EFFECT OF SALINOMYCIN OR VIRGINIAMYCIN AS FEED ADDITIVES ON SHEEP PERFORMANCE

Sayed M. S. Moustafa[1] and Gamal M. El-Garhy[2]

1- Animal Production Department Faculty of Agric., Minia University, Minia, Egypt.

2- Animal Production Department Faculty of Agric., Cairo University, Fayoum Branch, Fayoum, Egypt.

ABSTRACT:

Both salinomycin and virginiamycin as feed additives in ruminants diet were nutritionally evaluated through digestibility and feeding trials. Eighteen growing Ossimi lambs, averaging 11.6 ± 0.31 kg in live body weight were assigned on three diets. The diets were (D_1) control, (D_2) control + 12 ppm salinomycin, and (D_3) control + 36 ppm virginiamycin. The control ration consisted of 75% concentrate feed mixture (CFM) + 25% rice straw (RS). Significant differences (P <0.05) for the final body weight gain between control diet (D_1) and other two diets were recorded. Insignificant differences were observed between the control diet (D_1) and the other two diets containing salinomycin (D_2) or virginiamycin (D_3) in total dry matter intake (TDMI) or average dry matter intake, g/day (ADMI, g / day), while the digested crude protein (DCP) values recorded for D_2 and D_3 were significantly higher (P < 0.05) then those for D_1. Insignificant differences were observed in OM, CF, NFE and EE digestibility coefficients between treatments, but the crude protein digestibility (CPD), values were significantly different (P <0.05) for D_2 and D_3 compared to the D_1. Insignificant differences for TDN and SV were recorded. Concerning the economical evaluation, D_2 or D_3 were very similar and recorded clear advantage comparing to the D_1.

Key words: Salinomycin, virginiamycin, nutrient digestibility, nutritive value, performance, sheep.

INTRODUCTION:

In Egypt, animal breeders have a considerable problem in animal production, especially in feedlot because of high cost of the animal unit production. So, the use of feed additives can help in improving efficiency of feed utilization and animal performance and consequently reducing the cost of animal unit products.

Salinomycin and virginiamycin are the widely growth promoters used in the world for animal production especially in ruminants nutrition. Virginiamycin, a composite antibiotic, is an antimicrobial feed additive that is produced as a fermentation product of Streptomyces virginiae؛ it's approved for use in ruminants to improve feed efficiency, growth rate and animal performance **(Ives *et al.* 2002)**. Salinomycin or virginiamycin improved average daily gain and feed conversion of feedlot cattle and growing lambs **(Rogers *et al.* 1995, McAllister *et al.* 1996 and Wagner *et al.*, 2000).** 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 as dry matter (DM) basis **(Rogers *et al.* 1995).** It is believed to alter ruminal fermentation primarily by

changing ruminal microbial populations that inhabit the gastrointestinal tract or their metabolic activities **(Wagner *et al.*, 2000)**. The gram-positive bacteria antimicrobial activity and subsequent alterations in ruminal fermentation products are similar to those of monensin **(Hedde *et al.*, 1982; Nagaraja *et al.*, 1997 and Wagner *et al.*, 2000)**, namely an increase in propionate at the expense of acetate and methane.

The study of **McAllister *et al.*, 1996** suggested that the recommended dose of salinomycin was in between 10 and 16 ppm of the diet. However, effect of salinomycin or virginiamycin as growth promoters on improving the efficiency of feeds under Egyptian conditions have not been fully investigated. So, this study was carried out to investigate the effects of salinomycin or virginiamycin on digestibility coefficients of feed nutrients, animal performance, feed efficiency and a simple economical evaluation of feeds was calculated for growing lambs.

Materials and Methods:

This study was conducted at the Experimental Farm of Animal Production Department, Faculty of Agriculture, El-Minia University, El-Minia, Egypt, to evaluate the effect of salinomycin or virginiamycin as feed additives on animal performance and feed conversion. The tested rations (D_1, D_2 and D_3) represented three treatments that contain 0, 12 ppm salinomycin and 36 ppm virginamycin, respectively. Where, D_1 was the control diet, D_2 was the control diet + 12 ppm salinomycin and D_3 was the control diet + 36 ppm virginiamycin. The control diet contained 75% CFM and 25% RS. The chemical composition of ingredients used in formulating the tested rations are presented in (Table, 1).

