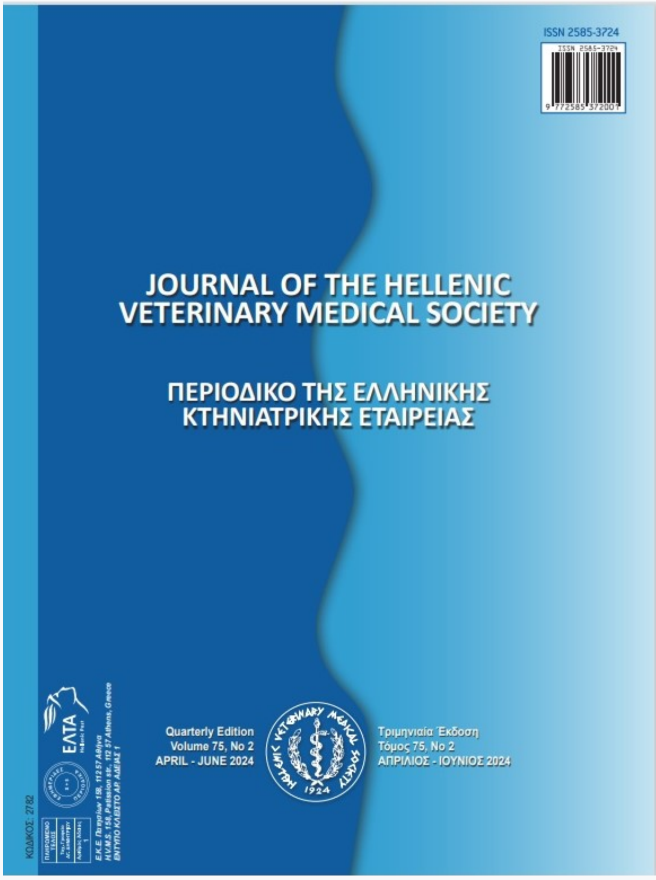
Journal of the Hellenic Veterinary Medical Society

Vol 75, No 2 (2024)



Effects of feeding corn Stover silage treated with optigen or soybean meal on digestibility, rumen fermentation, blood biochemistry and growth performance of fattening lambs

MA Abu El-Hamed, MK Mohsen, EM Abdel-Raouf, HM Gaafar, NIM Hassan

doi: [10.12681/jhvms.34335](https://doi.org/10.12681/jhvms.34335)

J HELLENIC VET MED SOC 2024, 75 (2): 7325-7332
ΠΕΚΕ 2024, 75 (2): 7325-7332

Research article
Ερευνητικό άρθρο

Effects of feeding corn Stover silage treated with optigen or soybean meal on digestibility, rumen fermentation, blood biochemistry and growth performance of fattening lambs

M.A. Abu El-Hamed[1]*, M.K. Mohsen[2], E.M. Abdel-Raouf[2], H.M. Gaafar[1], N. I.M. Hassan[3]**

*[1]*Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt*

[2]Animal Production Department, Faculty of Agriculture, Kafrelsheikh University, Kafr El-Sheikh 33516, Egypt

[3]Animal Production Department, Faculty of Agriculture, Kafrelsheikh University, Kafr El-Sheikh 33516, Egypt

ABSTRACT: Eighteen male *Rahmani* lambs with 4 months old and weighed 25.47±0.17 kg live body weight were divided into three identical groups and used in a 150-day growing experiment. In the first group, the lambs were fed on R1, which contained 60% concentrate feed mixture (CFM) and 40% corn stover silage (CSS) and considered as a control. Whereas, lambs in the second group were fed (R2) 50% CFM and 50% CSS supplemented with 0.5% optigen® (slow-release urea) and the third group fed (R3) 50% CFM and 50% CSS supplemented with 3% soybean meal. Results indicated that the dry matter (DM) and crude protein (CP) contents increased with soybean meal supplement, but nitrogen free extract (NFE) content in silage tended to decrease with optigen and soybean meal supplementation. Content of DM reduced in R2 with optigen supplementation. Higher CF, NDF, ADF and ADL contents and lower NFE content in R2 and R3 than those of R1content and lower NFE content in R2 and R3 than R1. The R2 and R3 had substantially higher digestion of all nutrients (OM, DM, CP, CF, NFE, and ether extract (EE)) as well feeding values (DCP and TDN) than R1. Lambs in various groups had almost equal ruminal pH values. Concentrations of ammonia-N and total VFA's in rumen fluid were significantly higher ($P<0.05$) in R2 and R3 compared to R1. Blood plasma biochemical profiles of the various groups were almost identical, with only minor variations. Intake of DM and CP were slightly higher in R2 and R3 than those of R1. The TDN and DCP intake were significantly ($P<0.05$) higher in R2 and R3 than R1. The final live body weight, total weight gain, and average daily gain (ADG) were significantly greater ($P<0.05$) in R2 and R3 than those of R1. DM and CP conversion improved significantly in R2 and R3 than R1. The addition of corn stover silage supplemented with 3% soybean meal or 0.5 % optigen was improving feed intake, digestion, feed conversion, rumen function, and body weight gain of fattening *Rahmani* lambs.

