. https://doi.org/10.1093/tas/txy071

Datt, C., Reddy, G. V. N., & Kundu, S. S. (2011). Effect of feeding differently processed paddy straw based complete diets on feed intake and nutrient utilization in Nellore rams. Indian Journal of Animal Nutrition, 28(2), 160–165. https://doi.org/10.5455/vetworld.2013.151-155

Defar, G., & Urgie, M. (2017). Bodyweight gain and carcass characteristics of Horro sheep fed urea-treated maize husk and untreated maize husk supplemented with different levels of concentrate mix at Bako, Western Ethiopia. International Journal of Livestock Production, 8(6), 87–94. https://doi.org/10.5897/IJLP2016.0343

Duncan, D. B. (1955). Multiple range and multiple F tests. Biometrics, 11(1), 1–42. https://doi.org/10.2307/3001478

Elkholy, M. E. H., Hassanein, E. I., Edrees, N., Eleraky, W., Elgamel, M. F. A., & Ibraheim, D. (2009). Nutritional aspects of recycling plants byproducts and crop residues (corn stalk) in sheep. Pakistan Journal of Nutrition, 8(12), 1834–1841. https://doi.org/10.3923/pjn.2009.1834.1841

Giger-Reverdin, S., Rigalma, K., Desnoyers, M., Sauvant, D., & Duvaux-Ponter, C. (2014). Effect of concentrate level on feeding behavior and rumen and blood parameters in dairy goats: Relationships between behavioral and physiological parameters and effect of between-animal variability. Journal of Dairy Science, 97(7), 4367–4378. https://doi.org/10.3168/jds.2013-7383

Haloi, S., Bhuyan, R., Borah, L., & Saikia, B. N. (2021). Complete feed block as a mode of enhancing ruminant production: A review. Indian Journal of Animal Health, 60(1), 10–15. https://doi.org/10.36062/ijah.60.1.2021.10-15

Hussein, A. M., Hassanien, H. A., Phillip, Y. L., Abou EL-Fadel, M. H., El-Badawy, M. M., El-Maghraby, M. M., Khayyal, A. A., & Salem, A. Z. (2024). Effect of urea-treated rice straw, mixed with faba bean straw, on nutrient digestibility, blood metabolites, and performance of growing lambs. Tropical Animal Health and Production, 56(3), Article 122. https://doi.org/10.1007/s11250-024-03971-7

Ibrahim, S. S., & Al-Ani, J. A. T. (2022). Influence of concentrate level with or without N-carbamyl glutamate on rumen bacteria and fermentation characteristics of Shami goats. Journal of Kerbala for Agricultural Sciences, 9(1), 17–25. https://doi.org/10.59658/jkas.v9i3.992

Khattab, I. M., Salem, A. Z. M., Abdel-Wahed, A. M., & Kewan, K. Z. (2013). Effects of urea supplementation on nutrient digestibility, nitrogen utilization and rumen fermentation in sheep fed diets containing dates. Livestock Science, 155(2-3), 223–229. https://doi.org/10.1016/j.livsci.2013.04.004

Konka, R. K., Kumar, D. S., Ramana, J. V., Ravi, A., & Rao, E. R. (2016). Fermentation pattern in Murrah buffalo bulls fed crop residue based complete rations vis-a-vis conventional feeding system. Animal Nutrition and Feed Technology, 16(1), 171–179. https://doi.org/10.5958/0974-181X.2016.00016.0

Kraidees, M. S. (2005). Influence of urea treatment and soybean meal (urease) addition on the utilization of wheat straw by sheep. Asian-Australasian Journal of Animal Sciences, 18(7), 957–965. https://doi.org/10.5713/ajas.2005.957

Lailer, P. C., Dahiya, S. S., & Chauhan, T. R. (2005). Complete feed for livestock concept, present status, and future trend: A review. The Indian Journal of Animal Sciences, 75(1), 114–122. https://epubs.icar.org.in/index.php/IJAnS/article/view/9667

