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EFFECTS OF DIETARY VIRGINIAMYCIN ON FEEDING VALUES, NITROGEN METABOLISM AND RUMEN FERMENTATION OF SHEEP

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ABSTRACT

This study was conducted at the Experimental Farm of Animal Production Department, Faculty of Agriculture, Minia University, Egypt, to evaluate the effect of virginiamycin as feed additive on feeding values, nitrogen metabolism and rumen fermentation of Ossimi rams. The tested rations (R1, R2, R3 and R4) represented four treatments that contain 0, 12, 24 and 36 ppm virginamycin, respectively. Virginiamycin tended to improve insignificantly the digestibility coefficients of crude protein (CP), and nitrogen free extract (NFE), but ether extract (EE) digestibility showed significant improvement for R2, R3 and R4 compared to the control diet. Crude fiber (CF) digestibility decreased insignificantly by the inclusion of virginiamycin in the diet, however, the digestibility coefficients of dry matter (DM) and organic matter (OM) were not affected by virginiamycin to the diet. Feeding values as TDN and SV increased gradually insignificantly in the case of animals fed virginiamycin supplemented rations. Total nitrogen excreted, digestible nitrogen (DN), showed insignificant differences, but urine nitrogen decreased ($P \leq 0.05$), for R2, R3 and R4 compared to the control. Nitrogen balance (g / day or as % digestible nitrogen) were insignificantly increased, but fecal nitrogen was insignificantly decreased.

Virginiamycin had no significant effect on ruminal pH, but a slight increase was recorded for diets R2 and R3. Sampling time lead to a decrease ($P \leq 0.05$) in ruminal pH, from 7.33 to 7.00 and 7.00 in 0, 2 and 4h after feeding, respectively. Propionate, butyrate and acetate / propionate ratio concentrations showed an

increase ($P \leq 0.05$), but insignificant effects were detected in the case of isovalerate and acetic acid concentrations. Sampling time had no significant effects on acetic, isobutyric, butyric and isovaleric. But, significant increases ($P \leq 0.05$) were recorded in the case of propionic and acetic / propionic ratio. Blood hemoglobin (Hb g/dl) and packed cell volume (PCV%) were increased for animals fed virginiamycin than the control animals.

INTRODUCTION

Virginiamycin, a composite antibiotic, is an antimicrobial feed additive that is produced as a fermentation product of *Streptomyces virginiae*. It is approved for use in ruminants to improve animal performance. Virginiamycin improved average daily gain and / or feed conversion of feedlot cattle. Also, incidence of liver abscess and severity was also reduced when virginiamycin was fed at levels of 19.3 or 27.6 mg/kg DM feed (Rogers *et al.* 1995). It can alter ruminal fermentation primarily by changing ruminal microbial populations that inhabit the gastrointestinal tract metabolic activities (Hedde *et al.*, 1982; Nagaraja *et al.*, 1997, Ives, *et al.*, 2002). It's antimicrobial activity on gram-positive bacteria and subsequent alterations in ruminal fermentation products are similar to those of monensin (Hedde *et al.*, 1982; Nagaraja *et al.*, 1987, 1997, Ives, *et al.*, 2002), namely an increase in propionate in the expense of acetate and methane. Virginiamycin is antimicrobial agent that limit *Lactobacillus sp.* and *S. bovis* overgrowth, thereby controlling lactic acid production. The accumulation of lactic acid has a number of undesirable effects including lowering ruminal pH, ruminitis, laminitis and other sequellae (Nocek, 1997 and Clayton *et. al.*, 1999). It is generally recognized that the use of ionophores in ruminants presents no hazard to human health arising from the potential to generate "resistant" foodborne bacteria, this is because ionophores are not used in human therapy due to their narrow therapeutic index; there is no genetic encoded resistance to their biophysical mechanism of action and there is rapid cell death (Russell and Houlihan, 2003).

However, the effect of virginiamycin on ruminal protein metabolism has not been fully investigated. So, this study was carried

out to investigate the effects of virginiamycin on feeding values, nitrogen metabolism and rumen fermentation using sheep.

