EFFECTS OF INCREASING LYSINE LEVELS ON CARCASS COMPOSITION, CUTTING YIELDS, AND FURTHER PROCESSED PRODUCT CHARACTERISTICS OF IMMUNOLOGICALLY CASTRATED MALE PIGS

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Abstract- **The objective of this study was to determine if increasing dietary lysine levels of immunologically castrated male pigs will increase carcass lean and cutting yields without negatively affecting further processed product characteristics. Approximately 1200 male pigs (physical castrates, immunologically castrated males (IC), and entire males) were assigned to 1 of 4 diet programs with increasing lysine levels: physical castrate - low lysine (0.7% in the late finishing diet), IC - low lysine (0.7%), IC - low/medium lysine (0.8%), IC - high/medium lysine (0.9%), IC - high lysine (1.0%), and entire - high lysine (1.0%). At 5 weeks post-second injection of an anti-gonadotropin releasing factor (GnRF) vaccine (Improvac®; Pfizer Animal Health), the two pigs in each pen closest to the median pig weight (n = 96) were selected and humanely slaughtered. Right sides of the carcass were dissected into soft tissue to determine percent fat free lean. Left sides were fabricated into primal pieces. Each primal piece was weighed and further fabricated into respective subprimal pieces. Further processed ham and bacon were made from the left sides of the carcasses. Immunological castration did not affect (P > 0.05) pork quality characteristics. IC males had a higher (P < 0.05) percent fat-free lean than physical castrates but were lower (P < 0.05) than entire males. High lysine and high/medium lysine level IC males had higher (P < 0.05) lean cutting yields and carcass cutting yields than physical castrates. Lean cutting yield and carcass cutting yields appeared to increase as dietary lysine was increased among IC males. There were no differences (P > 0.05) in cooked yield of further processed hams or bacon between physical castrates and IC males. Fresh bellies from IC males were thinner and had narrower flop distances (P < 0.05) than physical castrates but were thicker and had wider flop distances (P > 0.05) than entire males. Overall, immunological castration improved carcass cutability, increased percent fat free lean, and had no effect on further processed products when compared to physical castrates.**

Index Terms- **cutting yield, fat-free lean, further processed products, Improvac, lysine**

I. INTRODUCTION

Historically, sexually mature entire males have not been used in U.S. food production systems, despite their known advantages in feed efficiency and lean meat production, because of their tendency to cause objectionable odors in the meat (Babol and Squires, 1995). However, Font i Furnols et al. (2009) reported no differences (P > 0.05) in odor or flavor between meat from physical castrates or immunologically castrated males (IC), the latter being known to retain many of the production advantages of entire males. This makes the likelihood for IC adoption into U.S. swine production systems far more likely. The procedure involves vaccination against gonadotropin releasing factor (GnRF) and is currently approved in 56 countries worldwide, with more in the regulatory review phase.

Past studies have compared IC males with physical castrates or entire males when each gender is fed the same diet with equal lysine levels. It has not been determined whether IC males require elevated lysine levels to optimize growth potential. Current studies are focusing on nutritional questions such as this, as well as opportunities to manipulate fat coverage through alteration of the vaccination to slaughter interval. In a typical production system using IC, pigs are raised as entire males for most of their lives and then transition to IC status shortly before

slaughter. Studies have concluded IC will not negatively affect fresh pork quality (Pauly, Spring, O'Doherty, Ampuero Kragten and Bee, 2009) but, nearly two thirds of the United States pork supply is used to produce further processed products such as cured ham or bacon. Therefore, the objective of this study was to determine if increasing dietary lysine levels to IC male pigs will increase carcass lean and cutting yields without negatively affecting further processed product characteristics.

