

The effect of feeding *Propionibacterium* strain P63 alone and in combination with *Lactobacillus acidophilus* strain 53545 on the performance of feedlot cattle.

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ABSTRACT

Seventy-five crossbred calves weighing an average of 721 LB were used to compare the effects of feeding *Propionibacterium* strain P63 alone and in combination with *Lactobacillus acidophilus* strain 53545. Cattle were randomly assigned to one of three treatment groups:(1) no treatment, (2) *Propionibacterium* strain P63 at 3.0×10^{11} cfu/head/day, or (3) *Propionibacterium* strain P63 at 1.0×10^9 cfu/head/day in combination with *Lactobacillus acidophilus* strain 53545 at 1.0×10^8 cfu/head/day. The inoculum was thoroughly mixed with the ration each day throughout the trial. Cattle were fed a diet containing 50% concentrate and 50% roughage for 14 days followed by feeding a 90% concentrate diet containing 75% ground wheat and 25% corn for ten days. After the 10 day period on wheat, cattle were fed a 90% concentrate diet containing 100% ground corn for the remainder of the trial. Average daily gain (ADG) was higher ($P<.04$) during the wheat feeding period in cattle fed the combination of *Propionibacterium* and *Lactobacillus acidophilus* compared to control cattle (3.58 lb./day vs. 2.45 LB/day). ADG was significantly lower for cattle fed strain P63 alone compared to the combination during the first 10 days, however no other differences in ADG were detected. Dry matter intake (DMI) for cattle fed the *Propionibacterium* and *Lactobacillus acidophilus* combination was reduced by 7.8% ($P<.02$) during the first 83 days of feeding and 6.8% ($P<.08$) overall when compared to control cattle. DMI was lower in cattle fed P63 alone compared to controls during the first 10 days, however this difference was not highly significant ($P<.12$). Feed conversion during the 120 day feeding period was improved by 6.6% in cattle fed with the combination of *Propionibacterium* and *Lactobacillus acidophilus* compared to control cattle ($P<.04$). Cattle fed P63 alone had a slightly improved overall feed efficiency compared to control cattle, however the values were not determined to be statistically different. Overall carcass characteristics were similar for all treatment groups. Liver abscess scores were determined to be very low for all treatments compared to industry standards. These results indicate beef cattle treated with *Propionibacterium* strain P63 in combination with *Lactobacillus acidophilus* strain 53545 had significant improvement in feed efficiency based on similar rates of gain and reduced feed intakes compared to control cattle.

INTRODUCTION

Previous animal experiments conducted at Oklahoma State University during this study suggested that the detrimental affects associated with the accelerated adaptation of beef cattle to highly fermentable carbohydrates may be minimized with the introduction and establishment of a *Propionibacterium* culture in the rumen. Feeding *Propionibacterium* strain P63 has been shown to inhibit the accumulation of ruminal lactic acid by 38.5% compared to non-inoculated control cattle thus increasing ruminal pH by 0.2 to 0.5 units. Recent research has suggested additional factors other than the accumulation of lactic acid may be responsible for the production losses associated with ruminal acidosis. An increase in ruminal glucose concentrations following engorgement with ground corn has been shown to precede a significant decline in ruminal microorganisms. This decline has been reported to be the result of a low ruminal pH due to the accumulation of lactic acid. However, symptoms consistent with ruminal acidosis such as decreased feed intake and reduced rate of gain have been reported in cattle with no significant concentration of ruminal lactic acid. The affects on rumen function when ruminal glucose concentrations become elevated has received increased attention. Recent reports indicate the increased concentration of ruminal glucose may result in the production of intermediates of glucose metabolism such as glyoxal. These compounds have been shown to inhibit ruminal microbial populations thus reducing ruminal digestion. This experiment was designed to study the production impact of treating aggressively adapted cattle with a combination of glucose and lactic acid utilizing microorganisms.

