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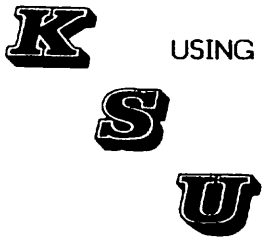


USING BIOTECHNOLOGY TO IMPROVE GROWTH RATE AND CARCASS COMPOSITION IN SWINE

J. L. Nelssen

Summary

Biotechnology has developed a number of compounds that partition nutrients away from fat tissue deposition and towards lean (muscle) tissue accretion in swine. Two compounds that have received considerable research attention are porcine somatotropin (growth hormone) and beta agonists. Somatotropin is a naturally occurring protein found in the blood of all mammals. Beta agonists are compounds commonly used in human medicine. Somatotropin and beta agonists can dramatically influence carcass leanness and ultimately pork product quality. Research has shown that porcine somatotropin can increase daily gains up to 19%, improve feed efficiency up to 28%, and reduce backfat thickness up to 33%. Research is underway to determine the effects of such compounds on nutrient requirements and reproduction in swine. Provided economic and safety requirements are met, somatotropin and/or beta agonist could revolutionize the future of the swine industry. These compounds are currently not available to the swine industry, except for research purposes.

Introduction

In the past 40 years, tremendous efforts have been expended by swine producers trying to produce leaner market hogs that utilize feed more efficiently and grow at a faster rate. The swine industry has been able to make some changes in backfat thickness, carcass muscling, and growth rates of pigs through classical, genetic selection approaches. Yet, progress in carcass leanness during the past decade has been extremely slow. Ironically, this lack of improvement in "lean value" pork production has occurred at a time with the health conscious consumer is demanding pork with a lower fat content. In fact, consumer surveys continue to point to the negative image of pork as having a higher percentage of fat than competitive meats.

Biotechnology in the simplest terms is the application of technology to the biological system, in this case, swine. Primarily during the last 15 years, scientists have worked extremely hard to develop technologies that will result in pork products capable of competing with other meat products in the marketplace. "Biological" compounds have been studied that play a key role in regulating metabolism and in partitioning of absorbed nutrients between muscle and fat tissue. Families of compounds have been developed that dramatically improve pork product leanness, with concomitant improvements in growth rate and utilization.

The goal of the swine industry by using these compounds should be to produce a more acceptable pork product at a lower cost of production. The objective of this paper is to review recent literature on the role of these

compounds in (1) improving growth rates and feed utilization in market hogs and (2) improving pork carcass leanness and muscling quality.

Porcine Somatotropin

Somatotropin is a naturally occurring protein that is produced at the base of the brain and can be found in the blood of all mammals. For several years, it was erroneously assumed that somatotropin only had an effect on general body growth in humans and farm animals. It is now known that somatotropin plays an important role in the metabolism of proteins, fats, and carbohydrates. Natural porcine somatotropin could never be obtained in sufficient quantities for use in commerical swine production. However, technology has been developed to produce large quantities for use in swine production.

Research results to date have shown a tremendous opportunity to produce an increase in lean tissue deposition, while markedly reducing fat synthesis in finishing swine. The effects are dramatic. In a study conducted at the Pennsylvania State University, daily injections of porcine somatotropin increased daily gain by 16%, improved feed efficiency by 35%, and increased loin eye area by 45%. Other studies have shown increases in daily gain of up to 19%, improvements in feed efficiency of up to 28%, reductions in backfat thickness of up to 33%, and increases in loin eye area of up to 27% in finishing pigs. Several studies have shown that the response to somatotropin may be dose-dependent (table 1).

The major stumbling block in the use of porcine somatotropin is our current lack of an appropriate delivery system to get it into the pig. To date, research using porcine somatotropin in swine has involved daily injections, which would not be feasible in the commerical swine industry. An appropriate delivery system will be developed, but we do not know when and by whom.

Beta agonist

Beta adrenergic agonists are compounds used in human medicine for a number of problems including relief from bronchial constriction commonly associated with asthma. Some of these compounds, phenethanolamines and cimaterol, are lipolytic (causing the breakdown of fat tissues) and have acute effects on blood glucose, insulin, and free fatty acids.

Research has shown that a phenethanolamine (Ractopamine®) will increase carcass leanness and increase loin eye area. In addition, finishing pigs fed Ractopamine® had an increased average daily gain and feed efficiency compared to pigs fed a control diet (table 2). The large effect of Ractopamine® on carcass leanness could benefit the swine industry in the future.

Cimaterol is a partitioning agent that has been evaluated as a compound to improve performance and carcass quality in finshing pigs. Cimaterol has been shown to slightly improve feed efficiency and dramatically improve carcass quality (table 3). If safety standards are met, cimaterol could be used to improve carcass composition and lower the cost of pork production.