Keywords: *Corn stover silage; optigen; digestibility; rumen fermentation; lamb's growth*

Corresponding Author:
Abu El-Hamed M.A, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt
E-mail address: abuelhamd68@yahoo.com , ** hamedgaafar@gmail.com

Date of initial submission: 01-05-2023
Date of acceptance: 24-10-2023

INTRODUCTION

As the use of animal proteins rises, so does the demand for feed containing plant proteins for livestock. If environmental issues and resource rivalry are adequately addressed, livestock production is predicted to surpass agriculture as the most valuable agricultural field in terms of added value (Henchion *et al*., 2017; Kim *et al.,* 2019; Pulina *et al*., 2018). Due to the environmental implications in industrialized nations and the price volatility in international markets, the European Union is becoming more and more concerned about the lack of plant protein in animal feed and emphasises the effect of reducing a heavy reliance on protein crop imports (Beever and Cottrill, 1994; Ferraretto and Shaver, 2015). The study of urea's usage in ruminant feeding was expedited due to the significant shortage of animal protein supplements generated from plants during the interwar period. Utilizing urea as much as feasible while feeding ruminants has drawn attention due to the growing requirement for plant protein in animal feed worldwide (Miranda et al., 2019; Olafadehan *et al*., 2014).

Silage production is to conserve as much fodder as possible for eventual use in livestock feed (Wilkinson and Rinne, 2018). Fermentation of silage is a complicated process which is influenced by several variables. Researchers have been studying silage and its additions for some years to improve its nutritional content and decrease some of the dangers involved with the silage process (González-Alcántara *et al*., 2020; Henderson, 1993). The silage supplement should be simple to implement, efficient in the reduction of DM losses, and eco-friendly. Silage additives are used in the post-processing of feed or crops to enhance the subsequent fermentation process, decrease the waste, lower the aerobic retrogradation at feed, improve the sanitary efficiency of silage, inhibit fermentation process, increase aerobic stability, and maximize the nutritional benefits of silage, leading to an increase in anisotropy (Merensalmi and Virkki, 1991; Supapong *et al*., 2022). Unavoidable losses, such as those caused by plant enzymes and microbes, as well as field losses, can be reduced with several silage additions (Charmley, 2001). The major five classes of silage supplements (propionic acid, lactic acid bacteria, etc.) including fermentation boosters (carbohydrate sources and bacterial culture), inhibitors of fermentation (formaldehyde, acids, etc.), and inhibitors of aerobic decomposition (acids, formaldehyde, etc) (Harrison *et al*., 1994; McDonald *et al*., 1991; Yitbarek and Tamir, 2014).

When compared to protein feed sources like soybean meal (SBM), non-protein nitrogen compounds offer a cost-effective alternative to natural and affordable plant protein sources per unit nitrogen (Ghizzi *et al*., 2020). Urea is the most widely used non-protein nitrogen molecule in ruminant feeds (Mentz *et al*., 2015; Varlyakov *et al*., 2015). In the diet of ruminants, the utilization of urea as a source of NPN is limited because urea's quick conversion to ammonia occasionally exceeds rumen bacteria's ability to utilize NH3-N, resulting in the loss of N for the synthesis of microbial protein (Galo *et al*., 2003). Over the years, numerous approaches have been investigated for addressing this issue and lowering the risk of urea toxicity in ruminants, including the creation of slow-release nitrogen sources (Mentz *et al*., 2015). The purpose of employing a delayed-release N source when rumen NH3-N levels are expected to be decreased after urea ingestion that is to give a slow release of nitrogen during the day and meet the nitrogen demand of rumen bacteria. The performance of microbial protein production and utilization is improved by providing a consistent source of nitrogen (Harrison and Karnezos, 2005). Also, give a delayed hydrolysis of these chemicals, which results in a steady release of ammonia at the front of the stomach and optimal conditions for photolytic microbial communities to thrive (Varlyakov *et al*., 2015).

The aim of this research was to see corn stover silage supplemented with soybean meal or optigen on feed intake, digestion, rumen fermentation, blood biochemistry, growth performance, and feed conversion of fattening lambs.

MATERIALS AND METHODS

Animals used in research

Eighteen male *Rahmani* lambs at 4 months of age had 25.47 ± 0.17 kg mean initial live body weight (LBW). Three similar groups of lambs were formed with six lambs for each and used in a 150-day growing experiment.

Experimental rations

Each group of lambs was allocated to one of three experimental rations. The first group, the lambs were fed on R1, which contained 60% concentrate feed mixture (CFM) and 40% corn stover silage (CSS) and considered as a control. Whereas lambs in the second group were fed (R2) 50% CFM and 50% CSS supplemented with 0.5% optigen® (slow-release urea) and

Table 1. Formulation of experimental rations.