TREATMENTS AND PROCEDURES

Seventy-five cross-bred, post weaned calves weighing 650-750 pounds were randomly assigned to one of three treatments: 1.) no treatment, 2.) *Propionibacterium* strain P63 treated at 3.0×10^{11} cfu/hd, or 3.) *Propionibacterium* strain P63 at 1.0×10^9 cfu/hd and *Lactobacillus acidophilus* strain 53545 at 1.0×10^8 cfu/hd. A total of 15 pens with 5 calves per pen were blocked by sex, weight and breed prior to treatment assignment. Calves were given free access to the feed bunk and water source during the course of the experiment.

Each treatment group, consisting of steers and heifers were fed a 50:50 ration (cracked corn, cottonseed meal, alfalfa pellets and balanced for minerals) at 1.5 to 2% of BW for 14 days. During this period the appropriate treatment was added directly to the feed. The treatment dose for each individual pen was added to 600 ml of water and completely mixed with the daily ration at the time of feeding throughout the entire feeding study.

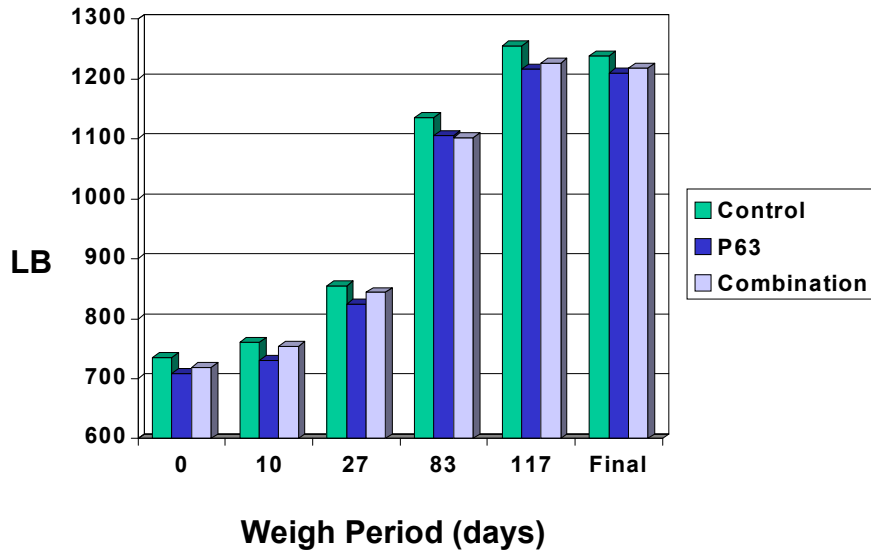
On the day following the 14-day establishment period, cattle did not receive any feed for a 24 h period. This procedure was performed in order to stimulate the engorgement of the next meal. Following the 24 hour fasting period, cattle were given a 90% concentration ration (75% cracked wheat and 25% cracked corn). This ration was fed for a total of 10 days. During this time, treatments were administered as stated above and cattle were closely monitored for signs of severe stress due to ruminal indigestion. Following the 10 day challenge period, cattle were fed a 90% concentrate diet consisting of 100% cracked corn. Cattle were fed to final weights of approximately 1,200 pounds (approx. 120 days).

All cattle were weighed at receiving and approximately every 28 days during the feeding period. Feed intake and animal health were monitored daily. Following the finishing period, cattle were transported to a packing plant at which time hot carcass weights, quality grades, yield grades, and carcass characteristics were determined.