II. MATERIALS AND METHODS

Pigs were selected from a much larger experiment that involved approximately 1200 head of commercial finisher pigs (PIC 337 x PIC 1050). Physical castrates, IC males and entire males were used in the study. The study used 4 diets differing in percent lysine inclusion. Those diets ranged in lysine level from low (0.7% in the late finishing diet) to high (1.0%). Two intermediate levels were also fed to IC males and designated as low/medium (0.8%) and high/medium (0.9%). All treatment groups were fed a common nursery diet until the pigs were 6 weeks old. At 6 weeks pigs were switched to their respective treatment diets, each with a step-down lysine inclusion that culminated in the concentrations above. An initial 2 mL subcutaneous injection of an anti-gonadotropin releasing factor (GnRF) vaccine (Improvac®; Pfizer Animal Health, Kalamazoo, MI) was administered to the IC males at 16 weeks of age. The second injection was administered at 20 weeks of age and pigs were harvested 5 weeks later at 25 weeks of age. No placebo injection was administered to the physical castrates or entire males during either injection period.

After the feeding trial, 96 pigs (16 per treatment) were selected based on ending live weight (weight 48 h prior to harvest) for further analysis. Two pigs per pen closest to the median pig weight were identified and slaughtered at a federally inspected abattoir.

A. Fat-Free Lean Dissection and Carcass Fabrication

A chilled right side weight was collected prior to dissection. Sides were skinned using an air skinner to remove less than 3 mm of tissue. All bones were separated from soft tissue and knife scraped to remove any residual tissue. Dissected sides were divided and weighed based on category of skin, bone and soft tissue. Soft tissue was homogenized for proximate composition and was determined by initially drying a 10 g sample at 110° C for approximately 24 h to determine percent moisture. The dried sample was washed multiple times in an azeotropic mixture of warm chloroform: methanol to determine percent fat. Percent fat was used to calculate percent fat free lean using the following equation: percent fat free lean = (soft tissue wt - (soft tissue wt * soft tissue % fat) / chilled right side wt) * 100.

Chilled left sides were weighed and initially fabricated into ham, loin, belly (spare ribs left on), whole shoulder and jowl. Each primal piece was weighed again prior to further fabrication. Hams were skinned and trimmed of excess fat and further fabricated into 5 separate pieces: inside ham (NAMP #402F), outside ham (NAMP #402E), knuckle, shank portion, and light butt. The inside, outside, and knuckle were completely denuded. All 5 pieces were individually weighed and identified. Identities of the inside, outside, and knuckle were retained to make NAMP #402G three piece hams at a later time. Skin on bone-in loins were skinned to meet the specifications of a NAMP #410 loin. Trimmed loins were weighed and fabricated into a NAMP #414 Canadian back, NAMP #415A tenderloin (side muscle off), and the sirloin end. The whole spareribs-in belly was fabricated into a NAMP #408 belly and NAMP #416 spareribs. The whole shoulder was fabricated into a modified NAMP #404 skinned shoulder, where the picnic portion was skinned also. The Boston butt was separated from the picnic to form a NAMP #406 bone-in Boston butt and a modified skinned NAMP #405 bone-in picnic shoulder. Each piece was then boned out to meet the specifications of NAMP #406A boneless Boston butt and a NAMP #405A boneless picnic shoulder. The boneless picnic shoulder was further fabricated by removing the cushion (*triceps brachii*) and making a NAMP #405B.

B. Further Processed Products

Fresh bellies were allowed to equilibrate to approximately 4° C for at least 24 h after fabrication. After equilibration, fresh belly flop distances was collected by draping a skin-side down belly over a stationary bar and measuring the distance between the 2 skin edges. Then bellies were weighed to determine green weight, injected with a cure solution to a target of 110% of original green weight, and weighed again to determine pump uptake.

A set of inside ham, outside ham, and knuckles originating from the same pig were stuffed into nylon nets and weighed as a set to determine green weight. Hams were injected with same cure solution to a target of 130% of green weight

Cure solution for both products was formulated to include 1.5% salt, 0.34% phosphate, 0.05% sodium erythorbate, 0.11% sugar, and 0.014% sodium nitrate in the finished product. Pump uptake was calculated using the following equation: ((pumped weight - green weight) / green weight) *100.