Table (1): Chemical composition of ingredients and calculated values for ration used in growth trial, on dry matter basis.

Item	% on DM basis						
	DM	OM	CP	CF	EE	NFE	Ash
CFM	88.4	89.45	12.5	16.6	2.3	58.05	10.55
RS	87.2	83.98	3.11	36.15	2.1	42.62	16.02
Control diet	88.1	88.08	10.15	21.49	2.25	54.19	11.92

Concentrate feed mixture (CFM), composed of : 40% wheat midlings, 20% undecorticated cotton seed cake, 11% wheat bran, 13% yellow corn, 9% rice germ, 4% molasses, 2% limestone and 1% commen salt.

Feeding trial: Eighteen weanling Ossimi male lambs of 11.6 ± 0.31 kg live body weight (three months old) were distributed into three groups, each of 6 lambs. Each group fed one of the experimental rations (D_1, D_2 or D_3) by the ratio of 1% and 3% of live body weight rice straw (RS) and CFM, respectively for 90 days. The animals were weighted every two weeks before morning feeding, the rations were offered twice daily at 9.0 a.m. and 2.0 p.m. into equal portions and adjusted according to body weight changes and water was freely available along the experimental period. Average daily gain, feed intake and feed conversion were determined.

Digestibility trials: Digestibility trials were carried out during the last two weeks of each treatment. Three animals of each group were used to determine digestibility coefficients of the tested diets. Animals were fed the experimental diets at 4% of live body weight. The weighted rations were offered twice

daily at 9.0 a.m. and 2.0 p.m. in equal portions, fresh water was available. Acid Insoluble Ash (AIA) was used as internal marker **(Van Keulen and Young, 1977)**.

Laboratory analysis:

Determinations of feeds and feces were carried out according to **A.O.A.C. (1990)** for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash determinations**.** Nitrogen free extract (NFE) was calculated by the difference.

Statistical analysis:

Complete randomized design was used for digestibility and feeding trials. The general linear model procedure adapted by SPSS (1997) was used and the least significant differences (LSD) was used when the treatments effect was significant **(Steel and Torrie, 1980)**.

Economical evaluation:

The cost of feeding was calculated, assuming that the price of one ton as DM of rice straw and concentrate feed mixture were 100 and 1000 LE, respectively and the price of one kg live body weight is 12 LE.

RESULTS:

Group feeding experiment:

Lambs performance: Results of growth performance, body weight gain for lambs fed on different diets are presented in (Table 2). Insignificant difference was found among treatments concerning initial body weight. Significant differences ($P < 0.05$) were obtained for final body weight gain between control diet (D_1) and other two diets (D_2 and D_3), while the differences between propiotic supplemented diets were insignificant.

Average total gain (ATG) and average daily gain (ADG) differed significantly ($P < 0.01$) between $_{D1}$ and both other two diets. The values were (9.1 *vs.* 11.63 and 11.52 kg) for ATG and (101.11 *vs.* 129.17 and 127.96 g / d) for ADG in D_1, D_2 and D_3, respectively.

Table (2): Effect of salinomycin and virginamycin as feed additives on ram lambs performance.

Item	Rations			SE
	D_1	D_2	D_3	
Average initial body weight, kg.	11.58	11.67	11.50	0.31
Average final body weight, kg.	20.68^{b}	23.29^{a}	23.02^{a}	0.49
Total gain, kg.	09.10^{B}	011.63^{A}	11.52^{A}	0.31
Average daily gain, gm.	101.11^{B}	129.17^{A}	127.96^{A}	3.49

Averages in the same raw with different superscripts are different ($P < 0.05$ for a and b, $P < 0.01$ for A and B). SE, standard error.

Feed intake: Insignificant differences ($P < 0.05$) were observed between control diet (D_1) and the other two diets containing salinomycin (D_2) or virginiamycin (D_3) in total dry matter intake (TDMI) or average dry matter intake, g/day (ADMI, g/d), while the digested crude protein (DCPg/d) values recorded significant differences ($P < 0.05$) for D_2 and D_3 compared to D_1 (Table 3). The figures concerning D_1, D_2 and D_3 were (56.96, 62.91 and 62.14), (632.89, 699.00 and 690.44) and (45.10, 52.26 and 52.01) for TDMI, ADMI and DCP respectively. While, no significant differences were observed between D_2 and D_3 for these parameters.

