Effect of Different Ionophore Treatments on Some Rumen Metabolic Measures of Steers

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ABSTRACT

Twelve 380 kg beef steers were fed a 90% concentrate, cracked corn- based diet at 85% of ad libitum. Steers were divided into three daily ionophore treatment groups, Monensin - Tylan (MT), Lasalosid (L) or rotation of MT and L (MTL). Each daily dosage of Monensin and Tylan was 2.7 and 1.1 mg per $BW^{.7S}$, respectively. Lasolosid additions were given at 3 mg per $BW^{'75}$ daily. Ruminal samplings were taken on d 0, 2, 5, 16 and 45 after beginning ionophore treatments. A conventional digestibility trial was conducted with nine steers (three per treatment) at day 34 of feeding the ionophore and lasted for six days. Digestible energy (83.7%), urinary losses (3.3%) of total feed energy and the ratio of ME/DE (90%) did not differ across treatments. Methane losses were from 17 to 37% less on d 2 and 5 for MT and MTL treatments but increased quadratically (PO.05) on d 16 and 45 so that production exceeded d 0 levels. Treatment L did not affect methane production. Acetate to propionate and to butyrate ratios were reduced (PO.05) by MT and MTL with no effect for L addition. These data suggest that methane suppression does not persist beyond two weeks of ionophore treatment and a daily rotation of ionophores had no digestive or metabolic advantage over feeding MT daily. Further research is recommended to investigate the proper dose, componation and duration of ionophores supplementation in order to achieve the best results out of the fattening operations.

KEYWORDS: ionophore, energy, lasalosid, monensin, fattening, steers.

INTRODUCTION

Ionophores are biologically active compounds used in feedlot operations to improve efficiency of feed utilization in growing and finishing cattle (Ives et al., 2002). Because ionophores have been shown to affect the rumen microbes, there has been interest in attempting to control the rumen fermentation by feeding these compounds. It is well documented that monensin changes the molar proportion of Volatile Fatty Acids (VFA) by increasing propionate and decreasing acetate (Richardson et al., 1976; Maas et al., 2001), decreasing ruminal methane (Joyner et al., 1979; Wedegaertner and Johnson, 1983; Rumpler et al., 1986), increasing protein digestibility (Beede et al., 1980; Ives et al., 2002), decreasing ruminal deamination (Schelling et al, 1977; Ives **et** al., 2002), and decreasing ruminal proteolysis (Hanson and Klopfenstein, 1979; Kung et al., 2000; Duff et al., 1994). However, Rumpler et al. (1986), reported methane suppression persisted for only two weeks after lasalocid was added to the diet.

It has been suggested that ruminal microbes could adapt to an ionophore (Dinius et al., 1976; Herod et al., 1979, Witt et al., 1980), so rotation of ionophores may reduce microbial adaptation (Galyean and Owens, 1987) and prove beneficial in practical feeding programs.

This study was conducted to determine the effect of monensin-tylan or lasalocid or a daily rotation of these two treatments on concentration of fatty acids, ammonia and digestibility. This is not a straight comparison between ionophores since no antibiotic was included with lasalocid, but represents commercial usage.

Materials and Methods

Twelve calves averaging 380 kg were used for the experiment. The animals were dewormed with thiabendazole and intramuscularly injected with a vitamin mixture containing 1,000,000 IU of vitamin A, 150,000 IU

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of vitamin D-2 and 2,000 1U of vitamin E. prior to initiation of the experiment. All steers were implanted with Synovex S. Each animal was halter broken, gentled and placed in digestion stalls for ten days prior to the experiment starting. Throughout the experiment, the steers were fed a 90% concentrate diet formulated to meet NRC (1984) requirements. Proximate analysis and percent composition of this diet are presented in Table (1).

The feed intake of each steer was maintained at 85% ad libitum throughout the experiment. The ad libitum intake was established by averaging the intake of seven feeding days during the ten days adaptation period.

The twelve steers were randomly assigned to one of the three treatment groups, Monensin-Tylan fed daily (MT), Lasalocis fed daily (L) and alternating between Monensin-Tylan one day and Lasalocid the next (MTL).

With half given in the morning and half given in the evening meal, ionophores were fed with the daily feed allowance. Monensin was fed to steers at the rate of 2.7 me per BW^{75} with 1.1 mg per BW*^{75} of Tylan daily. Lasalocid was fed to steers at the rate of 3 mg per BW" daily. No antibiotic was included. The same concentration was maintained throughout the experiment. Tylan was used along with Monensin to achieve conditions similar to common commercial feedlot practices.