RESULTS AND DISCUSSION

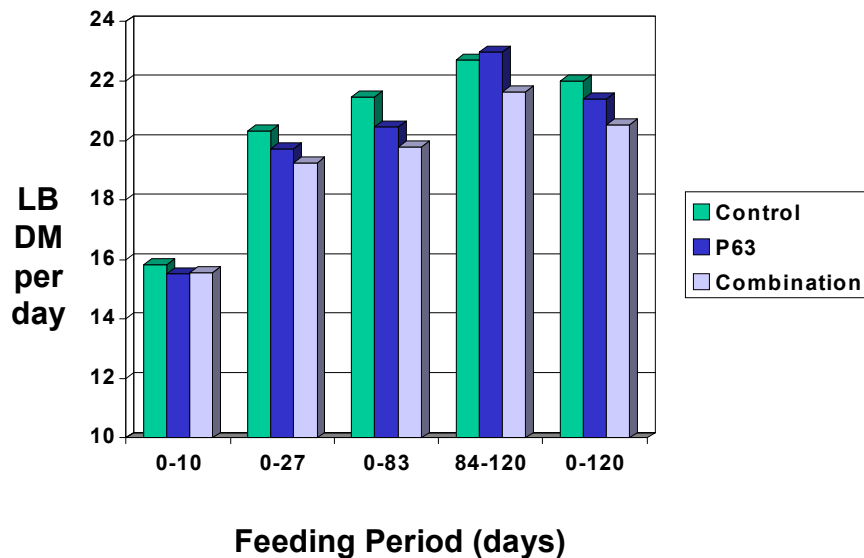
Animal weights are presented in Figure 1. The only significant differences ($p < .05$) in live weights were observed during the first 10 days of the study. Control cattle were 18 pounds heavier than cattle receiving the combination and 25 to 30 pounds heavier than cattle in the group fed P63 alone during this period. By day 27 no differences in live weight were observed ($P < .05$). To reduce the variation resulting from bulk fill differences, final weights were determined using hot carcass weights and dressing percentages. Control carcass weights were 13 pounds heavier compared to cattle fed the combination and 18 pounds heavier than cattle fed P63 alone, however these differences were not statistically different and considered to be animal variation.

Figure 1. Cattle weights during 120 day feeding period.



The feeding period means for daily feed intake are shown in Figure 2. Only small differences (less than 2%) were observed between treatments during the initial 10 day period while feeding a ration containing a high percentage of ground wheat. These differences were not determined to be highly significant.

Figure 2. Feed intake of cattle during 120 day feeding period.

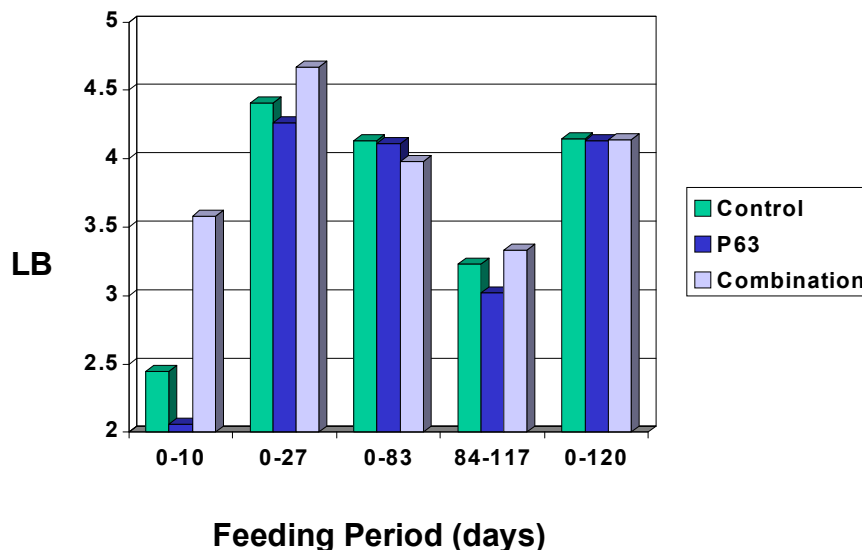


Intake was reduced in cattle being fed the combination inoculum by 7.8% when compared to control animals during the first 83 days ($p < .02$). Overall feed intake was 6.8% lower for the combination treatment ($P < .08$) and only 2.8% lower when animals received P63 alone (not significant) when compared to controls.