Table (3): Effect of salinomycin and virginamycin as feed additives on feed intake and feed conversion.

Item	Rations			SE
	D_1	D_2	D_3	
Feed intake:				
TDMI, kg/head.	56.96	62.91	62.14	01.33
ADMI, g / D	632.89	699.00	690.44	14.77
DCP, g / D	45.10[b]	52.26[a]	52.01[a]	01.08
Feed conversion,/ kg gain:				
DM, kg.	06.26[a]	05.41[b]	05.39[b]	0.13
DCP, g.	495.60[a]	449.36[b]	451.48[b]	06.86
SV, kg.	05.19[a]	04.02[b]	04.04[b]	0.18
TDN, kg.	06.15[a]	04.77[b]	04.80[b]	0.18

SE, standard error, TDN = Total digestion nutrients, DCP = Digestible crude protein and SV = Starch value.
Averages in the same raw with different superscripts are different (P<0.05) for a and b.

Feed conversion: Feed conversion expressed as DM, TDN, SV (kg/kg gain) and DCP (g / kg gain) are presented in (Table 3). Significant differences were recorded with D_2 and D_3 compared with D_1 concerning DM, TDN, SV and DCP. No significant differences were detected between D_2 and D_3 where the values were very close.

Digestibility trials:

Nutrients digestibility coefficients: Digestibility coefficients of OM, CP, CF, EE and NFE of different diets are presented in (Table 4). No significant differences were observed in OM, CF and EE digestibility coefficients values. However, D_2 and D_3 showed significant higher CP digestibility values compared to the control (D_1), the values were 70.20, 73.67 and 74.21 for D_1, D_2 and D_3 respectively. The improvement rate in CP digestibility were 4.94 % and 5.71 for D_2 and D_3, respectively compared with the control diet. The CF digestibility (CFD) values ranged between 29.17 for D_2 to 30.67% for D_1. Concerning the EE digestibility (EED), the values were close to each other and ranged between 84.90 to 85.30, (D_2 and D_3), respectively. The values of NFE digestibility ranged between 68.28 to 69.94 for D_3 and D_1, respectively.

Table (4): Digestibility coefficients of the tested diets, on dry matter basis.

Item	Rations			SE
	D_1	D_2	D_3	
Digestibility coefficients %				
OM	60.32	60.97	61.14	0.92
CP	70.20[b]	73.67[a]	74.21[a]	0.84
CF	30.67	29.17	30.10	0.56
EE	85.10	84.90	85.30	0.96
NFE	69.94	69.17	68.28	0.72

Averages in the same raw with different superscripts are different (P < 0.05) for a and b. SE, standard error.

Nutritive value: The nutritive values of the different diets used expressed as TDN, DCP and SV are presented in (Table 5). No significant differences were detected among D_1, D_2 and D_3 for TDN and SV. Concerning values for TDN and SV were (55.93, 55.53 and 55.32) and (47.20, 46.78 and 46.57) respectively. Even though the DCP showed significant differences (P < 0.05)

for the diets containing propiotics (D_2 and D_3) compared to the control diet, the values were (7.13, 7.48 and 7.53) for D_1, D_2 and D_3, respectively.

Table (5): Feeding values of the tested diets, on dry matter basis.

Item	Rations			SE
	D_1	D_2	D_3	
Feeding values:				
TDN %	55.92	55.53	55.32	0.65
SV %.	47.20	46.78	46.57	0.81
DCP %	07.13^b	07.48^a	07.53^a	0.11

Averages in the same raw with different superscripts are different ($P < 0.05$) for a and b. SE, standard error.

ECONOMICAL EVALUATION:

Taking into consideration the difference between the cost of feed intake and price of total gain (LE), it is clear that propiotic supplementation improved the interest. The relative percentage of cost of one kg gain for D_2 and D_3 were 86.36 and 86.17 % respectively compared to the control group (D_1).