MATERIALS AND METHODS

This study was conducted at the Experimental Farm of Animal Production Department, Faculty of Agriculture, Minia University, Egypt. The main objectives of this study were to evaluate the effects of virginiamycin as feed additive on feeding values, nitrogen metabolism and rumen fermentation of sheep. The tested rations (R1, R2, R3 and R4) represented four treatments that contain 0, 12, 24 and 36 ppm. virginiamycin, respectively.

Diet Preparation:

The rations used were prepared to contain 75% concentrate feed mixture (CFM) and 25% berseem (B) on DM basis.

Virginiamycin was added to the concentrate feed mixture to be 0, 12, 24 and 36 ppm DMB of the whole diet (75% CFM+ 25% B) on DMB. Diets chemical composition is presented in Table 1.

Digestibility trials:

Three yearling male sheep of an average 43 kg live body weight were assigned in a complete randomized design to determine digestibility coefficients and nitrogen metabolism of the tested rations. Animals were fed on one of the mentioned rations at a rate of 4% of their live body weight on DM bassis. The weighed diets were offered twice daily at 9.0 a.m. and 2.0 p.m. in equal portions; fresh water was available all the experimental period. Each digestibility experiment was continued for 21 days (14 days as preliminary period followed by 7 days total collection period of feces, urine and rumen liquor). Feces were weighed daily, mixed thoroughly and 10% representative samples were taken from each animal, dried at 60 °C for 72 hours. Dried feed fecal samples were ground through 1 mm screen and a sample of 50g / treatment / animal was taken for laboratory analysis. The samples of feed and feces were analyzed for crude protein (CP), crude fiber (CF), ether extract (EE) and ash according to A.O.A.C (1990). Daily acidified urine volume was measured, 10% representative sample was collected and used for urinary-N

determination at the end of experiment. Urine-N was carried out according to A.O.A.C. (1990) procedure.

Rumen fermentation:

Rumen liquor samples were collected day by day through the collection period of each experiment at 0, 2 and 4 hrs after the morning meal using stomach tube. Collected rumen fluid was tested immediately for pH using Jenway LTD 3020 pH meter. Few drops of saturated solution of mercuric chloride were added to the rest of filtrate portion to stop the microbial activity, strained through four layers of chesses cloth for each sampling time. Strained samples were frozen storage. VFA's concentrations were estimated using H.P.L.C.

Hematological parameters:

Heparinized blood samples (5ml) were collected from the jugular vein of each animal day by day through the collection period before animals access to feed or water. Whole blood samples were analyzed for hemoglobin (Hb) and packed cell volume (PCV) using the conventional methods.

Statistical Analysis:

Data were subjected to statistical analysis program (SPSS, program 1997), Duncan's multiple range test (1955) was used to detect significant differences among means.

RESULTS AND DISCUSSION

Digestibility coefficients and feeding values:

Digestibility of nutrients and feeding values as total digestion nutrients (TDN) and starch value (SV) are presented in Table, 2. It is clear that virginiamycin supplementation tended to insignificantly improve digestibility coefficients of CP and NFE, but a significant increase ($P \leq 0.05$) was detected in the case of EE digestibility. The digestibility coefficients of DM and OM did not altered by the inclusion of virginiamycin to the diet. Feeding values as TDN and SV showed insignificant increase in the case of animals fed virginiamycin supplemented rations by less than 2% for TDN and SV for R2, R3 and R4 compared to the control. The present results are in agreement with Wessels, *et. al.,* (1996), who concluded that dietary ionophore did not alter ruminal protein degradation or nutrient digestions.

Table 1 : Proximate analysis of concentrate feed mixture (CFM) and berseem (B).

Ingredients	Proximate analysis on DM basis						
	DM	OM	CP	CF	EE	NFE	ASH
CFM	89.08	89.08	14.20	13.03	2.09	59.76	10.92
Berseem (B)	90.12	86.15	16.97	22.45	2.23	44.50	13.85
75% CFM + 25% B	89.34	88.35	14.89	15.39	2.12	55.95	11.65

Where, DM, OM, CP, CF, EE and NFE are Dry matter, Organic matter, Crude protein, Crude fiber, Ether extract and Nitrogen free extract, respectively (CFM) composed of 30% wheat middling, 20% undecorticated cotton seed cake, 22% wheat bran, 12% yellow corn, 9% rice germ, 4% molasses, 2% limestone and 1% common salt.