The only significant difference in average daily gain was observed during the initial 10 days of the trial when cattle were abruptly switched from a 50% concentrate ration to a 90% concentrate diet containing 75% ground wheat. Figure 3 shows cattle receiving the combination treatment gained 1.13 LB more than control cattle during this intensive adaptation period ($p < .04$). Recall feed intakes during this period were not statistically different between treatment groups. Given the utilization of lactic acid and glucose by the combined inoculum the improvement in gain during this initial feeding period was expected since cattle are the most effected by ruminal indigestion at this time.

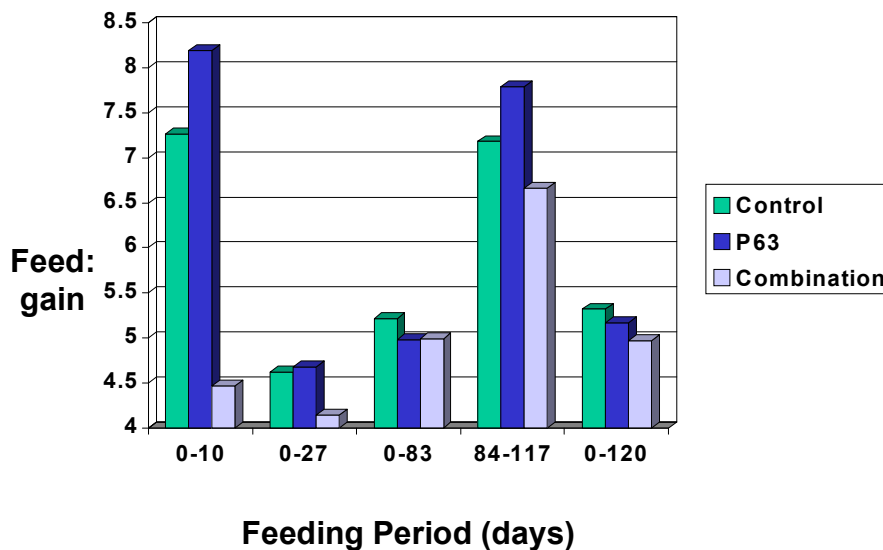
Average daily gains were slightly higher for cattle fed the combination during the first and last 30 days of the study. However, these differences were not significant. Cattle receiving P63 alone had slightly lower gains compared to control and cattle fed the combination inoculum during the entire study. Overall ADG were almost identical during the 120 day feeding period.

Figure 3. Average daily gain of cattle during 120 day feeding period.



Cattle fed the combination inoculum had significantly improved feed efficiencies over the entire 120 day feeding study when compared to controls. Figure 4 shows the mean feed to gain values arranged by treatment group for the entire feeding study. During the first 10 days of feeding, efficiency was improved by 38.4% ($P < .06$) and by 10.4% ($P < .03$) in the first 30 days when comparing cattle fed the combination to control cattle. The percent difference between treatments declined in the later periods of the feeding trial, however the significant treatment response of the combination inoculum during the initial period resulted in a significant treatment difference over the entire 120 day study ($P < .04$).

Figure 4. Feed efficiency of cattle during 120 day feeding period.



No significant differences in carcass quality and composition were observed. The incidence of liver abscesses was relatively insignificant compared to industry standards. Control and cattle fed P63 both had incidences of 8%. Cattle fed *Lactobacillus acidophilus* strain 53545 with *Propionibacterium* strain P63 had no liver abscesses. Generally, feedlot finished cattle will have a liver incidence of approximately 30%. Dressing percents, ribeye area, yield grades, and quality grades were similar for all treatments.

CONCLUSION

This study suggests the detrimental production losses associated with adapting cattle to highly fermentable diets can be reduced by pre-treating cattle with a microbial combination of *Propionibacterium* strain P63 and *Lactobacillus acidophilus* strain 53545.

Appendix 1. Performance summary for inoculation trial.