Table (6): Economical evaluation of salinomycin and virginamycin as feed additives in lamb rations.

Item	Rations		
	D_1	D_2	D_3
Cost of feed intake, LE.[1]	48.65	53.74	53.07
Price of total gain, LE.[2]	109.2	139.5	138.2
Difference, LE.	60.55	85.82	85.17
Relation % of difference	100	142	141
Cost / kg gain	5.35	4.62	4.61
Relation % of cost / kg gain	100	86.36	86.17

Difference = $step^2 - step^1$
Relation % = assuming that the control is 100%
Cost / kg gain = $step^1$ / total gain
Relation % of cost / kg gain = assuming that the control is 100%

DISCUSSION:

The average daily gain for lambs fed diets containing salinomycin (D_2) or virginiamycin (D_3) were significantly higher (P <0.01) than the control group, the advantage percents were 27.75 and 26.85., respectively, (Table 4). These results could be explained in view of the digestibility coefficients of CP. The animals fed diets containing salinomycin or virginiamycin recorded improving in CP digestibility by (4.9 and 5.7) for D_2 and D_3, respectively (Table 4).

Total intake expressed as DM and (digestible crude protein) DCP were greater for the animals fed D_2 and D_3 when compared with the control group (Table 3). It is widely acceptable that increasing the energy level in the diet improve digestibility, accordingly the intake would be increased at least from digestible nutrients and net energy. Consequently the weight gain would be enhanced **(Etman *et al.*, 1987, Ridla and Unchida, 1999 and Shalaby *et al.*1989)**.

In the present study supplementation of salinomycin or virginiamycin to the diet improved average daily gain and (or) feed conversion, with no

substantial effect on dry matter intake. Pooled analyses of our study providing salinomycin or virginiamycin at 12 and 36 ppm, respectively of DM in the complete diet indicated that growth and feed conversion were improved (P< .05). These obtained results are in agreement with **(Richter, 1991 and Rogers *et al.* 1995)** on salinomycin and virginiamycin, respectively.

Changes in body weight during the experiment were significantly higher for animals fed diets containing salinomycin or virginiamycin. Previous studies have reported that adding lasalocid to high forage diets improved **(Thonney *et al*., 1981, Paterson *et al*., 1983, Spears and Harvey, 1984)** or had no effect **(Beacom *et al*., 1988, Steen *et al*., 1992)** on growth rate in cattle or sheep. Results herein on sheep were consistent with these observations. However, ionophores may inhibit ruminal amino acid deamination **(Russell and Martin, 1984; Beacom *et al.*, 1988; Yang and Russell, 1993 and Ives *et al*. 2002)**. This effect could increase amino acids for absorption. It also could minimize energy cost for converting excess ammonia absorbed into urea. It therefore appears that inhibition of methane formation and deamination in the rumen by ionophores both could result in conservation of energy and amino acids **(Ives *et al.* 2002)**.

In addition, when animals are fed high amounts of low quality forage and concentrate with a high rumen degradable protein content, there is often an imbalance between ruminal protein (high CP degradability) and carbohydrate fermentation (low carbohydrate availability), and excess ammonia can accumulate in the rumen **(Nocek and Russell, 1988)**.

It is uncertain whether the improvement in gain observed resulted from an increased intake. Average dry matter intake (ADMI/d) for D_2 and D_3 appeared insignificant compared to the control diet (Table 3). Some reports indicated that feeding lasalocid had no effect on feed intake of animals fed high forage diets **(Thonney *et al*., 1981, Steen *et al*., 1992)**. However, in the present study, the animals in groups (D_2 and D_3) reported significant higher DCP by 15.57 and 15.30% compared to the control group.

CONCLUSION:

In conclusion, supplementation of salinomycin or virginiamycin to growing lambs diets improved CP digestibility, feed conversion and average daily gain. It appeared that the increased weight gain in salinomycin or virginiamycin fed lambs could be attributed partially to the improved utilization of absorbed N **(Ives, *et al*. 2002)**.

Salinomycin or virginiamycin as growth promoters appeared to have a protein-sparing effect on feed proteins in the rumen of steers fed corn-based finishing diets. Thus, the inclusion of salinomycin or virginiamycin into diets could increase metabolic protein supply to ruminants **(Ives, *et al* 2002)**. In addition, the percent of improvements in economical return were 41.73 and 40.66% for D_2 and D_3, respectively compared to the control.