Marcos, C. N., Carro, M. D., Yepes, J. F., Haro, A., Romero-Huelva, M., & Molina-Alcaide, E. (2020). Effects of agroindustrial by-product supplementation on dairy goat milk characteristics, nutrient utilization, ruminal fermentation, and methane production. Journal of Dairy Science, 103(2), 1472–1483. https://doi.org/10.3168/jds.2019-17182

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

Iraqi Journal of Agricultural Sciences –2026:57(6):1731-1741
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/ckfz5k26

Mir, I. A., Kumar, R., Sharma, R. K., & Barman, K. (2010). Effect of addition of herbs on in vitro digestibility of feed with rumen liquor of goat. The Indian Journal of Veterinary Research, 19(1), 13–18. https://doi.org/10.5958/j.0976-0555.48.1.019

Mokhtarpour, A., & Jahantigh, M. (2018). Effect of supplementing common reed (Phragmites australis) with urea on intake, apparent digestibility, and blood metabolites of Baluchi sheep. Iranian Journal of Applied Animal Science, 8(4), 623–628. https://doi.org/10.5555/20193016662

Mudgal, V., Mehta, M. K., & Rane, A. K. (2014). Utilization of ammoniated lentil (Lens culinaris) straw in the ratio of growing Barbari kids. Indian Journal of Animal Nutrition, 31(4), 340–344.

Nagi, P. R. S., Reddy, D. N., Nagalakshmi, D., Reddy, Y. R., & Raghunandan, T. (2012). Effect of particle size of paddy straw on physical characteristics and performance of lambs fed paddy straw based complete diets. Animal Nutrition and Feed Technology, 12(1), 111–119.

National Research Council (NRC). (2012). Nutrient requirements of beef cattle (7th rev. ed.). National Academies Press.

Pearlin, B. V., Muthuvel, S., Govidasamy, P., Villavan, M., Alagawany, M., Ragab Farag, M., Dhama, K., & Gopi, M. (2020). Role of acidifiers in livestock nutrition and health: A review. Journal of Animal Physiology and Animal Nutrition, 104(2), 558–569. https://doi.org/10.1111/jpn.13282

Resol, A. H. S., Muhamad, S. M. N., Aziz, N. M., & Mustafa, N. A. (2020). Response of local Karadi lambs for feeding by adding molasses and date to urea-treated straw. Plant Archives, 20(2), 1122–1125.

Santos, R., Ursu, O., Gaulton, A., Bento, A. P., Donadi, R. S., Bologa, C. G., Karlsson, A., Al-Lazikani, B., Hersey, A., Oprea, T. I., & Overington, J. P. (2017). A comprehensive map of molecular drug targets. Nature Reviews Drug Discovery, 16(1), 19–34. https://doi.org/10.1038/nrd.2016.230

SAS Institute. (2012). SAS/STAT user's guide (Version 9.3). SAS Institute Inc.

Sharma, V., Purohit, G. R., Arya, R. S., & Harsh, M. (2006). Evaluation of some complete rations in sheep incorporating unconventional feed resources of arid zone of India. Animal Nutrition and Feed Technology, 6(1), 135–141.

Simonov, M., Nedelkov, K., & Todorov, N. (2015). Influence of roughage in the rations of early weaned lambs. Journal of Dairy, Veterinary & Animal Research, 2(2), 42–49. https://doi.org/10.15406/jdvar.2015.02.00042

Tawfeeq, J. A., & Al-Attar, S. A. H. (2014). Nutrition science (1st ed.). College of Agricultural Engineering Sciences, University of Baghdad. Academic Press.

