Ionophore Comparisons for Feedlot Cattle

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Ionophores, such as monensin (Rumensin®) and Lasalocid, have received much interest and have been the subject of considerable research during the past few years. Monensin was the first inophore to be cleared 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 hoped for in the not too distant future. More recently (1982) Bovatec® (Lasalocid) was cleared for use in feedlot rations. *It is fair to say that the use of Rumensin or Bovatec 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 being researched at the present time include Narasin, Salinomycin and Polyether A, among others. Hopefully, at least one or more of these 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; in feedlot cattle, approx. + 2% + 7% for Rumensin and Bovatec with Salinomycin showing even greater increases in gain)
d) slight improvement in carcass quality traits (recent Idaho Study, Table 7)
e) earlier puberty (approx. one month) in heifers at the same weight (Texas)
f) increased propionic acid and decreased acetic production in rumen
g) possible protein sparing in the diet (lower requirement) or improved protein utilization and/or efficiency
h) decreased methane production and improved efficiency of fermentation in the rumen
i) decreased rate of passage and rumen turnover
j) increase in digestibility of low quality forages (Texas)
k) increase (small) in starch digestion on high grain diets (Okla)
l) less protein degradation in rumen and increased bypass; shift of more organic matter digestion to intestines
m) increase in protein deposition or accretion in cattle on low or marginal protein diets
n) control of or substantial decrease in level and frequency of coccidiosis in cattle and sheep (several stations), especially at the 30 g/ton level
o) effective against gram positive, but not gram negative micro-organisms
p) decrease in *Strept bovis* and other lactate producing rumen microorganisms (important in reduction of acidosis) (Kansas)
q) partial intake regulator in self feeding programs
r) decrease in excess hydrogen ions levels (energy sparing action)
s) improved cell membrane permeability for certain ions.

Information which may be of interest 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 emprical formula $C_{34}H_{52}O$	Hoffman-La Roche	Avatech or Bovatec
Narsin	**Streptomyces aureofaciens**	Elanco	
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 three 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 and Salinomycin. Moreover, results of some additional Oklahoma and other recent 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 and Salinomycin. It is recognized, however, that performance on the optimum drug level(s)

TABLE 1. Elanco summary of 19 feedlot trials with Rumesin (1975)[a].

	Gain	IM Feed Intake	Feed/Gain	Response
	lb.	lb./day		
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 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	Response	Control	Drug	Response	Control	Drug	Response
		lb/day		%	lb/day		%	lb/lb		%
Kansas	81:633	2.36	2.28	− 3.7	18.7	17.9	− 4.3	7.99	7.85	+ 1.8
Kansas	81:633	2.34	2.43	+ 3.8	19.5	18.9	− 2.7	8.38	7.69	+ 9.3
Kentucky	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
Illinois	80:576 or 53:1440	2.10	2.23	+ 6.3	15.6	15.8	+ 1.3	7.44	7.04	+ 5.4
Illinois	80:576 or 53:1440	2.25	2.28	+ 1.0	18.5	17.8	− 3.6	8.19	7.86	+ 4.0
Illinois	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
Nebraska	80:671	1.86	1.92	+ 3.6	12.6	12.2	− 2.65	6.76	6.36	+ 5.9
Nebraska	80:671	1.39	1.44	+ 3.2	12.3	12.2	− 1.1	8.84	8.48	+ 4.1
Kansas	79:530	3.23	3.45	+ 6.8	24.7	23.7	− 4.1	7.55	6.83	+ 9.5
Kansas	79:530	3.23	3.42	+ 6.2	27.7	26.3	− 5.3	8.54	7.60	+11.0
New Jersey	79:532	2.23	2.45	+ 9.9	18.3	19.0	+ 3.6	8.21	7.73	+ 5.9
Kansas	79:573	equal								better P < .05
TX Tech.	79:612	2.63	2.74	+ 4.2	19.9	20.0	+ 0.7	7.56	7.31	+ 3.3
E. Lilly[a]	79:617	2.91	2.92	+ 0.4	21.0	19.3	− 8.1	7.31	6.68	+ 8.6
S. Dakota	79:554	2.70	2.81	+ 4.1	19.1	18.0	− 5.6	7.10	6.41	+ 9.3
Colorado	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
Washington	51:843	2.76	2.56	− 7.2	19.9	18.3	− 7.8	7.19	7.12	+ 1.0
Washington	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
Kansas	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
Nebraska	48:476	1.35	1.41	+ 4.9	15.2	15.3	+ 0.3	11.46	11.15	+ 2.7
Nebraska	48:476	1.61	1.74	+ 8.2	15.6	16.0	+ 2.4	9.91	9.32	+ 6.0
Kansas	49:1066	1.86	1.88	+ 1.2	28.1	23.0	−18.1	15.12	12.24	+19.0
N. Mexico	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 Monesin and Tylosin combinations. Only monesin values are shown in the table; summary shows monesin-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 individual 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	Response	Control	Drug	Response	Control	Drug	Response
		lb/day		%	lb/day		%	lb/lb		%
New Jersey	81:631	2.56	2.61	+ 1.7	23.2	21.3	− 8.4	9.04	8.15	+ 9.8
Kansas	81:633	2.36	2.30	− 2.8	18.7	17.7	− 5.3	7.99	7.80	+ 2.4
Kansas	81:633	2.34	2.52	+ 7.6	19.5	18.7	− 3.9	8.38	7.53	+11.3
New Jersey	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
Illinois	80:576 or 53:1440	2.10	2.19	+ 4.2	15.6	15.5	− 0.7	7.44	7.06	+ 5.1
Illinois	80:576 or 53:1440	2.25	2.41	+ 6.9	18.5	18.5	0	8.19	7.64	+ 1.7
Illinois	80:576 or 53:1440	2.19	2.28	+ 4.0	19.2	18.1	− 5.9	8.75	7.94	+ 9.3
S. Dakota	80:647			+ 4.3			− 4.1			+ 8.3
Kansas	79:701	3.49	3.51	+ 0.6	26.4	23.3	−11.6	7.56	6.64	+12.1
Kansas	79:530	3.23	3.78	+17.1	24.7	24.3	− 1.8	7.55	6.46	+14.4
Kansas	79:530	3.29	3.69	+12.1	27.3	26.4	− 1.5	8.24	7.23	+12.3
New Jersey	79:532	2.23	2.41	+ 7.9	18.3	17.8	− 3.0	8.21	7.44	+ 9.4
Kansas	79:573		equal			reduced			improved	
Kansas	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	Response	Control	Drug	Response	Control	Drug	Response
		lb/day		%	lb/day		%	lb/lb		%
N. Dakota	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	25.5	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. Salinomycin responses in feedlot cattle.