Item	R1	R2	R3
Concentrate feed mixture (CFM)	60	50	50
Corn stover silage (CSS)	40	-	-
Corn stover silage (CSS1)	-	50	-
Corn stover silage (CSS2)	-	-	50
Total	100	100	100

Where, CSS was supplemented with 3% molasses + 1 ml effective microbes (EM1)/kg wet silage, CSS1 was CSS supplemented with 0.5% Optigen and CSS2 was CSS supplemented with 3% soybean meal (44% protein). Optigen® (Alltech, Nicholasville, KY) is urea encapsulated in a biodegradable polymer and fibrolytic enzyme technology are combined in this cattle feed additive. It contains 99% DM, 256% CP, 41% nitrogen, and 12% lipids. Effective microorganisms (EM1) contained photosynthetics bacteria (*Rhadopseudomonas plustris* and *Rhodobacters phacrodes*), lactic acid bacteria (*Lactobacillus plantarum*, *Lactobacillus casei* and *Streptococcus lactis*), yeasts (*Saccharomyces cerevisiae*) and Actinomycetes (Microhiza). Concentrate feed mixture (CFM) was composited from 51% yellow corn grains, 25% wheat bran, 17.7% soybean meal, 3% molasses, 2% limestone, 1% common salt and 0.3% premix.

the third group fed (R3) 50% CFM and 50% CSS supplemented with 3% soybean meal. The formulation of experimental rations is illustrated in Table (1).

Management procedure

All experimental lambs were fed on the tested rations sufficient to meet their suggested needs, following the NRC (2007). CFM was administered two times per day (8 am and 4 pm), whereas CSS was given once daily at 10 am, and water was readily available all day. Lambs are weighed every two weeks before the morning feeding after fasting night. The amounts of CFM and CSS were changed every 2 weeks in response to changes in live body weight.

Digestibility trials

Three digestibility trials were conducted on three lambs from each experimental group during the feeding experiment to determine the digestibility coefficients and feeding values of the experimental meals. The preparatory period of each digestion experiment lasted 15 days, while the collection period lasted 7 days using acid-insoluble ash as a standardized marker (Van Keulen and Young, 1977). Throughout the collection period, faeces specimens were collected twice daily at 12-hour intervals from each animal's rectum. Feed samples were obtained at the start, middle, and the termination of the collection period. Chemical analysis of CFM, corn forage, rice straw, and feces samples was performed using methods of (AOAC, 1990). The following equations were used by Schneider and Flatt (1975) to measure the digestibility of nutrients:

DM digestibility % =

$$100-\left[100\text{ x }\frac{\text{AIA\% in feed}}{\textit{AIA}\text{\% in feces}}\right]$$

Nutrient digestibility % =

$$100-\left[100\text{ x }\frac{\text{AIA\% in feed}}{\textit{AIA}\text{\% in feces}}\right]\text{x}\left[\frac{\text{Nutrient \% in feces}}{\text{Nutrient \% in feed}}\right]$$

Where, AIA is acid insoluble ash.

The contents of TDN and DCP were measured using the equations provided by McDonald et al. (1995).

Rumen fluid samples

Three lambs in each group had rumen fluid samples collected three hours after morning feeding using a rubber gastric tube connected to an electric suction pump and inserted through the esophagus into the rumen. Before giving the preservative, the rumen fluid was filtered through two cheesecloth layers and the pH was determined by using pH meter (Orian digital). The AOAC method of determining ammonia nitrogen (NH3-N) was used (AOAC, 1990). TVFAs were measured using Warner's steam distillation method (Warner, 1964).

Blood samples collection

Blood samples were collected three hours after the morning meal with a clean sterile needle from each lamb's jugular vein into clean dry plastic tubes containing two drops of heparin as an anticoagulant after three months of the feeding trial. Plasma was obtained by samples centrifugation at 4000 rpm for 15 hours and then storing them at -20 °C until the chemical analysis. Total protein, urea nitrogen, albumin, creatinine, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and levels in blood plasma were calorimetrically measured using commercial diagnostic instruments (Pasteur Lab Test-Mix-Test).

Feed conversion efficiency

Feed conversion of DM, TDN, CP and DCP were calculated as follows:

DM (kg/kg weight gain) = DMI/ADG

TDN (kg/kg weight gain) = TDNI/ ADG

CP (g/kg weight gain) = CPI/ ADG

DCP (g/kg weight gain) = DCPI/ ADG

Statistical analysis

The data for the user's guide were analyzed statistically using one-way analysis of variance (totally randomized design) following IBM SPSS Statistics (2020) General Linear Models (GLM) procedures with one-way ANOVA in accordance with the following equation: $Yij = \mu + xi + eij$

Where: Yij = observation. μ = mean, xi = treatment effect, eij = experimental error.

Duncan test inside the SPSS program was used to evaluate the degree of statistical significance between the means of treatments, and a level of alpha was used to declare statistical significance between the means.

