IONOPHORE COMPARISONS FOR FEEDLOT CATTLE

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Ionophores, such as monensin (Rumensin), have received much interest and have been the subject of considerable research during the past few years. Currently, monensin is the only one which has been cleared to date by the F.D.A. for use in feedlot cattle (in 1976) and in stockers (in 1978). Clearance for use of monensin in cows is expected or hoped for in the not too distant future. It is fair to say that the use of monensin or Rumensin would probably rank as one of the five greatest or most powerful tools for improving the efficiency of beef production to come along in the past 35-40 years. Other experimental ionophores which are being researched at the present time include Lasalocid (sodium), Narasin, Avoparcin, Salinomycin and Polyether A. At least one of these and perhaps others may also be cleared in the near future.

An ionophore is a compound which makes cations (ions which carry a + charge) lipid soluble. These have a polyether structure. Differences exist among them. Several ionophores have been used commercially as coccidiostats in poultry. Some of the effects which have been observed from use of monensin and some other ionophores in cattle and sheep include:

a) decreased feed intake (grain in feedlot cattle; and forage in cows, meaning more cow carrying capacity)
b) improved feed efficiency or feed/gain (in feedlot cattle, stockers and cows)
c) improved daily gain (in stocker cattle, approx. +.2 lb/day)
d) earlier puberty (approx. one month) in heifers at the same weight (Texas)
e) increased propionic acid and decreased acetic production in rumen
f) protein sparing in the diet (lower requirement) or improved protein utilization and/or efficiency
g) decreased methane production and improved efficiency of fermentation in the rumen
h) decreased rate of passage and rumen turnover
i) increase in digestibility of low quality forages (Texas)
j) increase (small) in starch digestion on high grain diets (Okla)
k) less protein degradation in rumen and increased bypass; shift of more organic matter digestion to intestines
l) increase in protein deposition or accretion in cattle on low or marginal protein diets
m) control of or substantial decrease in level and frequency of coccidiosis in cattle and sheep (several stations)
n) effective against gram positive, but not gram negative microorganisms

o) decrease in Strept bovis and other lactate producing rumen microorganisms (important in reduction of acidosis)(Kansas)
p) partial intake regulator in self feeding programs.

Information which may be of interest to some on several experimental ionophores follows:

Drug	Synthesized by	Company	Trade Name
Monensin	Streptomyces cinnamonensis	Elanco	Rumensin
Lasalocid	Streptomyces strain isolated in 1951 from soil; code X-537A empirical formula $C_{34}H_{52}O$	Hoffman-La Roche	Avatech or Bovatech
Narsin	Streptomyces aureofaciens	Elanco	
Avoparcin	Streptomyces candidus	Am Cyanamid	
Salinomycin	Streptomyces albus	A.H. Robbins	

Comprehensive summaries of feeding trials reported in the Abstracts of the Annual National Meetings of the American Society of Animal Science for the three most recent years (1979, 1980 and 1981) and in the Journal of Animal Science (1979, 1980 and 1981) are shown in the ensuing tables for Monensin, Lasalocid, Narasin, Avoparcin and Salinomycin. Moreover, results of 9 Oklahoma trials are given. Metric figures for gain and dry matter intake were converted to pounds. For review and comparative purposes, the widely reported "19 trial Rumensin summary of Elanco, 1975" is also included. For simplicity of presentation, only means are reported for different levels (where they existed) of Lasalocid, Narasin, Avoparcin and Salinomycin. It is recognized, however, that performance on the optimum drug level(s) may have exceeded the means reported herein. In this sense, the means shown in the tables may underestimate improvements actually noted on the best drug levels.

While it is recognized that some recent trials reported in annual State Experiment Station research reports or elsewhere are not included, the 1979-81 summaries shown involve numerous trials in many states. These include:

Monensin: 53 trials in 17 states, plus Canada
Lasalocid: 17 trials in 7 states
Narasin: 4 trials
Avoparcin: 5 trials
Salinomycin: 3 trials

Generally, larger improvements in feed/gain have been previously noted or reported with monensin on higher roughage diets(e.g. +15.4% in 7 high silage trials). A few of the trials included herein utilized relatively high roughage diets. While many factors could be involved, diet roughage level may have been somewhat of a contributing factor to the different mean improvements reported between the various monensin summaries ("19 trial 1975 Elanco summary" in table 1; 1979-81, 46 trial summary in table 2; and 7 trial Okla summary in table 7). Most interestingly, none of the 82 ionophore trials reported in Tables 2-6 showed a negative improvement in feed/gain.

