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A comparison of the quality of fresh and frozen pork from immunologically castrated males versus gilts, physical castrates, and entire males

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ABSTRACT

The objective of this study was to compare pork quality and sensory characteristics of pork from gilts, physical castrates, entire males, and immunological castrates. Loins (*Longissimus thoracis et lumborum*) were collected at harvest, aged for 10 days, and subsequently cut into chops and roasts. Two chops and one roast were frozen for a minimum of 14 days to a maximum of 30 days and chops and roasts from the same loin were evaluated in fresh form. A trained sensory panel evaluated the samples and results showed that gilt pork, physical castrate pork, and immunological castrate pork were similar in terms of boar odor and pork flavor. The evaluated pork quality characteristics showed no differences among sexes except for marbling in the frozen samples ($P < 0.05$). Results suggest that pork from immunologically castrated males is similar to pork from physical castrates in terms of sensory and pork quality characteristics and between fresh and frozen products.

1. Introduction

In the United States, male pigs designated for meat consumption are castrated at a young age. However, keeping pigs intact has several advantages such as increased feed efficiency, increased average daily gain, decreased feed intake, and leaner carcasses (Xue, Dial, & Pettigrew, 1997). Castration is practiced to eliminate or at least reduce the incidence of boar taint in the final pork product. This is important as consumers do not want a product with an unpleasant smell or flavor. Castration also helps to eliminate aggressive and mounting behavior that is much more common in entire males (EM) than physically castrated male pigs (PC) (Cronin et al., 2003).

Androstenone, which gives off a urine-like odor (Patterson, 1968), and skatole (Vold, 1970; Walstra & Maarse, 1970), which gives off a fecal like odor upon heating, are the two main compounds associated with boar taint, accumulating in the adipose tissue.

There is a newly approved immunization procedure (Improvest®, Zoetis, Florham Park, NJ) which binds to gonadotrophin releasing factor (GnRF) and temporarily stops the pituitary–hypothalamic–gonadal cascade and therefore inhibits the production of testicular steroids such as androstenone. In accordance with product label, two 2 mL doses must be administered with the first dose occurring at 9 weeks of age or later and the second dose occurring at least 4 weeks after the first dose and 3 to 10 weeks prior to slaughter (Improvest [package insert], 2013). Immunological castration of male pigs is a way to allow for clearance of boar taint from pork while still taking advantage of the benefits of raising entire males (Dunshea et al., 2001).

The development of this new technology that is aimed at increasing growth efficiency while eliminating boar taint in male pigs requires investigational research as to its effect on pork quality. While there have been many studies comparing sex differences, including immunological castrates (IC), in terms of pork quality (Gispert et al., 2010) and sensory characteristics (Font i Furnols et al., 2008, 2009), there is a deficit of information comparing the sexes in terms of fresh and frozen pork. Also, with the product's recent introduction into the United States, there are limited published data available at heavier market weights. Studies have investigated differences in pork quality measurements and some sensory evaluation with fresh and frozen pork but most of these studies evaluated preservation methods, freezing methods, and length of storage (Jeremiah, 1980). Therefore, the objective of this study was to evaluate pork quality and sensory characteristics of fresh and frozen pork from gilts (G), PC, EM, and IC. The hypothesis tested was that using the immunological castration procedure on intact male pigs would produce pork loin chops and roasts that are indistinguishable to male pigs that were physically castrated but distinguishable to non-castrated male pigs in terms of sensory, physical, and chemical characteristics and this would apply to both fresh pork and pork that was frozen for 14 to 30 days before evaluation.

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2. Materials and methods

2.1. Animals

Two replicates of 24 pigs each (PIC 337 × C22 or C29, Pig Improvement Company, Hendersonville, TN) selected from a previous growth performance and metabolism study were used in this experiment (Elsbernd, 2015). Two animals, one IC and one PC, were removed from that study due to health reasons, leaving a total of 46 pigs on test. There were four treatments: G, PC, EM, and IC with a total of 11 or 12 pigs per treatment. All pigs were fed the same diet which met or exceeded the nutrient requirements of all sexes (NRC, 1998). Pigs were fed ad libitum and housed individually. Immunological castrates were given anti-GnRF injections (Improvest®; Zoetis, Florham Park, NJ) at 13 and 18 weeks of age, which is in accordance with product label and regulatory requirements (Improvest [package insert], 2013). Quality assurance checks were undertaken by a trained professional at 2 weeks post-second dose and included visual inspection of the pigs' behavior and physiology (testicle size). Pigs were marketed 6 weeks post-second dose. Before harvest, pigs were individually tattooed for identification purposes at the slaughter plant. Pigs were harvested at a mean body weight of 145.0 ± 1.3 kg; this heavier harvest weight was intentionally selected to put maximum pressure on the immunological castration procedure.

2.2. Sample collection and preparation

Pigs were harvested at a USDA inspected facility. Loins (*Longissimus thoracis et lumborum*) from the left side of the pig were collected 1 day postmortem, placed in bags along with their respective identification tag, and transported with ice packs to the Iowa State University Department of Food Science and Human Nutrition Sensory Evaluation Unit (Ames, IA).