RESULTS

Composition of tested feedstuffs and rations

The composition of several silages and tested diets is shown in Table (2). The silage supplemented with soybean meal had more DM than the other silages. Moreover, CP content in R2 and R3 than in R1. However, NFE content tended to decrease in R3. There were minor differences in the concentrations of OM, CF, EE, ash, NDF, ADF, and ADL across various silages. Moreover, DM content was lower in R2 than those of R1 and R3. Higher CF and fiber fractions (NDF, ADF and ADL) content and lower NFE content in R2 and R3 than those of R1, which might be attributed to increase the percentage of silage in R2 and R3 (50%) than that of R1 (40%). While the contents of OM, CP, EE, and ash slightly differ among the different experimental rations.

Nutrients digestibility

Table 3 shows the nutrient digestibility of DM, EE, OM, CP, NFE, and CF were significantly higher ($P<0.05$) in R2 and R3 than in R1. When feeding values of experimental meals as presented in Table (3), R2 and R3 had significantly greater TDN and DCP values ($P<0.05$) than R1.

Rumen fermentation parameters

Table 4 shows the rumen fermentation parameters of lambs fed experimental rations. The ruminal pH values of lambs in all groups were nearly identical. The TVFA and NH3-N concentrations in the rumens of R2 and R3 were significantly higher ($P<0.05$) compared to R1.

Biochemical analysis of blood plasma

Table 5 shows the blood plasma biochemical results of lambs fed various types of corn stover silage. Total protein, albumin, globulin, urea, and creatinine concentrations, as well as AST and ALT enzyme activity, were not statistical.

Feed intake

Table 6 shows the daily feed intake of lambs fed a variety of experimental diets. Lambs fed R1 consumed more concentrate feed mixture than R2 and R3, but R1 had a lower intake of corn stover silage and a lower overall intake on a fed basis than R2 and R3. The differences in concentrate feed mixture to corn stover ratio between R (60:40) and both R2 and R3 is due to these findings (50:50). Moreover, the intake of DM and CP were slightly higher with feeding R2 and R3 than R1. On the other hand, TDN and DCP intake were considerably higher ($P<0.05$) in R2 and R3 than in R1.

Table 2. Composition of tested feedstuffs and rations.

Item	DM %	DM Composition%								
		OM	CP	CF	EE	NFE	Ash	NDF	ADF	ADL
Feedstuffs										
CFM	91.74	91.40	14.36	9.88	3.57	63.59	8.60	16.47	5.92	1.60
CSS	33.35	91.45	7.92	28.65	2.46	52.42	8.55	62.54	34.95	5.82
CSS1	33.63	91.28	9.24	28.43	2.43	51.18	8.72	62.06	34.68	5.78
CSS2	35.48	91.72	9.35	28.15	2.54	51.68	8.28	61.45	34.35	5.72
Experimental rations										
R1	48.91	91.42	11.78	17.39	3.13	59.12	8.58	34.90	17.53	3.29
R2	45.60	91.34	11.80	19.16	3.00	57.38	8.66	39.27	20.30	3.69
R3	47.23	91.56	11.86	19.02	3.06	57.62	8.44	38.96	20.14	3.66

Table 3. Digestion of nutrients and feeding values of experimental rations.

Item	Experimental rations			±SE	*p-value*
	R1	R2	R3		
Digestion coefficients %					
DM	64.76^{b}	67.13^{a}	67.02^{a}	0.58	0.045
OM	66.34^{b}	69.30^{a}	68.82^{a}	0.63	0.025
CP	67.49^{b}	69.66^{a}	69.45^{a}	0.56	0.048
CF	62.19^{b}	65.04^{a}	64.67^{a}	0.61	0.021
EE	70.48^{b}	72.06^{a}	72.47^{a}	0.55	0.049
NFE	64.81^{b}	67.66^{a}	67.56^{a}	0.56	0.021
Feeding values %					
TDN	62.04^{b}	64.37^{a}	64.40^{a}	0.56	0.037
DCP	7.95^{b}	8.22^{a}	8.24^{a}	0.07	0.048

a, b: Values in the same row with different letters significantly differ at 5% level.

Table 4. Rumen fermentation parameters of lambs fed tested rations.

Item	Experimental rations			±SE	p-value
	R1	R2	R3		
Rumen fermentation parameters					
pH	6.26	6.37	6.30	0.04	0.184
TVFA's (meq/100 ml)	12.41^{b}	13.92^{a}	14.05^{a}	0.27	0.041
NH3-N (mg/100 ml)	17.50^{b}	19.25^{a}	18.76^{a}	0.29	0.039

a, b: Values in the same row with different letters are significantly different at 5% level.

Table 5. Biochemical analysis of lambs fed tested rations.

Item	Experimental rations			±SE	*p-value*
	R1	R2	R3		
Total protein (g/dL)	6.45	6.46	6.57	0.05	0.654
Albumin (g/dL)	3.13	3.13	3.17	0.03	0.817
Globulin (g/dL)	3.32	3.33	3.40	0.03	0.783
Albumin: globulin ratio	0.94	0.94	0.93	0.01	0.915
Urea (mg/dL)	62.28	64.67	63.33	0.54	0.826
Creatinine (mg/dL)	1.09	1.10	1.07	0.01	0.792
AST (U/L)	57.67	59.57	58.00	0.50	0.756
ALT (U/L)	21.33	21.00	20.30	0.21	0.734

a, b: Values in the same row with different letters are significantly different at 5% level.