Following an equilibration period, hams were removed from the nylon nets, macerated twice, vacuum tumbled as a set in a plastic bag for 1.5 h and stuffed into ham nettings. Netted hams were weighed just prior to loading into the smokehouse to determine stuffed weights.

Both products were cooked, showered, and allowed to cool for at least 24 h. After cooling, products were weighed again to determine cooked yield. Cooked yield was calculated from the following equation: (cooked wt / green wt) *100.

D. Statistical Analysis

Data were analyzed with the Mixed procedure of SAS (SAS Institute, 2004) as a general linear mixed model. Pen served as the experimental unit where the fixed effects in the model were gender, lysine level, and their 2 way interaction. Random effects were block and the interaction between block and lysine level. If the overall effect was significant, then all possible pair wise comparisons were made.

III. RESULTS AND DISCUSSION

Percent fat free lean was lower ($P < 0.05$) for physical castrates (53.77%) than entire males (64.23%) or any of the IC male treatment groups. Entire males had a higher ($P < 0.05$) percent fat free lean value than any other treatment group. Percent lean increased 3.73% in IC males as lysine level was increased from low (56.11%) to high (59.84%). There were no statistically significant differences ($P > 0.05$) in IC males in low, low/medium, or high/medium treatment groups, but there appeared to be a linear increase in percent lean as lysine level was increased (Table 1).

Cutting yields were determined with the following equations: lean cutting yield = ((trimmed ham + trimmed loin + Boston butt + picnic) / chilled left side wt) *100 and carcass cutting yield = ((lean cutting yield components + trimmed belly / chilled left side) *100. Small numerical increases in weights of the primal pieces led to significant differences in cutting yields. Entire males (66.09%) had a higher ($P < 0.05$) lean cutting yield than any of the other treatment groups. Physical castrates (61.51%) numerically had the lowest lean cutting yield of all treatments. Increased dietary lysine level increased lean cutting yield of IC males. High/medium (64.08%) and high level (64.01%) IC males had higher ($P <0.05$) lean cutting yields than physical castrates by nearly 2.5%. Carcass cutting yields results were similar to lean cutting yield results. Entire males (77.87%) had the highest ($P < 0.05$) carcass cutting yields of any treatment group. Physical castrates (73.70%) had numerically the lowest carcass cutting yield of any treatment group. There appeared to be a linear increase in carcass cutting yield as lysine level was increased in the IC male diets. The high/medium (76.12%) and high (76.33%) lysine level IC males had higher ($P < 0.05$) carcass cutting yields than low lysine level IC males (74.28%) or physical castrates. The differences were 1.8% between low level IC males and high/medium IC males and 2.42% between physical castrates and the high/medium IC males (Table 1).

Physical castrates (8.65%) took up the lowest and entire males (11.35%) took up the highest percent brine in cured bellies. There were no differences ($P > 0.05$) in percent uptake between IC males regardless of dietary lysine inclusion. There were no differences ($P > 0.05$) in cooked yield between physical castrates and any IC male treatment groups. Entire males (95.12%) had the lowest ($P < 0.05$) cooked yield of all treatment groups (Table 2).

There were no differences ($P > 0.05$) between any treatment groups for percent brine uptake of cured hams. There were no differences in cooked yield of cured hams among any treatment groups except for High/medium IC males (103.55%) which were lower ($P < 0.05$) than entire males (105.93%) (Table 2).