Table 2 : Nutrient digestibility coefficients and feeding values (DM basis) of the tested rations (R1, R2, R3 and R4) fed to sheep.

Item	Rations				±SE
	R1	R2	R3	R4	
Digestibility coefficients, %					
DM	64.12	64.12	64.72	64.91	2.92
OM	65.52	65.97	66.30	66.55	2.79
CP	74.70	77.11	77.49	79.26	1.90
CF	51.03	42.64	39.01	42.98	4.43
EE	54.40[a]	64.54[b]	73.43[b]	62.01[b]	3.28
NFE	67.49	69.47	70.55	69.83	2.54
Feeding values, %					
TDN	59.33	60.00	60.52	60.45	3.16
SV	58.29	58.88	59.35	59.32	3.52

±SE: Plus or Minus Standard error, TDN: Total digestion nutrition, SV: Starch value.
A and b: Averages in the same raw with different superscripts are different ($P \leq 0.05$).

Nitrogen metabolism:

Total nitrogen excreted and digestible nitrogen (DN) values were insignificantly different by virginiamycin supplementation, but urine nitrogen was decreased ($P \leq 0.05$) for R2, R3 and R4 (19.48, 19.16 and 19.74) compared to the control (20.18) as presented in Table 3. Nitrogen balance (as g / day or as % digestible nitrogen) increased insignificantly, but fecal nitrogen decreased insignificantly by virginiamycin addition (Table 3). Ruiz, *et. al.*, (2001) found that the apparent nitrogen digestibility was increased by 5.4%, fecal nitrogen output was lower ($P < 0.05$), but urinary N output was not different for cows fed monensin supplemented diet compared with

proportion of propionate relative to other VFA's (Kellaway and Stimson. 1991).

Table 5 : Effects of sampling time on pH values and VFA's concentrations in rumen liquor of sheep.

Item	Time post-feeding			
	0h	2h	4h	±SE
Rumen liquor pH	07.33[a]	07.00[b]	07.00[b]	0.12
Acetic	46.96	47.56	46.59	1.29
Propionic	28.45[a]	29.02[b]	30.73[c]	0.67
Isobutyric	02.48	02.22	01.46	0.61
Butyric	20.80	20.29	20.59	1.25
Isovaleric	00.49	00.56	00.32	0.18
Valeric	00.84[a]	00.35[b]	00.31[b]	0.21
Acetic/Propionic ratio	01.66[a]	01.65[a]	01.52[b]	0.07

±SE, Plus or Minus Standard error.

a, b, and c: Averages in the same raw with different superscripts are different ($P \leq 0.05$).

Hematological parameters:

The obtained results of hematological parameters in the present study such as hemoglobin concentration (Hb g/dl) and packed cell volume% (PCV%) are presented in Fig. 1.

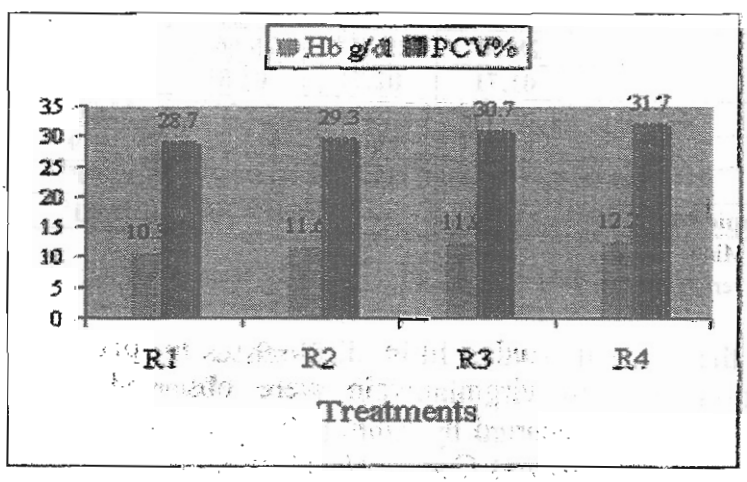

Figure 1: Effects of virginiamycin level on hemoglobin concentration (Hb) and packed cell volume (PCV%) of sheep.