Growth performance

The growth performance of lambs given various experimental meals is shown in Table 7. With small changes, the average initial live body weight of lambs fed the varied meals was essentially identical for all groups. Lambs fed on R2 and R3 gained significantly more total body weight, average daily increase, and final live body weight than lambs fed R1. When compared to R1, the ADG of R2 and R3 increased by 5.62 and 8.84 percent, respectively. Table 7 shows the feed conversion efficiency of lambs fed various rations. When, feeding R2 and R3 diets compared to feed in R1 diet. The DM and CP conversion improved significantly ($P<0.05$) in R2 and R3 compared with R1. The TDN and DCP conversion were essentially same in all groups, with very minor variances.

DISCUSSION

Corn stover silage supplemented with soybean meal or optigen can promote anaerobic fermentation of dry matter, which improves nutrient utilization efficiency and plays a guided role in improving digestion in abomasums, resulting in improved R2 and R3 digestibility coefficients. The current results were validated by Galina *et al*. (2003), who found that feeding a diet containing slow-release urea (SRU) enhanced nutrient digestibility in children. Moreover, they proposed that this was due to an increase in rumen pH and increased fiber fermentation by rumen bacteria as a result of providing nonprotein nitrogen (NPN), additional Sulphur essential amino acids, and phosphorus, as well as a consistent source of phosphorus. According to Obeidat *et al*. (2020), soybean

Table 6. Feed intake by lambs fed different tested rations.

Item	Experimental rations			±SE	*p-value*
	R1	R2	R3		
As fed (g/head/day)					
Concentrate feed mixture	792.15	672.33	682.80		
Corn stover silage	1452.70	1834.10	1765.50		
Total intake	2244.85	2506.43	2448.30		
As DM (g/head/day)					
DM	1211.20	1233.60	1252.80	9.32	0.199
TDN	751.48^{b}	797.42^{a}	806.77^{a}	9.67	0.021
CP	142.68	145.56	148.58	1.20	0.120
DCP	96.29^{b}	101.40^{a}	103.19^{a}	1.18	0.034

a, b: Values in the same row with different letters are significantly different at 5% level.

Table 7. Growth performance and feed efficiency of lambs fed tested rations.

Item	Experimental rations			±SE	*p-value*
	R1	R2	R3		
Period (day)	150	150	150		
Initial body weight (kg)	25.40	25.40	25.60	0.17	0.347
Final body weight (kg)	50.30^{b}	51.70^{a}	52.70^{a}	0.49	0.032
Total weight gain (kg)	24.90^{b}	26.30^{a}	27.10^{a}	0.36	0.029
Average daily gain (g)	166.00^{b}	175.33^{a}	180.67^{a}	2.43	0.021
ADG improvement %	0.00^{c}	5.62^{b}	8.84^{a}	1.30	0.025
DM (kg/kg gain)	7.30^{a}	7.04^{b}	6.93^{b}	0.07	0.031
TDN (kg/kg gain)	4.53	4.55	4.47	0.03	0.253
CP (g/kg gain)	859.52^{a}	830.21^{b}	822.38^{b}	4.71	0.042
DCP (g/kg gain)	580.09	578.33	571.16	3.60	0.316

a, b, c: Values in the same row with different letters vary significantly at 5% level.

meal supplementation improved nutrient digestibility in Awassi lambs fed on a low-quality pasture (65% wheat straw and 35% Alfalfa hay mixture) diet. According to Taylor-Edwards *et al*. (2009), the apparent total tract digestibility of DM, ADF, NDF, and OM were equal in diets supplemented with soybean meal and slow-release urea. Furthermore, Santiago *et al*. (2015) discovered that slow-release urea in place of soybean meal had no significant effect on the digestibility of DM, CP, or NDF.

The fact that soybean meal and optigen supplementation extend microbial consumption during rumen fermentation may explain the improvement in R2 and R3 feeding parameters. Srour (2017) also discovered that partially substituting Optigen as slow-release urea for soybean meal increased the nutritional content of lamb diets. Without reducing nutritional value, soybean meal can be partially replaced with a slow-release urea, according to Sinclair *et al*. (2012) and Eweedah *et al*. (2016).

The rumen pH of Awassi lambs fed different diets was similar, and soybean meal supplementation had no impact (Obeidat *et al*., 2020). The VFS are produced in the rumen as a result of anaerobic fermentation. They are absorbed through the rumen wall, used by rumen bacteria, and a trace quantity of which is excreted in the lower intestine. The rumen TVFA concentration is constrained by a variety of factors, such as rate of absorption, digestibility, rumen pH and transit of the digest from the rumen to other regions of the digestive system, and the rumen microbial population and its activity (Wanapat *et al*., 2014). By modifying its pattern over time, one or more of these factors can influence the total concentration of TVFA detected in the rumen medium. Because the ammonia level of the rumen is determined by the balance of production (proteolysis) and absorption, all efforts to maximize nitrogen use in the rumen should aim to achieve an optimal balance between metabolic activities (De Visser *et al*., 1997). Mehrez (1992) the rumen's dietary type and amount of fermented energy also controlled the ideal ammonia-N concentration for maximum rumen fermentation rate. According to Eweedah *et al*. (2016), while no significant changes in pH were observed across experimental groups (P

>0.05), significant differences in ruminal ammonia-N and total VFA concentrations were observed (P 0.05).