Table 1. Elanco summary of 19 feedlot trials with Rumensin (1975)[a]

	Gain lb	DM Feed Intake lb/day	Feed/Gain	Response
Control	2.29	21.46	9.46	
Rumensin	2.28	19.17	8.46	+10.6%

[a]Summary by Elanco which has been widely cited in the national press and also partially used in obtaining original F.D.A. clearance (1976) for use of monensin in feedlot cattle.

Table 2. Monensin responses in feedlot cattle (1979, 1980, 1981).

Location	Reference[d]	Gain			DM Feed Intake			Feed/Gain		
		Control	Drug	Resp	Control	Drug	Resp	Control	Drug	Resp
		lb/day		%	lb/day		%	lb/lb		%
Kan.	81:633	2.36	2.28	- 3.7	18.7	17.9	- 4.3	7.99	7.85	+ 1.8
Kan.	81:633	2.34	2.43	+ 3.8	19.5	18.9	- 2.7	8.38	7.69	+ 9.3
KY	80:678	2.87	3.18	+10.8	21.7	20.6	- 4.9	7.54	6.47	+14.2
Cornell	80:707	1.35	1.15	-14.8	21.4	18.1	-15.0	14.25	13.77	+ 3.4
Ill.	80:576 or 53:1440	2.10	2.23	+ 6.3	15.6	15.8	+ 1.3	7.44	7.04	+ 5.4
Ill.	80:576 or 53:1440	2.25	2.28	+ 1.0	18.5	17.8	- 3.6	8.19	7.86	+ 4.0
Ill.	80:576 or 53:1440	2.19	2.28	+ 4.0	19.2	17.9	- 6.7	8.75	7.93	+ 9.4
L.S.U.	80:627	2.94	3.14	+ 6.8	22.3	22.5	+ 0.9	7.58	7.16	+ 5.5
Nebr.	80:671	1.86	1.92	+ 3.6	12.6	12.2	- 2.65	6.76	6.36	+ 5.9
Nebr.	80:671	1.39	1.44	+ 3.2	12.3	12.2	- 1.1	8.84	8.48	+ 4.1
Kan.	79:530	3.23	3.45	+ 6.8	24.7	23.7	- 4.1	7.55	6.83	+ 9.5
Kan	79:530	3.23	3.42	+ 6.2	27.7	26.3	- 5.3	8.54	7.60	+11.0
N.J.	79:532	2.23	2.45	+ 9.9	18.3	19.0	+ 3.6	8.21	7.73	+ 5.9
Kan.	79:573	equal							better	P<.05
TX Tech.	79:612[a]	2.63	2.74	+ 4.2	19.9	20.0	+ 0.7	7.56	7.31	+ 3.3
E.Lilly[a]	79:617[a]	2.91	2.92	+ 0.4	21.0	19.3	- 8.1	7.31	6.68	+ 8.6
S.D.	79:554	2.70	2.81	+ 4.1	19.1	18.0	- 5.6	7.10	6.41	+ 9.3
Colo.	79:563	3.18	3.23	+ 1.4	21.8	21.0	- 3.7	8.80	8.39	+ 4.7
TX Tech.	79:649	2.36	2.41	+ 1.9	23.3	21.9	- 6.3	9.86	9.07	+ 8.0
TX Tech.	79:649	2.61	2.65	+ 1.7	26.7	25.2	- 5.6	10.22	9.49	+ 7.2
Wash.	51:843	2.76	2.56	- 7.2	19.9	18.3	- 7.8	7.19	7.12	+ 1.0
Wash.	51:843	2.61	2.43	- 6.8	23.3	21.8	- 6.4	8.97	8.97	0
Florida	50:43	1.74	1.90	+ 8.9	27.5	26.1	-10.1	15.76	13.71	+13.0
Ohio	51:158	1.74	1.72	- 1.3	13.2	12.5	- 5.5	7.60	7.24	+ 5.8