Methane production was estimated for each steer using the equation described by Czerkawski (1972) as:

$$\% \text{ Methane} = 8.0 - 0.113 \text{ propionate concentration.}$$

Calculations were made at days 0, 2, 5, 16 and 45.

A 6-day conventional digestion trial was conducted after d-34 of treatment with nine of the steers, three steers from each treatment, to determine metabolizability. Nitrogen content of feed and feces was determined according to the micro kjeldhal procedure (AOAC, 1980). Gross energy content of feed, feces and urine was measured using automatically controlled Parr Adiabatic oxygen bomb calorimeter* (AOAC, 1980).

Ruminal fluid was obtained from each steer 15 h after feeding, using a stomach tube. The first portion of the collection was discarded and the subsequent 100 ml was saved. The pH was determined immediately then the fluid was strained through four layers of cheese cloth. One portion of the strained ruminal fluid was mixed at a ratio of 5:1 with 25% metaphosphoric acid to be used for VFA analysis (Erwin et al., 1961). The other portion was preserved with mercuric chloride and stored for ammonia measurements. Samples for VFA determination were centrifuged at 10,000 RPM for ten minutes and the supernatant stored at - 12C for subsequent analysis. Concentrations of VFA were determined by gas-liquid chromatography procedures of Erwin et al. (1961) using a Shimadzu instrument**. Ammonia concentration was measured using 3 ml of rumen fluid samples via the MgO procedure of Bermner and Keeney (1965).

Data were analyzed using SAS (1986). This study was designed to examine the treatment by time interaction in a repeated measures design. The initial measurements on d 0 were not included in the analysis of variance, however, they were used for comparative purposes and were used as a covariate in some analyses.

Results **and Discussion**

Calculated methane production was initially depressed by as much as 37% below pre-treatment levels but increased over time of treatment in a quadratic manner ($P<0.01$) for treatment MT and MTL (Table 2). For treatment MT and MTL, methane production decreased on d 2 and 5 but increased afterwards. Meanwhile, none of these changes were different for treatment L. Methane production averaged 4.0% of GEI for treatment L (Table 2).

Similar to data of Rumpler et al. (1986) treatments with L, as well as, MT and MTL did not suppress methane production in steers fed with a high concentrate diet over the entire feeding period. Where there was an initial suppression, methane production had increased to initial levels by d 16. Initial methane suppression was more rapid for MT than MTL, suggesting suppression effects were delayed by the MT and L rotation. The lack of depression in initial methane in steers fed L containing diets agreed with results of Delfino et al. (1988) who reported lack of L effect on methane depression on steers fed a high concentrate diets. However, it is in contrast with results of Rumpler et al. (1986) who confirmed the effect of L on initial methane suppression. The typical response is not clear, however, the different fermentation pattern, i.e. high butyrate, of steers assigned *to* lasalocid perhaps should be noted.

Ionophore treatments did not differ in their effect on

* Parr Instruments, Molina, Illinois, USA, (AOAC, 1980).

** Shimadzu 8A GC Model, Shimadzu Corporation, Analytical Instrument Division, Koyoto, Japan.

digestibility of DM and energy (Table 3). Steers fed the lasalocid averaged lower (P<0.05) digestibility of CP **than** MT or MTL treatments. Little effect among treatments was observed on digestibility measurements. The trend for lower DM digestibility with L treatment was consistent with the literature when cattle were fed with a high concentrate diets (Berger et a!., 1981) or high roughage (Paterson et al., 1983; Kirk et al., 1994; Maas et al., 2001) diets. Unlike data of Peterson et al. (1983), we observed a lower digestibility of CP with treatment L.

Urinary losses of energy did not differ across treatments. Losses of energy as methane, when measured after 45 d of feeding ionophores, also did not differ across treatments.

The pH of rumen fluid samples was not affected by ionophore or day of treatment. Approximately 20% of the samples were found to have a pH of 7 or above indicating that the attempts to avoid saliva dilution were not always successful. Ammonia concentration in these rumen fluid samples averaged lower during the first three sampling periods than prior to ionophore treatments but **non** of these changes were significant.

Molar proportions of VFA (Table 4) are expected to accurately reflect treatment effects, unbiased by the probable saliva dilution. Molar proportions of acetate held approximately constant over the experiment regardless of treatment. Molar proportions of propionate increased during the early days of treatment but declined in a quadratic manner (PO.05) after ionophore addition for MT and MTL treatments. Propionic acid concentrations were inversely related to methane production over days of treatment. They were generally consistent with stoichiometric transfer of H 2 described by Czerkawski (1972), where propionic acid formation competes directly with nethane formation for the available hydrogen.