Protein catabolism and anabolism in the body must be in balance is shown by plasma protein concentration (Abdel Hameed *et al*., 2013). Antibodies for a general immune response are carried by globins, which hold the lipid fraction of proteins (Rastogi, 2008). As renal exertion is reduced, non-protein nitrogen such as urea accumulates in plasma. A high-protein meal, intestinal hemorrhage, dehydration, shock, severe hemorrhage, and other factors all contributed to the increase in its blood concentration. Urea levels in the blood can be decreased as a result of liver failure, a low-protein diet, and anabolic steroids, for example, diabetes insipidus (Bush, 1991). Creatinine is one of the metabolites that are formed in the muscle when water is removed from creatine phosphate. Additionally, its origins are in cellular metabolism. Due to the fact that creatinine is produced daily and constantly excreted per kilogram of muscle mass, it is the most commonly utilized marker for estimating daily urine excretion. Furthermore, its efficacy is independent by food intake or diet composition (Valadares Filho *et al*., 2007). Dietary consumption of soybean meal or urea had no influence on blood protein, urea, ALT, or AST levels (P>0.05) (Saro *et al*., 2019). Besides other biochemical indicators, SRU showed no effect on serum glucose, total protein, albumin, globulin, urea, creatinine, ALT, or AST (Ravi Kanth Reddy *et al*., 2019).

Low-quality forages and protein supplementation had a favorable interaction impact on nutritional quality and consumption, which was consistent with previous research. However, favorable response to protein supplement consumption was not uniform across different protein supplement sources (Obeidat *et al*., 2020). SBM supplementation enhanced forage consumption in the current research, which was consistent with Paulino *et al*. (2008). McDonald *et al*. (1995) discovered that protein intake and feed digestibility have a beneficial relationship. Maintaining a healthy protein-to-energy ratio in the diet might assist in increasing forage consumption according to Figueiras *et al*. (2016). On the other hand, protein supplements can help to maintain nutritional balance. This can help to alleviate metabolic discomfort in the animal and boost forage consumption. Saro *et al*. (2019) revealed that In Assaf male lambs fed diets supplemented with soybean meal or urea, feed consumption was nearly same.

Obeidat *et al*. (2020) reported that lambs fed the SBM had significantly larger final BW and ADG (P0.008) than lambs fed the control diet. According to other researches, such as Chegini *et al*. (2019) and Manera *et al*. (2014), protein supplementation increased the ADG and BW benefit of various sheep breeds that received greater doses of protein supplements. Saro *et al.* (2019) observed that Assaf male lambs fed diets supplemented with soybean meal or urea acquired roughly the same final body weight and average daily growth whether fed diets supplemented with soybean meal or urea. These findings are backed up by Eweedah *et al*. (2016), who found that Holstein steers fed a ration containing optigen had higher feed conversion values than those fed a control ration without optigen. Saro *et al*. (2019) revealed that the feed efficiency of Assaf male lambs fed diets supplemented with soybean meal or urea was approximately comparable.

CONCLUSION

The addition of corn stover silage supplemented with 3% soybean meal or 0.5% optigen, improved feed intake, digestion, feed conversion, rumen function, and body weight gain of fattening *Rahmani* lambs.

CONFLICT OF INTEREST

None declared.

REFERENCES

Abdel Hameed, A., Fedel Elseed, A. and Salih, A., 2013. Growth performance and rumen fermentation of lambs fed untreated or urea treated groundnut hull with different protein sources. J. Anim. Prod. Advances 3, 86-96.

AOAC, 1990. Official Methods of Analysis: Changes in Official Methods of Analysis Made at the Annual Meeting. Supplement, Assoc Off Anal Chem J.

Beever, D.E. and Cottrill, B.R., 1994. Protein Systems for Feeding Ruminant Livestock: A European Assessment. J. Dairy Sci., 77, 2031-2043.

Bush, B., 1991. Interpretation of laboratory results for small animal clinicians. Blackwell Scientific Publications Ltd.

Charmley, E., 2001. Towards improved silage quality - A review. Canadian J. Anim. Sci., 81, 157-168.

Chegini, R., Kazemi-Bonchenari, M., Khaltabadi-Farahani, A.H., Khodaei-Motlagh, M. and Salem, A.Z.M., 2019. Effects of liquid protein feed on growth performance and ruminal metabolism of growing lambs fed low-quality forage and compared to conventional protein sources. The J, Agric, Sci., 157, 272-280.

