Behavior of immunologically castrated boars compared to surgically castrated pigs[1]

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Introduction

Boar taint is an unpleasant odor that can be found in pork and pork products from male pigs (and occasionally, to a lesser degree, in castrates and females). Compounds contributing to boar taint include androstenone, a pheromone, biologically related to testosterone and produced in the testes, that has biological meaning to the adult boar and sow during reproduction. Sows express a willingness to breed when androstenone is present. Other compounds, for example skatole, have no sex-related biological function, but have a tendency to accumulate in the meat of adult male pigs (boars) because of androgen dependent changes in liver metabolism. Pork containing boar taint is objectionable to many consumers and may impact buying and pork consumption patterns.

Because the boar-taint compounds are androgens or are androgen dependent, they accumulate in the blood, fat and meat of male pigs starting at the onset of puberty. The majority of male pigs in the world are castrated to prevent boar taint in pork. However, there are a few countries that do not routinely castrate pigs (ex., the UK and Australia) and market pigs at a young age and small body weight, before most males have reached puberty. Economics favor marketing pigs at heavier weights in most countries, at a weight and age that is well past the onset of puberty. However, to help prevent boar taint pigs are subjected to surgical castration.

Surgical castration is typically a non-sterile, surgical procedure performed at a young age (typically less than 14 days of age). The scrotum is cut with a scalpel or sharp, surgical, side-cutting pliers and the testes are either pulled completely out or the spermatic cord is severed with a sharp instrument. Castration causes pain that is not completely relieved by use of commonly available analgesics and anesthetics (McGlone and Hellman, 1988, McGlone et al., 1993; von Borell et al., 2009; Sutherland et al., 2010).

One alternative to surgical castration is immunological castration (IC) of male pigs. Immunological castration is a non-surgical method in which reproductive hormones are temporarily blocked to stop gonadal development or function. Immunological castration may be performed by temporarily blocking one of the reproductive hormones GnRF, LH/FSH, or Testosterone[2]. The Pfizer product Improvac/Innosure/Vivax/Improvest© is a GNRF analog-protein conjugate (GnRF-analog is bound to a large protein molecule which stimulates the immune system to make antibodies that can bind this reproductive hormone). When given in two doses according to label guidelines the levels of GnRF are significantly reduced. The consequence of temporarily blocking GnRF is that the male pig will produce

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[2] GnRF = Gonadotrophic Releasing Factor; LH = Luteinizing Hormone; FSH = Follicle Stimulating Hormone.

much less LH/FSH, Testosterone and Testosterone-dependant offensive odors (ex., androstenone and skatole), also known technically as boar taint.

The primary objective of this technical note is to examine and report how sexual, aggressive and feeding behaviors are impacted by IC. Other behavioral and pig handling issues that are lacking in the scientific literature will be examined in the section on gaps in our knowledge.

Developmental Changes in Boar Behavior

Pigs are precocious at birth with the ability to walk and see within minutes of parturition. Pigs are not sexually developed at birth. A boar that has reached one year is very capable of fertile mating. But when does sexual development start and end? Sexual development begins in utero with brain and gonad development. However, boars have significant gonad growth and behavioral changes starting at about 100 days of age. The testes size grows and seminiferous tubules mature rapidly between 3 and 5 months of age (Ford and Wise, 2011). Testes of the domestic pig reach a plateau in size about 10 months of age (Ford and Wise, 2011). Associated with the growth of testes size and gonadal development, the boar has, at the same time, an increase in synthesis of androstenone in the Leydig cells of the testes (Oskam et al., 2008). The pig shows some variation in sexual development among breeds and in different photoperiods and plains of nutrition (Andersson et al., 1998a,b). Boar sexual behavior develops at the same time as the male rapidly grows, the testes develop, and androstenone secretion increases.

Male sexual behavior begins with play behaviors which can be observed in the neonate. Play behavior turns into more organized attempted sexual behaviors as the testes develop. Pigs, as with all other mammals, show the characteristic behaviors of mount, intromission, pelvic thrusting and ejaculation. Most mammals, including the pig, show nudging, nosing of the perineum, licking, and striking out a forelimb as a pre-mount behavior (Fraser and Broom, 1997). The male pig shows additional species-specific sexual behaviors including grunts and chomps, salivation (sometimes profuse), rubbing the head on the female while salivating, rhythmic urination, nudging and nosing the flank and olfactory evaluation of the ano-genital region or head (Hemsworth and Tilbrook, 2007). The most clear and objective sign of sexual interest and activity is the mount by the male.