Additionally, molar percentages of propionate and butyrate were inversely related over days of treatment. These observations are evident in the erratic fermentation pattern and changes in propionate, butyrate and methane observed on d 16 for all treatments. Acetate to propionate ratio (A/P) decreased from when MT and MTL treatments began but then increased (PO.05) quadratically with day after ionophore treatment began. Treatments MT and MTL appeared to reduce the A/P, however, an erratic fermentation was detected in a high A/P on day 16 for both treatments. There was no change in A/P due to time for treatment L. Molar proportions of butyrate did not differ among treatments or due to day after ionophore feeding began. There was some evidence of a group difference (P<0.13) prior to treatment. Prior to ionophore addition (d 0), the molar proportions of acetate and butyrate were generally greater and propionate lower for steers allotted to treatment L verses steers which were to receive treatments MT and MTL.

Eventhough the component losses were **not** significantly different, there was some evidence of a metabolizabihty effect (Table 3). The ME value for treatment L was less (P<0.05) than the ME for MT and MTL. The high ME/DE ratios observed for all treatments is similar to other published results of high concentrate diets fed to cattle (Deramus, 1972; Moe et al., 1972; Brasher, 1973; Byers, 1974). However, these values were unlike the average value accepted by NRC (1984).

In conclusion, this study suggests that methane suppression does not persist beyond about two weeks for ionophore treatments and a daily rotation of ionophores had no digestive or metabolic advantage over feeding MT daily.

It is recommended that further research is needed to investigate the best procedure and does for ionophores to exert its effect on the parameter measured. The potential advantages of ionophores in fattening operations deserve this effort.

Implications

The suppression of methane by ionophores fed with high grain diets to feedlot cattle when observed, persist for less than 16 days. This action is unlikely to account for major long term effectiveness of ionophores. Rotation between ionophores does not appear to provide metabolic or digestive efficiency advantages.

Table 1. Composition of the diet fed to steers during the ionophore rotation experiment.

Feed constituent	Percent of dry matter
Cracked corn	80
Chopped alfalfa	**10**
Supplement*	10
Chemical composition**	
Crude protein, %	14.7
NDF%	27
ADF%	23
GE (Mcal/kg)	4.49
NEm (Mcal/kg)	2.22
NEg (Mcal/kg)	1.54
P,%	0.36
Ca, %	0.59
Na, %	0.03
K,%	0.57
Mg, %	0.15

*supplement composition: 85% SBM, 1.2% limestone, 0.286% salt, o.ol4% premix***.

* Calculated from NRC (1984) except for crude protein and GE which were by analysis, see text.

***Premix specifications: 3.9% Fe, 3.7% S, 12% I, 4% Mg, 2% Mn, 0.125% Cu, 0.18% Zn,^0.01% Se.

Table 2. Effect of MT, L or MTL on methane losses as percent of gross energy intake over 45 days of treatment to a 90% concentrate diet.

Treatment[ab]	0	2	5	16	45
MT	3.8	2.6	2.7	4.3	4.2
L	3.9	3.6	4.2	3.9	4.3
MTL[C]	4.1	3.4	2.6	6.0	5.6

''residual standard deviation.

[b] Day x treatment interaction (P<0.09).

[c] Quadratic effect due to day after treatment began (P<0.05).

-fable 3. Estimation of digestibility and metabolizability during week six of ionophore treatment (3 steers per treatment).

Ionophore treatment[3]	BW(kg)	DM intake, g/MBS/D	DIGESTIBILITY,% DM	CP	Energy	Losses,%GEI UE	CH4	ME,%
MT	373	69.8	82.8	68.3	84.8	3.6	4.4	76.9
L	357	67.5	**79.7**	**66.4[b]**	**81.0**	3.8	4.9	72.T
MTL	406	74.8	**84.3**	67.9	85.5	2.6	5.0	77.6
RSD[C]			**4.5**	**2.0**	**5.5**			6.2

Monensin-tylan (MT), Lasalocid (L), and rotation between these (MTL).

[b] Treatment L difference (P<0.05).

[c] Residual standard deviation.

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Table 4. Effect of MT, L or MTL on ruir inal volatile fatty acids **and pH** over **45** days **of** treatment to 90% concentrate diet.