Table 1. Effects of Porcine Somatotropin (PST) on Swine Growth and Carcass Criteria[a]

Criterion	Dose PST, µg/lb body weight				
	0	13.6	27.3	54.5	90.9
Experiment 1					
Daily gain (lb), % control	100	102	119	116	111
Daily feed (lb), % control	100	95	97	83	78
Feed/gain, % control	100	93	82	72	71
Back fat, % control	100	92	87	78	67
Loin eye area, % control	100	103	105	110	112
Experiment 2	0	4.5	13.6	31.8	
Daily gain (lb), % control	100	109	106	114	
Feed gain, % control	100	93	90	83	
Back fat, % control	100	100	92	88	
Loin eye area, % control	100	105	114	123	

[a]Data from Feedstuffs 59:28 (1987); Animal Health and Nutrition (1987); Journal of Animal Science 64:433 (1987).

Table 2. Effect of a Phenethanolamine on Growth and Carcass Characteristics

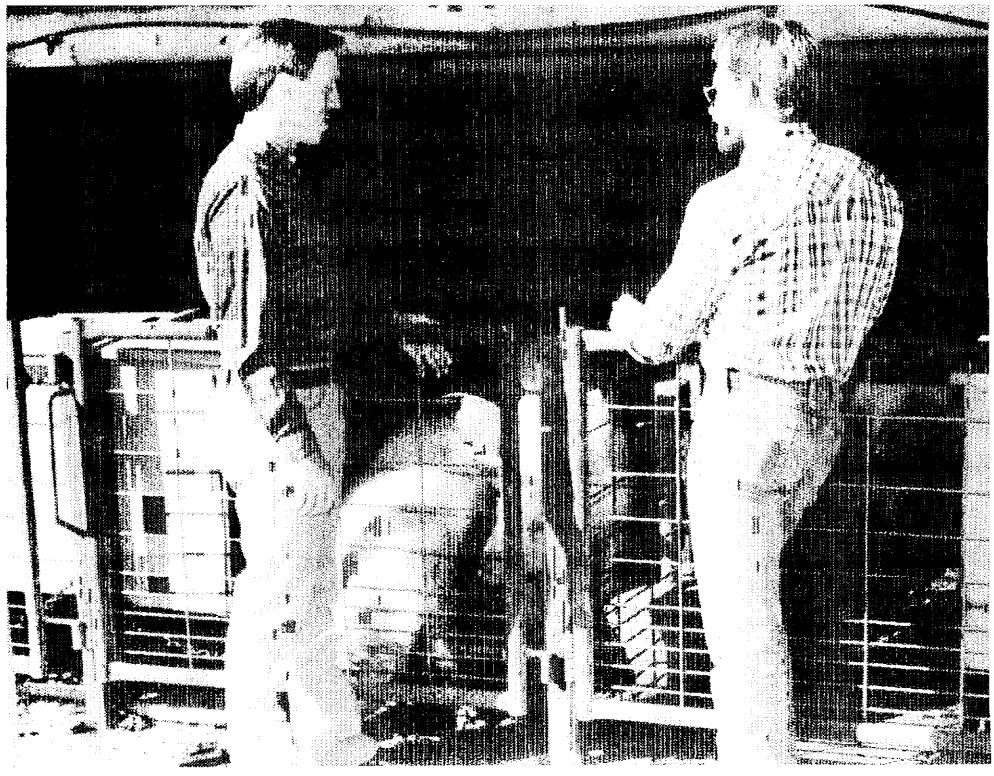
Criterion	Ractopamine® level, ppm				
	0.0	2.5	5.0	10.0	20.0
Daily gain (lb)[a]	1.74	1.86	1.85	1.93	1.89
Daily feed (lb)	6.36	6.27	6.16	6.25	6.09
Feed/gain[a]	3.66	3.37	3.33	3.25	3.22
Loin eye area (in^2)[a]	5.18	5.44	5.58	5.75	5.98
Tenth rib fat (in)[a]	.96	.82	.89	.85	.84

[a]Ractopamine effect ($P<.01$).
Data provided by Elanco Products Co.

Table 3. Effect of Cimaterol on Carcass Characteristics[a]

Criterion	Drug level, ppm					
	0.0	0.25	0.50	0.50 + withdrawal	1.0	1.0 + withdrawal
Loin eye area (in^2)	4.63	4.95	5.26	4.97	5.18	5.11
Biceps femoris (lb)	2.96	3.16	3.22	3.11	3.28	3.13
Tenth rib fat (in)	1.02	0.91	0.89	0.97	0.84	0.94
Leaf fat (lb)	2.81	2.57	2.51	2.86	2.42	2.65

[a]Data from Journal of Animal Science 61:905 (1985); Feedstuffs 59:28(1987). Withdrawal indicates the drug was removed from the diet seven days prior to slaughter.



Dr. Jim Nelssen discusses current finishing trials with Mike Johnston.