Salinomycin supplemented diets recorded the highest values of Hb or PCV% compared to the control diet, the values of R1, R2, R3 and R4 were (10.3, 11.6, 11.9 and 12.2) and (28.7, 29.3, 30.7 and 31.7) for Hb and PCV%, respectively. The present results are in agreement with the finding of Soliman, *et. al.*, (2002). They reported that salinomycin at 12ppm on sheep diet led to a significant increase in both of Hb and PCV% of growing rams. The effects of virginiamycin may be the same as Salinomycin effect on hematological parameters, the increase of Hb and PCV for animals fed virginiamycin may attributed to the effect of such ionophore on rumen fermentation may account for the enhanced performance (Soliman *et. al.*, 2002).

CONCLUSIONS

In conclusion, supplementation of virginiamycin to sheep diet alter ruminal fermentation primarily by changing ruminal microbial populations. Virginiamycin altered the concentrations of propionic, butyric, valeric acids and acetic / propionic ratio in the rumen. Virginiamycin has the potential to increase the efficiency of N utilization in sheep fed 25% forage and to decrease fecal N excretion. Because of the increase in apparent N digestibility. The results of this trial suggest that virginiamycin spared amino acids from wasteful degradation in the rumen. The results of this study demonstrate that the virginiamycin can be used to formulate diets for growing sheep.

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تأثير إضافة الفيرجينياميسين إلى العليقة على القيمة الغذائية، ميتابوليزم النيتروجين وتخمرات الكرش فى الأغنام.

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أجريت هذه الدراسة فى مزرعة الإنتاج الحيوانى بكلية الزراعة جامعة المنيا لتقدير تأثير إضافة الفيرجينياميسين كمنشط نمو إلى علائق الأغنام على معاملات الهضم للمركبات الغذائية ، القيمة الغذائية ، ميتابوليزم النيتروجين وكذلك تخمرات الكرش. أضيف الفيرجينياميسين إلى العليقة التى تكونت من (٧٥% علف مركز + ٢٥% برسيم) على أساس المادة الجافة للحصول على أربعة معدلات من الفيرجينياميسين بالعليقة الكلية (المأخوذ الكلى من المادة الجافة) وهى:-

(R1) عليقة الكنترول خالية من الفيرجينياميسين.

(R2) عليقة الكنترول + ١٢ جزء/المليون فيرجينياميسين.

(R3)عليقة الكنترول + ٢٤ جزء/المليون فيرجينياميسين.

(R4)عليقة الكنترول + ٣٦ جزء/المليون فيرجينياميسين.

وكان من أهم النتائج المتحصل عليها مايلى:

أدت إضافة الفيرجينياميسين إلى زيادة تدريجية غير معنوية فى معاملات هضم المركبات الغذائية فيما عدا الألياف فأظهرت معامل هضم منخفض غير معنوى. إضافة الفيرجينياميسين للعليقة أدى إلى زيادة غير معنوية فى كلا من مجموع المركبات الغذائية المهضومة وكذلك معادل النشا وكانت هذه الزيادة تدريجية مع زيادة الفيرجينياميسين بالعليقة.

لم يتأثر كلا من الأزوت الخارج فى الروث ، الخارج الكلى ، المهضوم من الأزوت وكذلك ميزان الأزوت بإضافة الفيرجينياميسين غير أنه حدثت زيادة معنوية عند مستوى ٠,٠٥% فى الأزوت الخارج فى البول مع إضافة الفيرجينياميسين وخاصة عند مستويات ٢٤ ، ٣٦ جزء/المليون.

زيادة كلا من حمض البروبينيك والبيوتريك معنويا (٠,٠٥%) مع انخفاض كلا من الخليك والفاليريك ونسبة الخليك/البروبينيك معنويا (٠,٠٥%) فى الحيوانات التى تغذت على الفرجينياميسين بالمقارنة بالكنترول ، فى حين أنه لم تتأثر قيمة ال pH عند كل المستويات من الفرجينياميسين.

لوحظ ارتفاع تدريجى فى كلا من الهيموجلوبين ونسبة المكونات الخلوية بالدم مع زيادة الفرجينياميسين فى الحيوانات التى تناولت الفرجينياميسين بالعليقة بالمقارنة بالكنترول.