Table continued on next page

(Monensin responses in feedlot cattle, continued)

Location	Reference[d]	Control lb/day	Drug lb/day	Resp %	Control lb/day	Drug lb/day	Resp %	Control lb/lb	Drug lb/lb	Resp %
Kan.	50:563	2.12	2.21	+ 4.2	17.8	17.6	- 0.6	8.62	8.38	+ 2.8
Florida	50:48	2.14	2.16	+ 1.0	18.9	16.4	-13.5	8.88	7.61	+14.3
Nebr.	48:476	1.35	1.41	+ 4.9	15.2	15.3	+ 0.3	11.46	11.15	+ 2.7
Nebr.	48:476	1.61	1.74	+ 8.2	15.6	16.0	+ 2.4	9.91	9.32	+ 6.0
Kan.	49:1066	1.86	1.88	+ 1.2	28.1	23.0	-18.1	15.12	12.24	+19.0
N.Mex.	53:780	2.96	3.23	+ 9.0	19.0	19.0	0	6.42	5.90	+ 8.1
Ontario	60:107 C J Ansi	2.34	2.30	- 1.9	21.6	19.7	- 8.9	9.23	8.57	+ 7.2
Ontario	60:107 C J Ansi	3.25	3.40	+ 4.8	17.1	16.4	- 4.4	5.27	4.81	+ 8.7
Ontario	60:107 C J Ansi	3.05	3.00	- 1.4	23.1	20.4	-11.7	7.59	6.79	+10.5
	Avg[b]	2.38	2.44	+ 2.5	20.14	19.09	- 5.2	8.84	8.19	+ 7.2
	Avg[c]	2.53	2.58	+ 2.0	20.39	19.15	- 6.1	8.40	7.75	+ 7.7

[a]Summary mean includes data from 2241 cattle in 14 trials in 10 states to evaluate Monensin and Tylosin combinations. Only monensin values are shown in the table; summary shows monensin-tylosin combination improved gain 1.4% and feed/gain 1.9% above monensin alone; the combination also lowered abcessed liver incidence 20% below monensin fed alone and 18.5% below the control (no monensin-no tylosin), respectively.

[b]Mean of 32 indivudual trial summary values listed above.

[c]Weighted mean of 45 trials, including the 14 trials described in footnote a.

[d]Am Soc Ani Sci National Meeting Abstract, year:abstract number or J Ani Sci, vol:page.

Table 3. Lasalocid responses in feedlot cattle (1979, 1980, 1981).

Location	Reference[a]	Gain			DM Feed Intake			Feed/Gain		
		Control	Drug	Resp	Control	Drug	Resp	Control	Drug	Resp
		lb/day		%	lb/day		%	lb/lb		%
N.J.	81:631	2.56	2.61	+ 1.7	23.2	21.3	- 8.4	9.04	8.15	+ 9.8
Kan.	81:633	2.36	2.30	- 2.8	18.7	17.7	- 5.3	7.99	7.80	+ 2.4
Kan.	81:633	2.34	2.52	+ 7.6	19.5	18.7	- 3.9	8.38	7.53	+11.3
N.J.	81:651	2.43	2.28	- 6.4	22.5	20.1	-10.8	9.30	8.80	+ 5.4
Florida	81:684			+19.0						+15.0
Cornell	80:707	1.35	1.59	+18.0	21.4	22.0	+ 3.2	14.25	12.25	+14.0
Ill.	80:576 or 53:1440	2.10	2.19	+ 4.2	15.6	15.5	- 0.7	7.44	7.06	+ 5.1
Ill.	80:576 or 53:1440	2.25	2.41	+ 6.9	18.5	18.5	0	8.19	7.64	+ 1.7
Ill.	80:576 or 53:1440	2.19	2.28	+ 4.0	19.2	18.1	- 5.9	8.75	7.94	+ 9.3
S.D.	80:647			+ 4.3			- 4.1			+ 8.3
Kan.	79:701	3.49	3.51	+ 0.6	26.4	23.3	-11.6	7.56	6.64	+12.1
Kan.	79:530	3.23	3.78	+17.1	24.7	24.3	- 1.8	7.55	6.46	+14.4
Kan.	79:530	3.29	3.69	+12.1	27.3	26.4	- 1.5	8.24	7.23	+12.3
N.J.	79:532	2.23	2.41	+ 7.9	18.3	17.8	- 3.0	8.21	7.44	+ 9.4
Kan.	79:573		equal			reduced			improved	
Kan.	49:1066	1.86	1.90	+ 2.4	28.1	25.1	-10.6	15.12	13.20	+12.7
	Avg.	2.42	2.56	+ 6.4	21.7	20.6	- 4.6	9.23	8.32	+ 9.9

[a] Am Soc Ani Sci National Meeting Abstract, year:abstract number or J Ani Sci, vol:page.