ITEM	Control	P-63 & Lacto	P-63	1 vs 2&3	1 vs 3	1 vs 2	2 vs 3
Weights, lb.					Probability, P<		
Initial	736	718	709	.07	.06	.19	.50
Day 10	761	754	730	.14	.05	.62	.11
Day 27	855	844	824	.16	.08	.51	.23
Day 83	1136	1103	1106	.13	.20	.17	.91
Day 117	1255	1226	1217	.26	.27	.39	.78
Carcass wt	768	755	750	.38	.37	.54	.77
Final weight (carcass wt/.62)	1239	1219	1210	.38	.37	.54	.77
Feed intake, (lb.dry matter/day)							
Days 0-10	15.81	15.56	15.51	.11	.12	.18	.80
Days 0-27	20.34	19.26	19.71	.07	.22	.06	.37
Days 0-83	21.46	19.79	20.47	.03	.13	.02	.29
Days 84-120	22.71	21.64	22.98	.68	.81	.35	.25
Days 0-120	22.01	20.51	21.39	.13	.42	.08	.26
Average daily gain, lb.							
Days 0-10	2.45	3.58	2.06	.38	.41	.04	.01
Days 0-27	4.41	4.67	4.26	.79	.53	.29	.11
Days 0-83	4.13	3.98	4.11	.55	.91	.36	.42
Days 84-117	3.23	3.33	3.02	.85	.54	.78	.38
Days 0-117	4.36	4.27	4.27	.61	.65	.67	.99
Days 0-120	4.15	4.14	4.13	.91	.92	.93	.99
Feed efficiency, (feed/gain)							
Days 0-10	7.26	4.47	8.19	.41	.47	.06	.02
Days 0-27	4.62	4.14	4.68	.21	.74	.03	.02
Days 0-83	5.21	4.99	4.98	.12	.16	.18	.93
Days 84-117	7.18	6.66	7.79	.91	.22	.29	.04
Days 0-117	5.07	4.82	5.01	.22	.67	.10	.19
Days 0-120	5.32	4.97	5.17	.08	.34	.04	.19
Calculated Net Energy Values							
ME, Mcal/kg	2.86	2.96	2.87	.32	.84	.14	.19
NEm, Mcal/kg	1.95	2.03	1.96	.32	.84	.14	.19
NEg, Mcal/kg	1.30	1.37	1.31	.32	.84	.14	.19

Appendix 2. Impact of inoculation on carcass characteristics.

ITEM	Control	P-63 & Lacto	P-63	1 vs 2&3	1 vs 3	1 vs 2	2 vs 3
Dressing percentage	61.26	61.63	61.61	.25	.33	.31	.96
Ribeye area, sq inches	13.79	13.63	13.85	.85	.85	.60	.48
Ribeye area, sq in/cwt carcass	1.80	1.80	1.85	.43	.24	.88	.29
Kidney pelvic & heart fat, %	2.17	2.30	2.20	.37	.77	.21	.32
Unadjusted backfat, inches	.48	.47	.45	.62	.48	.88	.58
Adjusted backfat, inches	.56	.56	.51	.59	.36	1.00	.36
Preliminary yield grade	2.54	2.54	2.44	.75	.58	1.00	.58
Final yield grade	2.84	2.87	2.63	.50	.19	.84	.14
Marbling score ^a	312	335	309	.86	.96	.72	.68
Quality grade	1.48	1.44	1.32	.56	.43	.84	.55
Choice or prime %	32	36	16	.61	.26	.77	.16
Select grade, %	68	64	84	.61	.26	.77	.16
Skeletal maturity	153	152	155	.94	.82	.93	.75
Lean maturity	141	144	155	.08	.01	.57	.05
Overall maturity	147	148	155	.39	.20	.86	.25
Liver abscesses, %	8	0	8	.65	1.00	.44	.44

^a slight amount of marbling (200-299); small amount of marbling (300-400).