De Visser, H., Valk, H., Klop, A., Van Der Meulen, J., Bakker, J.G.M.

and Huntington, G.B., 1997. Nutrient Fluxes in Splanchnic Tissue of Dairy Cows: Influence of Grass Quality. J. Dairy Sci., 80, 1666-1673.

Eweedah, N., Bassuony, M., EL-Razik, A. and El-Baky, M., 2016. Effect of supplementing different levels of opteigen as a replacer to soybean on the steers' performance. J. Agric. Research. Kafr El-Shaikh University 42, 129-143.

Ferraretto, L.F. and Shaver, R.D., 2015. Effects of whole-plant corn silage hybrid type on intake, digestion, ruminal fermentation, and lactation performance by dairy cows through a meta-analysis. J. Dairy Sci., 98, 2662-2675.

Figueiras, J.F., Detmann, E., Franco, M.O., Batista, E.D., Reis, W.L.S., Paulino, M.F. and Valadares Filho, S.C., 2016. Effects of Supplements with Different Protein Contents on Nutritional Performance of Grazing Cattle During the Rainy Season. Asian-Australasian J. Anim. Sci., 29, 1710-1718.

Galina, M.A., Pérez-Gil, F., Ortiz, R.M.A., Hummel, J.D. and Ørskov, R.E., 2003. Effect of slow release urea supplementation on fattening of steers fed sugar cane tops (Saccharum officinarum) and maize (Zea mays): ruminal fermentation, feed intake and digestibility. Livestock Prod. Sci., 83, 1-11.

Galo, E., Emanuele, S.M., Sniffen, C.J., White, J.H. and Knapp, J.R., 2003. Effects of a Polymer-Coated Urea Product on Nitrogen Metabolism in Lactating Holstein Dairy Cattle. J. Dairy Sci., 86, 2154-2162.

Ghizzi, L.G., Del Valle, T.A., Zilio, E.M.C., Sakamoto, L.Y., Marques, J.A., Dias, M.S.S., Nunes, A.T., Gheller, L.S., de P. Silva, T.B., Grigoletto, N.T.S., Takiya, C.S., da Silva, G.G. and Rennó, F.P., 2020. Partial replacement of corn silage with soybean silage on nutrient digestibility, ruminal fermentation, and milk fatty acid profile of dairy cows. Anim. Feed Sci. and Tech. 266, 114526.

González-Alcántara, F.d.J., Estrada-Flores, J.G., Morales-Almaraz, E., López-González, F., Gómez-Miranda, A., Vega-García, J.I. and Arriaga-Jordán, C.M., 2020. Whole-crop triticale silage for dairy cows grazing perennial ryegrass (Lolium perenne) or tall fescue (Lolium arundinaceum) pastures in small-scale dairy systems during the dry season in the highlands of Mexico. Tropical Animal Health and Production 52, 1903-1910.

Harrison, G. and Karnezos, T., 2005. Can we improve the efficiency of nitrogen utilization in the lactating dairy cow. Recent Advances in Animal Nutrition in Australia 15, 143-154.

Harrison, J.H., Blauwiekel, R. and Stokes, M.R., 1994. Fermentation and Utilization of Grass Silage. J. Dairy Sci., 77, 3209-3235.

Henchion, M., Hayes, M., Mullen, A.M., Fenelon, M., Tiwari, B., 2017. Future Protein Supply and Demand: Strategies and Factors Influencing a Sustainable Equilibrium. Foods 6.

Henderson, N., 1993. Silage additives. Anim. Feed Sci. and Tech., 45, 35-56.

Kim, S.W., Less, J.F., Wang, L., Yan, T., Kiron, V., Kaushik, S.J. and Lei, X.G., 2019. Meeting global feed protein demand: challenge, opportunity, and strategy. Annual Review of Anim. Biosciences 7, 221-243.

Manera, D.B., Voltolini, T.V., Yamamoto, S.M., de Araújo, G.G.L. and Souza, R.A., 2014. Productive performance lambs on grazing supplemented with concentrates containing fruit processing by-products. Semina: Ciências Agrárias 35, 1013-1022.

McDonald, P., Edwads, R.A., Greenhalh, F.D. and Morgan, C.A., 1995. Animal Nutrition. 5th Ed., Prentices Hall, London, UK.

McDonald, P., Henderson, A. and Heron, S., 1991. The biochemistry of silage 2nd ed. Marlow, UK: Chalcombe Publications.

Mehrez, A., 1992. Influence of roughage: concentrate ratio on N requirements of rumen microbes for maximal rate of fermentation, Proc of Int Conf on Manipulation of Rumen Microorganisms to Improve Efficiency of Fermentation and Ruminant Production. Alex Egypt, p. 234.

Mentz, A., Van Niekerk, W.A., Hassen, A., Coertze, R.J. and Gemeda, B.S., 2015. Effect of diets differing in rumen soluble nitrogen on utilization of poor-quality roughage by sheep. South African J. Anim. Sci., 45, 528-537.

Merensalmi, M. and Virkki, M., 1991. The role of enzymes in the preservation and utilization of forage, Proc. 5th Int. Symp. Forage Preservation, Nitra, Czechoslovakia, pp. 43-46.