The domestic pig shows aggressive behaviors starting at birth. Pigs will fight with unfamiliar pigs. The intensity of aggressive interactions is dependent on genetics, previous experience and stage of development. Prepubertal males, females and castrates fight at about the same level (McGlone et al., 1987). However, after puberty, entire males can become increasingly aggressive. Data presented below show that peri-pubertal entire males are, on average, more aggressive than castrated males.

Feeding behaviors also change with age, genetics, and gender. Piglets nurse about once per hour (about 20 meals per day) within the first three days of life. A limitation to feed intake of the nursing piglet is the milk production of the sow. By three weeks of age, the domestic piglet's motivation for feed exceeds most sows' ability to produce milk. After weaning, there is an abrupt nutritional change from liquid to solid feed and typically, the post-weaning feed is supplied (at least in the USA) *ad libitum*. The feed supply is not limited after weaning and consequently, feed availability exceeds the pigs' feed intake

capacity. Gradually, pigs eat fewer, larger meals. By 6 months of age, pigs will eat 4 to 20 meals per day, with an average of about 8 meals per day.

Once puberty approaches, entire males have a growth spurt, then they level off. The barrow (castrated male) has an increased motivation to consume feed during what would be its peri-pubertal phase. Barrows are fatter than boars and they tend to grow faster than boars in large part because they have an increased appetite (see data below).

Behavioral Effects of Immunological castration

Within limits the timing of the immunization program may vary and still be effective. The current Improvac/Innosure/Vivax/Improvest© label indicates that two doses of antigen (GnRF analog-conjugate) are required. In USA the first dose is given no earlier than 9 weeks of age but the timing is flexible based on labor availability and marketing schedule. The second dose should be given at least 4 weeks after the first injection but the gap can be longer. The current label indicates pigs should be harvested between 3 and 10 weeks after the second dose although most producers are likely to target from 4 to 8 weeks. Thus, an example immunization protocol, considering a 24-week growth period, might be to give the first injection at 12 weeks (approximately 80 lb body weight) and the second injection at 18 weeks of age (approximately 200 lb body weight). It is important to note two critical factors: first, no matter when the peri-pubertal pig is injected, the large effect on pig physiology and behavior will be after the second immunization (since the first priming dose doses not significantly impact GnRF or have a physiological effect). Second, because the product is an immunization, it will reverse with time.

In terms of behavioral effects of IC, the most significant effects are observed shortly after the second immunization. After the second immunization the animal that has been behaving like an immature boar rapidly starts behaving like a barrow. They are also known as immunologically castrated barrows (IC Barrows).

The first complete report on the behavior of immunologically castrated was by Cronin et al., (2003). The results are summarized in Tables 1 and 2 for periods before (Table 1) and after (Table 2) the second immunization with the GnRF-analog conjugate.

Feeding behavior was similar among boars, immunologically castrated and surgically castrated pigs at 17 weeks of age, although it is known from production studies that from weaning to the point of second injection entire males will generally consume approximately 8 to 10% less feed on a daily basis than castrated males. By 21 weeks of age, however, barrows had increased feeding motivation relative to entire males. Indeed, barrows and immunologically castrated pigs showed about a 40% increase in the time spent at feeders (assumed increased feeding behavior) compared with entire males at this age.

Cronin showed that before the second immunization (at 17 weeks of age), pigs to be immunologically castrated showed aggressive behaviors similar to boars and higher aggressive behaviors than barrows. However, 3 weeks after after the second immunization (at 21 weeks of age), the immunized males showed aggressive behavior similar to barrows and much lower than boars. Skin lesions also correlated with aggressive behavior. Thus in late finishing, castrated males have about the same skin lesions as

immunologically castrated males and fewer skin lesions than entire males. This has been confirmed by several authors (Einarsson, 2006; Velarde et al., 2007; Schmidt et al., 2011).

At 17 weeks of age, the entire male pig already has increased sexual behaviors, most notably mounting. Cronin et al., (2003) reported that barrows and boars differ significantly in mounting at this time. The immunologically castrated males in his study were intermediate in level of mounting at 17 weeks and not significantly different from either comparison group. After the second immunization (Table 2) the immunologically castrated pigs show mounting at a low level and equivalent to the level expressed by barrows. The behavioral findings of Cronin et al., (2003) were replicated by Zamaratskaia et al., (2008), Baumgartner et al., (2010), Fabrega et al., (2010), Rydhmer et al., (2010), and Schmidt et al., (2011), confirming the finding of boar-like behavior in immunologically castrated males before the second dose and castrate-like behaviour afterwards.