IV. CONCLUSION

The use of vaccination against GnRF (immunological castration) on intact male pigs did not have any detrimental effects on pork quality. This experiment agrees with previous literature showing that IC males have higher percent lean values than physical castrates, but lower percent lean values than entire males. As lysine level increased among the IC males backfat decreased and percent lean increased. Lean cutting yields and carcass cutting

yields were higher in IC males than in physical castrates, but were lower than entire males. As lysine level increased in IC males cutting yields also increased. It appears from this population of pigs, IC males should be fed a diet higher in lysine than a physical castrate to maximize cutting yields. When IC males were fed the high/medium and high lysine diet, the advantage in carcass cutting yield was about 2.5% higher than physical castrates with no negative effects on pork quality parameters (tenderness, water holding capacity, ultimate pH, or color). Furthermore, immunological castration did not affect processing characteristics (cooked yields) of ham or bacon made from these raw materials. This advantage could have major economic implications to U.S. pork production systems.

REFERENCES

Babol, J., and E. J. Squires. 1995. Quality of meat from entire male pigs. Food Res. Int. 28: 201-212.

Font i Furnols, M., J. González, M. Gispert, M. A. Oliver, M. Hortós, J. Pérez . 2009. Sensory characterization of meat from pigs vaccinated against gonadotropin releasing factor compared to meat from surgically castrated, entire male and female pigs. Meat Sci. 83: 438-442.

NAMP. 2007. The Meat Buyer's Guide. North American Meat Processors Association., Reston, VA.

Pauly, C., P. Spring, J. V. O'Doherty, S. Ampuero Kragten, and G. Bee. 2009. Growth performance, carcass characteristics and meat quality of group-penned surgically castrated, immunocastrated (improvac) and entire male pigs and individually penned entire male pigs. Animal. 3: 1057-1066.

Table 1. The effect of GnRF immunological on percent lean and cutting yields of finishing male pigs

		Treatment						
	Sex	Castrate	Immunological castrate				Entire	
Item	Lysine level	Low	Low	Low/Med	High/Med	High	High	SEM
[1]Percent lean		53.77[a]	56.11[b]	56.78[b]	57.57[bc]	59.84[c]	64.23[d]	0.51
[2]Lean cutting yield, %		61.51[a]	62.73[ab]	62.88[ab]	64.08[b]	64.01[b]	66.09[c]	0.26
[3]Carcass cutting yield, %		73.70[a]	74.28[a]	74.83[ab]	76.12[b]	76.33[b]	77.87[c]	0.27

Means within a row for experimental treatments without a common superscript differ (P < 0.05)

[1]Percent lean =((soft tissue wt - (soft tissue wt * soft tissue % fat) / right chilled side wt)*100

[2]Lean cutting yield = ((trimmed ham + trimmed loin + Boston + picnic) / left chilled side wt)*100

[3]Carcass cutting yield = ((lean cutting yield components + trimmed belly) / left chilled side wt)*100

Table 2. The effect of GnRF immunological on cured product characteristics of finishing male pigs

		Treatment						
	Sex	Castrate	Immunological castrate				Entire	
Item	Lysine level	Low	Low	Low/Med	High/Med	High	High	SEM
Fresh Bellies								
Thickness, cm		3.77[a]	3.30[b]	3.73[a]	3.33[b]	3.40[b]	2.85[c]	0.05
Flop distance, cm		31.91[a]	22.62[bc]	27.10[ab]	22.97[bc]	19.22[c]	10.75[d]	1.16
Cured Bellies								
Pump uptake, %		8.65[c]	10.60[ab]	10.67[abc]	10.11[bc]	9.93[bc]	11.35[a]	0.28
Cooked yield, %		97.03[a]	96.96[a]	97.91[a]	96.76[a]	96.74[a]	95.12[b]	0.20
Cured Ham								
Pump uptake, %		27.61	26.97	28.70	26.73	28.23	28.08	0.32
Cooked yield, %		104.69[ab]	104.47[ab]	104.93[ab]	103.55[b]	105.69[ab]	105.93[a]	0.30
[1]PFF		21.94	22.13	21.95	21.88	21.60	21.80	0.10

Means within a row for experimental treatments without a common superscript differ (P < 0.05)

[1]PFF (Protein Fat-Free) = (%Protein / (100 - %Fat))*100