REFERENCES:

A.O.A.C. (1990): Official method of Analysis. Association of Official Analytical Chemists. 15th ed. Washington, D.C., USA.

Beacom, S.E., Z. Mi, G.O. Korsrud, W.D.G. Yates, and J.D. MacNeil. (1988). Effect of the feed additives chlortetracycline, monensin, and

lasalocid on feedlot performance of finishing cattle, liver lesions, and tissue levels of chlortetracycline. Can. J. Anim. Sci. 68:1131–1141.

Etman, K.E.I., M.E.S. Youseff, A.K.,Abu-Raya, Y. EL-Talty, and A.A.M. Fahmy (1987). Supplementing green forages with concentrate for buffalo-calves meat production: 2- Effect of berseem: concentrate ratios on fattening of calves and carcass qualities. Agriculture Res. Rev. 65: 831 – 841

Hedde, R.D., L. Shor, R. Quach, S.M. Free, R.C. Parish and C.J. Di Cuollo (1982). Virginiamycin activity and safety in ruminants. Proc. 2nd European Congress for Veterinary Pharmacology and Toxicology, Toulouse, France .

Ives, S.E., E.C. Titgemeyer, T.G. Nagaraja, A. del Barrio, D.J. Bindel and L.C. Hollis (2002). Effects of virginiamycin and monensin plus tyrosine on ruminal protein metabolism in steers fed corn-based finishing diets with or without wet corn gluten feed. J. Anim. Sci. 80:3005-3015

McAllister, T.A., C.B. Annett, M.E. Olson, D.W. Morck, and K.J. Cheng (1996). Effect of Salinomycin on Giardiasis and Coccidiosis in Growing Lambs. J. Anim. Sci. 74:2896–2903

Nagaraja, T.G., C.J. Newbold, C.J. Van Nevel, and D.I. Demeyer (1997). Manipulation of ruminal fermentation. Pages 523–632 in Rumen Microbial Ecosystem. 2nd ed. P.N. Hobson and C.S. Stewart, ed. Blackie Academic and Professional, London .

Nocek, J. E., and J. B. Russell (1988). Protein and energy as an integrated system. Relationship of ruminal protein and carbohydrate availability to microbial synthesis and milk production. J. Dairy Sci. 71:2070–2107.

Paterson, J. A., B. M. Anderson, D. K. Bowman, R. L. Morrison, and J. E. Williams (1983). Effect of protein source and lasalocid on nitrogen digestibility and growth by ruminants. J. Anim. Sci. 57:1537–1544.

Richter, GH. G. Flachowsky (1991): The effect of salinomycin on apparent digestibility, indices of rumen fermentation and fattening and slaughter yields of cattle**.** Arch Tierernahr. Jan; 41(1):85-96.

Ridla, M. and S. Unchida. (1999): Comparative study on the effects of the combined treatments of lactic acid bacteria and cellulose on the fermentation characteristics and compositions of Rhodes grass (Chloric gayana kunth) and Italian rye grass (*Lolium multiform* Lam) silages. Asian Oust. J. Anim. Sci. 12: 525-530.

Rogers, J., A.M.E. Branine, C.R. Miller, M.I. Wray, S.J. Bartle, R.L. Preston, D.R. Gill, R.H. Pritchard, R.P. Stilborn and D.T. Bechtol (1995). Effects of dietary virginiamycin on performance and liver abscess incidence in feedlot cattle. J. of Anim. Sci. 73, Issue 1: 9-20.

Russell, J.B., and S.A. Martin (1984). Effects of various methane inhibitors on the fermentation of amino acids by mixed rumen microorganisms in vitro. J. Anim. Sci. 59:1329–1338.

Shalaby, A.S., G.M. Abdul –Aziz, A.M. Rammah, and M.G. Beshay, (1989). Fodder beet a new forage in Egypt. 2-Nutritional evaluation of fresh fodder beet **(*Beta vulgaris* L.)** and its silage, with or without Roughage's. Third Egyptian – British conference on Animal, fish and poultry production, Alexandria, 7-10 October, 1989, 145-152.