After aging for 10 days at 4 °C, loins were cut. The loin was cut 15.24 cm from the sirloin end to make a roast. The roast was then vacuum packaged and frozen. Next, two 2.54 cm chops were cut, vacuum packaged, and frozen. The chop cut closest to the roast was used for pork quality measurements and the next following chop was used for sensory analysis. These samples were frozen at −20 °C for a minimum of 14 days to a maximum of 30 days before analysis. The second half of the loin, starting with the side opposite of the blade end, was cut into two 2.54 cm chops followed by a 15.24 cm roast. These samples were weighed and used for fresh analysis. The first chop was used for sensory analysis and the second chop, located closest to the roast, was used for pork quality measurements. Every sample was trimmed to approximately 6 mm of subcutaneous fat. After cooking, each roast was faced and cut into four 2.54 cm slices. Slices closest to the sirloin end and blade end of the loin were used for pork quality measurements. The remaining 2 slices were used for the sensory analysis.

2.3. Physical and chemical evaluation

Loin purge percent was completed before the loin was cut and was calculated by dividing the purge weight by the sum of the loin and purge weight. Frozen chops and roasts were thawed at 4 °C for 48 h. Purge loss was calculated by dividing the purge weight by the sum of the roast or chops and purge weight. Cooking loss was determined by weighing the chop or roast before and immediately after cooking to an internal temperature of 68 °C. Cooking loss was calculated as the weight of the cooked sample subtracted from the raw sample weight, then divided by the weight of the raw sample.

Star probe force was measured on a room temperature cooked sample by an Instron (model 5566, Norwood, MA) with a 1 kilonewton load cell and a 200 mm per minute crosshead speed. Six readings of each sample were taken and the average value was used. The pH was measured in the center of a sample using a Hanna HI925 meter with an FC200 hard glass electrode (Hanna Instruments, Woonsocket, RI). A Minolta Chroma Meter (model CR-310, Minolta, Osaka, Japan) with a 50 mm measuring head at D_{65} lighting was used for Minolta L*(lightness), a* (redness), and b* (yellowness) measurements. Marbling was scored on a 1 to 10 scale based on the standards set by the National Pork Producers Council (NPPC, 1999). The Japanese color scale, ranging from 1 to 6, was used for the visual color score (Nakai, Saito, Ikeda, Ando, & Komatsu, 1975). The pH, Minolta measurements, marbling, and color scores were all evaluated on raw pork chop samples.

2.4. Sensory evaluation

Samples were thawed for 48 h at 4 °C. Chops were cooked on a clam shell grill (George Foreman, Russell Hobbs, Madison, WI) and roasts were cooked in an oven (National Manufacturing Company, Lincoln, NE) at 177 °C. Temperature was monitored by using digital temperature monitors (Omega Engineering Corporation, Stamford, CT) and thermo couples (Omega Engineering Corporation, Stamford, CT). When samples reached 68 °C, they were removed, and the center of the sample was cut into seven or eight 2.54 cm cubes. Samples were placed in a Styrofoam cup which had a random 3 digit blind code and capped with a plastic lid. Blinding codes were used to identify the sample and to ensure that there was no sample bias. Samples were served randomly to panelists.

A trained sensory panel comprised of seven or eight individuals evaluated the samples. Panelists completed training sessions and were

Table 1
Least square means for the effect of sex on the physical and chemical properties of the *Longissimus thoracis et lumborum* of fresh or frozen samples.

	Sex[a]					
	G	PC	EM	IC	SEM[b]	*P*-value
Samples (n)	12	11	12	11		
Fresh samples						
Loin purge, %	0.94	0.68	0.88	1.10	0.169	0.39
Chop						
pH	5.64	5.68	5.67	5.65	0.018	0.28
Marbling[c]	1.3	1.6	1.3	1.5	0.13	0.12
Color[d]	3.0	3.0	3.0	3.0	0.22	0.99
Minolta L*	49.02	48.86	47.79	48.85	1.069	0.46
Minolta a*	14.59	14.93	14.56	14.71	0.201	0.56
Minolta b*	4.03	4.31	3.93	4.20	0.135	0.20
Cook loss, %	16.67	17.38	16.78	14.64	1.170	0.16
Average star probe force, N	51.22	50.29	48.03	50.60	4.187	0.65
Roast						
Cook loss, %	20.79	20.89	20.51	21.17	1.006	0.89
Average star probe force, N	47.51	44.29	41.58	43.94	1.620	0.15
Frozen samples						
Chop						
Purge, %	4.10	3.56	3.57	4.28	1.576	0.60
pH	5.68	5.73	5.72	5.68	0.025	0.39
Marbling[c]	1.6^{y}	2.1^{x}	1.5^{y}	1.7^{xy}	0.11	0.005
Color[d]	2.8	2.9	2.8	2.8	0.23	0.95
Minolta L*	48.55	48.52	48.03	48.83	0.917	0.82
Minolta a*	14.42	14.53	14.14	14.05	0.238	0.33
Minolta b*	3.80	4.29	4.12	3.94	0.238	0.50
Cook loss, %	17.34	16.99	17.03	18.08	1.520	0.79
Average star probe force, N	50.87	49.43	47.86	52.41	2.219	0.35
Roast						
Purge, %	3.08	2.89	2.74	3.09	0.570	0.89
Cook loss, %	21.96	21.07	20.84	21.80	0.610	0.49
Average star probe force, N	56.14	54.29	52.00	55.20	2.417	0.46

Least square means within a row with different letters (x–y) are different ($P < 0.05$).
[a] Sex: G = gilt; PC = physical castrate; EM = entire male; IC = immunological castrate.
[b] Standard error of the mean.
[c] Scored on a 1 to 10 scale (NPPC, 1999).
[d] Scored on a 1 to 6 scale (Japanese color scale; Nakai et al., 1975).