Table 4. Narasin responses in feedlot cattle.

Location	Reference[b]	Gain			DM Feed Intake			Feed/Gain		
		Control	Drug	Resp	Control	Drug	Resp	Control	Drug	Resp
		lb/day		%	lb/day		%	lb/		%
N.Dak.	79:547			+10.8						+ 9.5
E.Lilly	79:631	2.07	1.98[a]	- 4.3	26.4	22.0[a]	-17.0	12.78	11.09	+13.2
E.Lilly	79:631	2.33	2.05[a]	-12.3	25.8	21.2[a]	-17.6	11.08	10.42	+ 6.0
E.Lilly	79:631	2.79	2.66	- 4.7	25.4	21.6	-14.7	9.10	8.14	+10.5
	Avg.	2.40	2.22	- 2.6	25.9	21.6	-16.4	10.99	9.88	+ 9.8

[a]Mean of 2.75, 5.5 and 16.5 ppm; 33 ppm also improved F/G, but greatly lowered intake and gain.

[b]Am Soc Ani Sci National Meeting Abstract, year:abstract number.

Table 5. Avoparcin responses in feedlot cattle.

Location	Reference[a]	Gain			DM Feed Intake			Feed/Gain		
		Control	Drug	Resp	Control	Drug	Resp	Control	Drug	Resp
		lb/day		%	lb/day		%	lb/lb		%
S.D.	79:554	2.68	2.84	+ 5.7	19.0	17.4	- 8.2	7.10	6.14	+13.5
TX Tech.	79:649	2.35	2.55	+ 8.4	23.2	23.0	- 0.9	9.86	9.02	+ 8.5
TX Tech.	79:649	2.60	2.75	+ 5.9	26.5	26.7	+ 0.6	10.22	9.70	+ 5.1
Wash.	48:1340	2.60	2.75	+ 5.9	23.2	23.1	- 0.4	8.97	8.42	+ 6.1
Wash.	51:843	2.75	2.75	0	19.8	18.9	- 4.7	7.19	6.88	+ 4.3
	Avg.	2.60	2.73	+ 5.1	22.3	21.8	- 2.3	8.67	8.03	+ 7.4

[a]Am Soc Ani Sci National Meeting Abstract, year:abstract number or J Ani Sci, vol:page.

Table 6. Salinomycin responses in feedlot cattle.

Location	Reference[b]	Gain			DM Feed Intake			Feed/Gain		
		Control	Drug	Resp	Control	Drug	Resp	Control	Drug	Resp
		lb/day		%	lb/day		%	lb/lb		%
VPI	80:609									improved
VPI	80:657	2.86	3.21[a]	+12.3	24.2	23.2[a]	- 4.3	8.46	7.21[a]	+14.8[a]

[a]Mean of 16.5, 33 and 50 g/ton; improvement in gain averaged +16.9% and feed/gain +21% at 16.5 and 33 g levels.

[b]Am Soc Ani Sci National Meeting Abstract, year:abstract number.

Table 7. Recent ionophore comparisons from feedlot trials at Oklahoma State[a]

Ionophore	Cattle fed	Trials	Daily gain			Feed efficiency		
			Control	Drug	Response	Control	Drug	Response
			lb	lb	%	lb	lb	%
Monensin	800	7	3.33	3.33	0.0	5.82	5.53	5.0(3.3-5.8)
Lasalocid	84	1	3.38	3.40	0.6	5.75	5.31	7.7
Salinomycin	140	1	3.10	3.39	9.4	6.53	6.02	7.8

[a]Rations used in these trials contained from 5 to 15% roughage, primarily 5%.