Location	Reference[b]	Gain			DM Feed Intake			Feed/Gain		
		Control	Drug	Response	Control	Drug	Response	Control	Drug	Response
		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 6. Recent inonphore comparisons from feedlot trials at Oklahoma State[a].

Inonphore	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%.

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
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 and improved methods of preparing or isolating Rumensin may have been several contributing factors 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 6). Most interestingly, none of the numerous ionophore trials reported in Tables 2-6 showed a negative improvement in feed/gain.

Several recent studies are also included from Idaho and Oklahoma for Lasalocid, Monensin and Salinomycin. Trials with Salinomycin look especially promising, showing the greatest improvements in gain.

TABLE 7. Fifteen trial feedlot summary, Bovatec vs. Rumesin feed 30 g/ton[a].

	Improvement for Bovatec
Avg. daily gain	+ 4.8%
Feed efficiency (lb. feed/lb. gain)	+ 4.9%

[a]As widely advertised by Roche Chemical Co.

TABLE 8. Lasalocid v. Monensin for Cattle.

	Performance data				
	Control	Lasalocid 20 g	Lasalocid 30 g	Monensin 20 g	Monensin 30 g
Initial weight, lb.	623	621	617	630	616
Final weight.lb.	1008	1047	1047	1053	1029
Avg. daily gain, lb.					
Growing	1.63	1.73	1.75	1.61	1.61
Finishing	2.37[b]	2.69[ab]	2.71[a]	2.76[a]	2.66[ab]
Total	2.02[b]	2.23[a]	2.25[a]	2.21[a]	2.16[ab]
Avg. daily feed, lb.					
Growing	17.2[a]	16.8[ab]	16.0[c]	16.6[bc]	16.2[bc]
Finishing	17.7[b]	18.8[ab]	18.9[ab]	19.2[a]	18.6[ab]
Total	17.5	17.8	17.5	17.9	17.4
Feed conversion, lb.					
Growing	10.60[a]	9.82[ab]	9.22[b]	10.30[ab]	10.10[ab]
Finishing	7.50	7.00	6.98	6.96	7.01
Total	8.69[a]	8.00[b]	7.80[b]	8.11[b]	8.07[b]

[a, b, c] Means in the same row bearing different superscripts differ significantly ($P < 0.05$).

	Carcass data				
	Control	Lasalocid 20 g	Lasalocid 30 g	Monensin 20 g	Monensin 30 g
Carcass wt., lb.	626[b]	655[ab]	651[ab]	656[a]	649[ab]
Marbling Score[1]	3.43	4.06	3.58	4.42	4.19
Fat thickness, in.	0.49[b]	0.54[a]	0.53[ab]	0.55[a]	0.56[a]
Ribeye, sq. in.	11.68	11.72	11.95	11.28	11.65
KPH fat	2.75[b]	3.00[ab]	3.15[a]	2.96[ab]	2.97[ab]
Quality grade[2]	11.8	12.0	11.7	12.0	12.0
Yield grade	2.88[b]	3.15[a]	3.05[ab]	3.22[a]	3.19[a]
Carcass yield	62.1	62.6	62.2	62.3	63.1

1. Small − = 3, Small = 4, Small + = 5.
2. Good + = 11, Choice − = 12.

[a, b] Means in the same row bearing different superscripts differ significantly ($P < 0.05$)

Dan Hinman, Univ. of Idaho Res. Rpt. No. 8, 1983.

TABLE 9. Ionophore trial (1983).

	Daily gain	Feed/gain
	lb	lb/lb
Control	2.91	6.55
Bovatec	2.96	6.37
Salinomycin	3.45	5.92

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