Spears, J.W., and R.W. Harvey (1984). Performance, ruminal and serum characteristics of steer fed lasalocid on pasture. J. Anim. Sci. 58:460–464.

SPSS (1997). Statistical Package for Social Science release 8.0 copyright (c), SPSS INC., Chicago, USA.

Steen, T.M, J.D. Quigley, R.N. Heitmann and J.D. Gresham (1992). Effects of lasalocid and undegradable protein on growth and body composition of Holstein heifers. J. Dairy Sci. 75:2517–2523.

Steel, R.G. and J.H. Torrie (1980). Principles and procedures of Statistical. 2nd Ed. Mc-Grow-Hill, Book Co. Inc., London. U.K.

Thonney, M.L., E.K. Heide, D.J. Duhaime, R.J. Hand and D.J. Perosio (1981). Growth, feed efficiency and metabolite concentrations of cattle fed high forage diets with lasalocid or monensin supplements. J. Anim. Sci. 52:427–433.

Van Keulen, J. and B.A. Young (1977). Evaluation of acid insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44: 282.

Wagner, J. T., D. R. Grll, M. L. Gibson and R. L. Ball (2000). Effect of virginiamycin and monensin on efficiency and feed intake of growing heifers. J. Anim. Sci., 78: 87-90.

Yang, C.M.J., and J.B. Russell (1993). The effect of monensin supplementation on ruminal ammonia accumulation in vivo and the numbers of amino acid-fermenting bacteria. J. Anim Sci. 71:3470–3476.

تأثير السالينوميسين أو الفيرجينياميسين كمضافات غذائية على أداء الأغنام

سيد احمد محمد سيد احمد مصطفى[١] ؛ جمال محمود الجارحى[٢]

١- قسم الإنتاج الحيواني - كلية الزراعة – جامعة المنيا – المنيا - مصر

٢- قسم الإنتاج الحيواني – كلية الزراعة – جامعة القاهرة/ فرع الفيوم – الفيوم - مصر

أجريت هذه الدراسة بمزرعة كلية الزراعة بالمنيا – جامعة المنيا على عليقة تسمين مضافاً إليها منشطات نمو. أستخدم فى هذه الدراسة ١٨ حمل من ذكور الأوسيمي عند عمر ثلاثة أشهر بمتوسط وزن ١١.٦١ ± ٠.٣١ كيلو جرام. تم توزيع الحيوانات عشوائيا على ثلاثة مجاميع مع الأخذ في الاعتبار أن تكون متوسطات المجاميع متساوية بقدر الإمكان. وتم تغذيتها على العلائق المختبرة لمدة ٩٠ يوم. وتتمثل هذة العلائق في، عليقة الكنترول، عليقة الكنترول + ١٢ جزء في المليون سالينوميسين، عليقة الكنترول + ٣٦ جزء في المليون فيرجينوميسين. وتكونت عليقة الكنترول من ٧٥% علف مصنع + ٢٥% قش أرز. أوضحت النتائج المتحصل عليها ما يلي:

١- حققت العلائق المضاف إليها سالينوميسين وفيرجينياميسين أعلى معدلات نمو وكانت الزيادة معنوية عند مستوى ٥% عند مقارنتها بالكنترول وكذلك حققت تحسن في كل من معدل تحويل الغذاء بمستوى معنوية ٥% بالمقارنة بالكنترول وكذلك البروتين المهضوم، بينما لم يوجد اختلافات معنوية في قيم المركبات المهضومة الكلية، معادل النشا.

٢- أوضحت حسابات التقييم الاقتصادي للعلائق المختلفة على أساس تكلفة الغذاء وكذلك سعر الزيادة في الوزن الحي تفوق المجاميع التي غذيت على علائق تحتوى على منشط نمو (سالينوميسين وفيرجينياميسين) على الكنترول وكان معدل التحسن في العائد ٤٢%، ٤١% على التوالي. وكان من خلاصة هذه الدراسة إمكانية استخدام منشطات النمو موضع الدراسة في تسمين الأغنام مع الأخذ في الاعتبار النسب المسموح باستخدامها والتي تعطى التحسن المطلوب.