Item/trt	*0*	*2*	*5*	*16*	*45*
Acetate, Moiar%					
(RSD[a]= 4.9)					
MT	48.5	44.7	44.7	45.3	45.3
L	51.5	53.3	49.0	50.0	47.3
MTL	49.3	44.5	45.5	48.8	44.0
Propionate[11], Molar%					
(RSD= 9.3)					
MT°	36.0	41.8	42.5	37.3	39.5
L	28.8	26.0	34.3	34.3	33.0
MTL[C]	36.3	42.0	44.0	23.5	33.0
Butyrate, Molar%					
(RSD= 9.3)					
MT	7.8	8.8	7.7	10.5	8.2
L	11.5	10.5	**10.0**	8.5	12.0
MTL	7.3	7.0	5.1	17.0	9.0
Acetate/pro ionate[1'],					
MT[C]	1.36	1.08	1.04	1.62	1.14
L	1.92	2.19	1.54	1.45	**1.59**
MTL[C]	1.39	1.05	1.04	2.55	1.46
Total VFA,mmole					
MT	64.5	67.4	71.3	93.9	76.1
L	72.8	63.6	73.8	69.6	84.1
MTL	73.5	90.1	81.8	65.4	120.5
pH					
MT	6.8	6.5	6.8	6.0	6.7
L	6.7	6.6	6.9	6.6	6.5
MTL	6.6	6.3	6.2	6.4	5.8

Residual standard deviation.
[b] Day x treatment interaction during d 2 to d 45 (P<0.02).
[c] Quadratic effect due to day after treatment began (P<0.05).

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التأثيرات الهضمية والايضية الناجمة عن اضافة مركبات النمو في علائق عجول التسمين

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استخدم في التجربة اثنا عشر عجلا من عجول التسمين وبمعدل وزن ٣٨٠ كغم، تمت تغذيتها على عليقة مركزة بنسبة ٩٠% تشكل الذرة المجروشة المادة الرئيسة لمكوناتها، وقد اعطيت العجول ٨٥% من كمية التناول الطوعي. قسمت العجول الى ثلاث مجموعات، غذيت المجموعة الاولى بمادة المونتسين مضافا اليها التايلان، والمجموعة الثانية بمركب اللاسالوسيد، بينما غذيت المجموعة الثالثة بالتبادل يوميا بين المونتسين-التايلان واللاسالوسيد. وكانت الجرعة اليومية من المونتسين والتايلان بمعدل ٢,٧ و١,١ ملغم لكل وحدة من الوزن الحيوي للحيوان، على الترتيب. وقد كانت الجرعة اليومية من اللاسالوسيد بمعدل ٣ ملغم لكل وحدة من الوزن الحيوي. وتم احتساب كمية الميثان الناتج بينما تم اخذ عينات من الكرش في الايام ٠، ٢، ٥، ١٦ و٤٥ من البدء بالتغذية على المركبات المذكورة. واشتملت الدراسة على تجربة هضم استخدم فيها تسعة من العجول (ثلاثة من كل مجموعة) حيث تم البدء بها في اليوم الرابع والثلاثين من بدء التغذية بالمركبات واستمرت ستة ايام. بينت التجربة انه لم يكن هناك تاثير معنوي للمركبات المستخدمة على الطاقة المهضومة وكمية الطاقة المفقودة في البول، والتي كانت قيمها المسجلة ٨٣,٧ و٣,٣% من الطاقة الكلية المتناولة، على الترتيب. وكانت نسبة الطاقة التمثيلية/الطاقة المهضومة تعادل ٩٠%، حيث لم تتاثر معنويا بالمركبات المضافة للعلائق. وبينت التجربة ان الميثان الناتج عن العجول في المجموعة الاولى والثالثة قد انخفض بنسبة ١٧ الى ٣٧% في اليوم الثاني واليوم الخامس الا ان نسبته قد ازدادت معنويا ($P<0.05$) في اليومين ١٦ و٤٥ ليساوي ويزيد عن النسبة الناتجة قبل البدء بالتغذية على المركبات المذكورة. هذا ولم يكن للاسالوسيد اي تاثير على نسب الميثان الناتج. وبينت التجربة ان نسب الاحماض الدهنية الطيارة قد تاثرت ($P<0.05$) في عجول المجموعة الاولى والثالثة بخلاف الثانية التي لم تتاثر بمركب اللاسالوسيد. ويستدل من التجربة ان تاثير المركبات المستخدمة على تثبيط الميثان كان لفترة زمنية لا تزيد عن اسبوعين بينما لم يكن هناك تاثيرات هضمية او حيوية للمركبات عند استخدامها بالتناوب. وبناء على هذه النتائج يوصى باجراء المزيد من البحث من اجل الاستخدام الامثل لمركبات النمو من حيث الجرعة الملائمة والفترة المستخدمة لهذه المركبات، وذلك من اجل الحصول على النتائج المتوخاة من هذه المركبات في حيوانات التسمين.

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