Miranda, M.S., Arcaro, J.R.P., Saran Netto, A., Silva, S.L., Pinheiro, M.G. and Leme, P.R., 2019. Effects of partial replacement of soybean meal with other protein sources in diets of lactating cows. Anim., 13, 1403-1411.

NRC, 2007. Nutrient requirements of small ruminants. National Academy of Sciences, Washington, DC. USA.

Obeidat, B.S., Subih, H.S. and Ata, M., 2020. Protein Supplementation Improves Performance of Lambs Fed Low-Quality Forage. Anim., 10.

Olafadehan, O., Adewumi, M. and Fakolade, P., 2014. Effect of replacement of soybean meal with urea or urea supplemented with sulphur on the performance of lambs. Sch. J. Agric. Vet. Sci 1, 80-185.

Paulino, M., Detmann, E., Valente, E. and Barros, L., 2008. Nutrition of grazing cattle. Simpósio Sobre Manejo Estratégico Da Pastagem 4, 131-169.

Pulina, G., Milán, M.J., Lavín, M.P., Theodoridis, A., Morin, E., Capote, J., Thomas, D.L., Francesconi, A.H.D. and Caja, G., 2018. Invited review: Current production trends, farm structures, and economics of the dairy sheep and goat sectors. J. Dairy Sci., 101, 6715-6729.

Rastogi, S.C., 2008. Essentials of Animal Physiology. Fourth edition. New Age International (P) Limited, New Delhi. .

Ravi Kanth Reddy, P., Srinivasa Kumar, D., Raghava Rao, E., Venkata Seshiah, C., Sateesh, K., Pradeep Kumar Reddy, Y. and Hyder, I., 2019. Assessment of eco-sustainability vis-à-vis zoo-technical attributes of soybean meal (SBM) replacement with varying levels of coated urea in Nellore sheep (Ovis aries). PLoS One 14, e0220252.

Santiago, B.T., Villela, S.D.J., Leonel, F.d.P., Zervoudakis, J.T., Araújo, R.P., Machado, H.V.N., Moreira, L.M., Oliveira, T.S.d., 2015. Slow-release urea in diets for lactating crossbred cows. Revista Brasileira de Zootecnia 44, 193-199.

Saro, C., Mateo, J., Andrés, S., Mateos, I., Ranilla, M.J., López, S., Martín, A., Giráldez, F.J., 2019. Replacing Soybean Meal with Urea in Diets for Heavy Fattening Lambs: Effects on Growth, Metabolic Profile and Meat Quality. Anim., 9.

Schneider, B.H., Flatt, W.P., 1975. The Evaluation of Feeds Through Digestibility Experiments. The University of Georgia Press, Athens, Georgia, USA. .

Sinclair, L.A., Blake, C.W., Griffin, P., Jones, G.H., 2012. The partial replacement of soyabean meal and rapeseed meal with feed grade urea or a slow-release urea and its effect on the performance, metabolism and digestibility in dairy cows. Anim., 6, 920-927.

Supapong, C., Sommai, S., Khonkhaeng, B., Suntara, C., Prachumchai, R., Phesatcha, K., Chanjula, P., Cherdthong, A., 2022. Effect of Rhodanese Enzyme Addition on Rumen Fermentation, Cyanide Concentration, and Feed Utilization in Beef Cattle Receiving Various Levels of Fresh Cassava Root. Fermentation 8.

Taylor-Edwards, C., Elam, N., Kitts, S., McLeod, K., Axe, D., Vanzant, E., Kristensen, N., Harmon, D., 2009. Influence of slow-release urea on nitrogen balance and portal-drained visceral nutrient flux in beef steers. J. Anim. Sci., 87, 209-221.

Valadares Filho, S., Pina, D., Azevêdo, J., Valadares, R., 2007. Estimativa da produção de proteína microbiana utilizando a excreção de derivados de purinas na urina. Simpósio Internacional avanços em técnicas de pesquisa em nutrição de ruminantes 1, 90-120.

Van Keulen, J., Young, B., 1977. Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44, 282-287.

Varlyakov, I., Radev, V., Slavov, T., Mihaylov, R., 2015. Ethological and haematological indices in yearling sheep fed various dietary nitrogen sources. Agric. Sci. and Tech., 7, 423-430.

Yitbarek, M. B. and Birhan, T., 2014. Silage Additives: Review. Open J. Applied Sci., 4, 258-274.

Wanapat, M., Gunun, P., Anantasook, N., Kang, S., 2014. Changes of rumen pH, fermentation and microbial population as influenced by different ratios of roughage (rice straw) to concentrate in dairy steers. The J. Agric. Sci., 152, 675-685.

Warner, A., 1964. Production of volatile fatty acids in the rumen: methods of measurement. Nutr.Abst. and Rev. 34, 339.

Wilkinson, J.M., Rinne, M., 2018. Highlights of progress in silage conservation and future perspectives. Grass and Forage Science 73, 40-52.