Table 1. Effect of immunological castration and surgical castration on finishing pigs (17 weeks of age) before the second immunization. At this point, immunologically castrated pigs are expected to act like entire males. Adapted from Cronin et al., 2003.

Behavior	Entire male	Immunologically castrated	Surgically castrated	SE	P-value
Time at feeders, %	7.0	6.7	7.4	0.67	0.54
Aggressive behavior, number/pig/day	27.4[a]	28.6[a]	4.5[b]	6.23	0.008
Mounting events, number/pig/day	9.4[a]	5.3[a,b]	0.1[b]	1.71	0.002

[a,b] Means in a row with a different superscript differ, P < 0.05.

Table 2. Effect of immunological castration and surgical castration on finishing pigs (21 weeks of age) 3 weeks after the second immunization. At this point, immunologically castrated pigs are expected to act like surgically castrated males. Adapted from Cronin et al., 2003.

Behavior	Entire male	Immunologically castrated	Surgically castrated	SE	P-value
Time at feeders, %	5.3[a]	7.7[b]	7.2[b]	0.72	0.03
Aggressive behavior, number/pig/day	27.9[a]	9.5[b]	9.5[b]	4.66	0.006
Mounting events, number/pig/day	7.2[a]	0.6[b]	0.1[b]	1.47	0.002

[a,b] Means in a row with a different superscript differ, P < 0.05.

Finishing pigs may be housed in single sex or mixed sex pens. If males to be immunologically castrated are penned with gilts, these gilts may experience increased aggression and mounting until shortly after the second injection. This observation was made by Schmidt et al., (2011) who suggested that the

second immunization be given as early as possible to avoid “entire male” behaviors from reducing the welfare of gilts, or alternatively, the issue was resolved (for them) if the pigs were penned in single sex pens.

Gaps in Knowledge

The effects of sex and IC on growing pig feeding, aggressive and social behaviors are well documented. Until the second injection, the males to be immunologically castrated act like boars. After the second injection, they act like barrows. However, two areas of behavior are less well documented; handling and transport, and human-pig interaction of immunologically castrated males compared with surgically castrated males.

The USA pig industry encourages producers to walk through the pens each day to observe pigs and resolve animal or equipment issues in a timely manner. Some lines of domestic pig are already aggressive towards producers. It is not clear how pigs will interact with the human, especially in the phase before the second injection (while they are peri-pubertal boars), although the global experience so far has not shown any indication of a problem in this regard. It should also be kept in mind that routine practice in countries such as the UK and Austrlalia is to rear entire male pigs until past the typical age of second immunization.

Handling and transport of pigs going to market are key economic and animal welfare issues. While we expect immunologically castrated males to handle and transport like barrows, this has not been well documented in the USA

Implications for On-Farm Management

Producers and barn managers that are familiar with rearing typical surgical castrates will see a distinct difference in activity level of entire males as they are introduced to the pig flow once the decision is made to stop surgical castration. Growing entire male pigs will show increased levels of playful bouts, time standing, walking, mounting and nudging compared to surgical castrates. Aggression between pigs is not likely to be a problem at this stage, but practices likely to encourage fighting, such as mixing of unfamiliar pigs or feed restriction, should be avoided. After the second immunization, the level of activity will more closely resemble the behavior of barrows (less active than entire males).

During the middle to later finishing period, feed consumption or feed disappearance rates will be reduced significantly among entire males compared to surgical castrates. Thus feed budgets and feed utilization will be different and observant barn managers may question the health or performance of a group of eentire males compared to previous groups of surgical castrates. However, these pigs have a higher daily lean growth potential, thus proper dietary nutrition must be provided to support this growth. Sub-optimized diets and a lower feed intake will result in reduced daily gain. Then, around 10 days after the second immunization, the feed intake of immunized males will increase sharply. This increase in feed intake and accelerated growth is normal among immunologically castrated males.

It is unclear how human-pig interactions will change both before and after the second immunization. Speculation at this time predicts that the entire males prior to the second immunization will be more active and interactive with human caretakers. Then, after the second immunization, they will be calmer and focused more on feeding than human interactions. And although it remains to be documented, the handling before, during and after transport, is expected to be similar for immunological castrates compared with surgically castrated males.

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