Voltolini, T. V., de Moraes, S. A., de Araújo, G. G. L., de Oliveira, P. L. T., & Pereira, L. G. R. (2010). Urea levels in multiple supplement for lambs grazing on buffelgrass. Acta Scientiarum. Animal Sciences, 32(4), 423–429. https://doi.org/10.4025/actascianimsci.v32i4.7829

Wahyono, T., Sholikin, M. M., Konca, Y., Obitsu, T., Sadarman, S., & Jayanegara, A. (2022). Effects of urea supplementation on ruminal fermentation characteristics, nutrient intake, digestibility, and performance in sheep: A meta-analysis. Veterinary World, 15(2), 331–340. https://doi.org/10.14202/vetworld.2022.331-340

Wang, R., He, S., Huang, D., Wu, D., Peng, H., He, S., Guo, T., Chen, T., Fu, X., Chen, C., & Jiaka, L. (2023). The response of rumen pH, fermentation parameters and rumen bacteria to feeds of different concentrate to roughage ratios in buffalos. Frontiers in Microbiology, 14, Article 1053794. https://doi.org/10.3389/fmicb.2023.1053794

Iraqi Journal of Agricultural Sciences –2026:57(6):1731-1741
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تأثير نظام التغذية الكاملة في معامل الهضم وبعض المعايير الكيموحيوية للدم في ذكور الماعز

مهند حميد كاظم[1]، جمال عبدالرحمن توفيق[1]، سلام شعبان إبراهيم[2]
[1] قسم الإنتاج الحيواني/ كلية علوم الهندسة الزراعية / جامعة بغداد
[2] الهيئة العامة للبحوث الزراعية/ وزارة الزراعة

المستخلص

تناولت الدراسة تقييم تأثير نظام التغذية الكاملة على معدل استهلاك العلف، وكفاءة الهضم، والمؤشرات الكيميائية الحيوية في دم ذكور الماعز، عبر تجربتين مُنفصلتين اعتمدتا نسبتَي علف خشن إلى علف مركز (70:30 و50:50) مع تضمين مستويات متباينة من حمض الأسيتيك (0%، 2%، 3%). شملت المواد العلفية اعلاف خشنة معاملة باليوريا وغير معاملة (كسعف النخيل المطحون وقش القمح)، اذ خُصصت التجربة الأولى لأربع مجموعات معاملة (T4,T3,T2,T1) بنسبة 70% علف خشن و30% علف مركز مع اضافة الأسيتات، بينما نُفذت التجربة الثانية على نفس العدد من الحيوانات باستخدام نسبة 50:50 لتشكيل مجموعات(T8,T7,T6,T5) ، ضمن تصميم عشوائي كامل (2×4) . كشفت النتائج تفوُّق المعاملات ذات النسبة 50:50 (T6 و T7)التي تضمنت علف خشن معامل باليوريا مع إضافة 2% أسيتات - في تعزيز الاستهلاك الغذائي، حيث ارتفع معدل استهلاك المادة الجافة في المعاملة T6 الى 1215 غم / يوم كذلك ، المادة العضوية اصبح معدل استهلاكها 1104 غم / يوم والبروتين الخام 171 غم / يوم ومستخلص ايثر 44 غم / يوم والياف الخام 297 غم / يوم اما مستخلص الخالي من النتروجين فارتفاع معدل استهلاكه الى 591 غم / يوم كذلك الطاقة الممثلة معدل استهلاكها 13.18غم / يوم ، ورفع معدلات هضم العناصر، وزيادة إجمالي العناصر الغذائية القابلة للهضم (TDN) ، فضلًا عن تحسين المؤشرات الدموية. وأكدت الدراسة أن دمج 50% علف خشن معامل باليوريا مع 50% علف مركز وإثرائها بـ2% أسيتات المعاملة (T6) يُحسّن كفاءة امتصاص العلف، ويُخفف من الآثار السلبية لتراكم الأمونيا الناتجة عن تحلل اليوريا، ويرفع من أداء الكرش الوظيفي، مما يضع إطارًا استراتيجيًا مُثلى للتغذية المتوازنة للمجترات، يجمع بين الفعالية والسلامة الصحية .

الكلمات المفتاحية: الماعز، نسبة العلف الخشن إلى المركز، اليوريا، حامض الخليك، العلف الكامل.