

Maj-Britt Hastrup

ERK

Fra: Elise S. Hansen [ESH@da.dk] på vegne af Dansk Arbejdsgiverforening [DA@da.dk]

Sendt: 1. juli 2008 17:26

Til: Justitsministeriet

Emne: SV: Høring over Dyreværnsrådets udtalelse om kastration af pattegrise - 2008-5440-0017

Under henvisning til det til DA fremsendte høringsbrev af 1. juli 2007 vedrørende Høring over Dyreværnsrådets udtalelse om kastration af pattegrise - 2008-5440-0017 skal vi oplyse, at sagen falder uden for DA's virkefelt, og at vi under henvisning hertil ikke ønsker at afgive bemærkninger.

Med venlig hilsen

Niils Trampe, sekretariatschef

Fra: Justitsministeriet Departementet - Justitsministeriet Departementet [mailto:jm@jm.dk]

Sendt: 1. juli 2008 16:29

Til: rigsadvokaten@ankl.dk; Dansk Arbejdsgiverforening; post@dyrefondet.dk; ddd@ddd.dk; info@dansksvineproduktion.dk; dmri@danishmeat.dk; db@dyrenes-beskyttelse.dk; lo@lo.dk; fvst@fvst.dk; peter_mollerup@post9.tele.dk; jvp@danishmeat.dk; jvp@danishmeat.dk; kl@kl.dk; dl@dansklandbrug.dk; info@anima.dk; mim@mim.dk; oem@oem.dk; alledyrret@mail.dk; info@wspa.dk; sns@sns.dk; Info@dansksvineproducenter.dk; landbrugsraadet@landbrug.dk; politi@politi.dk; sbc@life.ku.dk; detvs@fvst.dk; fvm@fvm.dk; info@sala.dk; kf@meatboard.dk; 3f@3f.dk; info@okologi.dk; lyngdalgaard@mail.dk; regioner@regioner.dk; dma@danishmeat.dk; peter.munster@bm.com; transport@di.dk; di@di.dk; mirja@oasa-dk.dk; itd@itd.dk; ylva@get2net.dk; life@life.ku.dk; hoeringssager@danskerhverv.dk; djf@agrsci.dk

Cc: EJOUREDyrevelfærdskontoret (951s35)

Emne: Høring over Dyreværnsrådets udtalelse om kastration af pattegrise - 2008-5440-0017

Justitsministeriet fremsender hermed høring vedrørende Dyreværnsrådets udtalelse om kastration af pattegrise.

Fristen for afgivelse af bemærkninger er **senest fredag den 22 august 2008 kl. 12.00.**

Se venligst vedhæftede filer.

Med venlig hilsen

JUSTITSMINISTERIET

Maj-Britt Hastrup
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Justitsministeriet
Dyrevelfærdskontoret

Akt.nr. 3

2008 NR. 5440-0017

Jmt. Mdt.
14 JULI 2008

11 JULI 2008 hj

Justitsministeriet

J.nr.: 2008-005-160
/ OA

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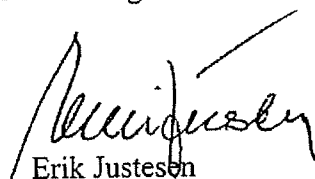
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Vedr. Justitsministeriets sagsnr. 2008-5440-0017

Ved brev af 1. juli 2008 har Justitsministeriet anmodet om eventuelle bemærkninger til Dyreværnsrådets udtalelse om kastration af pattegrise og den dermed forbundne smertefølelse.

Det kan i den anledning oplyses, at Rigspolitiet ikke har bemærkninger til udtalelsen.

Med venlig hilsen



Erik Justesen
vicerigspolitichef

Justitsministeriet
Brevkøntoret

2008 NR. 5440-0017

KL.NR.

4



Modtaget i 7/7.08
Dyrevelfærdskontoret

Justitsministeriet
Slotsholmsgade 10
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7. juli 2008
Eksp.nr. 554867
/meo-dep

Høring over Dyreværnsrådets udtalelse om kastration af pattegrise

Økonomi- og Erhvervsministeriet har modtaget ovenstående høring fra Justitsministeriet. Økonomi- og Erhvervsministeriet har sendt materialet i høring hos Erhvervs- og Selskabsstyrelsen.

Økonomi- og Erhvervsministeriet har på denne baggrund ingen bemærkninger til denne høring.

Med venlig hilsen

Mette Olsen
Kontorfuldmægtig

ERK 44
Justitsministeriet
Dyrevelfærdskontoret

Akt.nr. 5

2008 NFv. 5440.0017

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Sendt: 21. august 2008 13:48
Til: Eddie Omar Rosenberg Khawaja
Cc: Jensen, Jens Christian Eskjær
Emne: Høringssvar fra Pfizer Animal Health
Prioritet: Høj

Vedhæftede filer: Høringssvar fra Pfizer Animal Health.pdf; 01_Improvac_Food Safety_Clarke_2008_IJARVM.pdf; 02_Hennessy and Newbold. IPVS 2004.pdf; 03_Hennessy et al. Eating Quality. IPVS 2006..pdf; 04_Jeong et al Eating Quality and Sensory IPVS 2008.pdf; 05_Boghossian et al_Immunocastration_A Strategy to Produce Taint Free Pork.pdf; 06-Lagerkvist_Swedish consumer preferences.pdf; 07_Hennessy_Consumer attitudes_APVS 2007.pdf; 08_Giffin et al Consumer Acceptance IPVS 2008.pdf; 09_Allison_Improvac Consumer Acceptance_IPVS Proceedings 2008.pdf; 10_Cronin behavior of IC EM and CM.pdf; 11a_MacKinnon Pearce_The Pig Journal 2007 59_29-67.pdf; 11b_MacKinnon Pearce_The Pig Journal 2007 59_68-90.pdf

Kære Eddie Khawaja,

Denne henvendelse sker på vegne af Pfizer Animal Health.

Jeg fremsender hermed et høringssvar vedr. Dyreværnsrådets udtalelse til Justitsministeren ang. kastration af pattegrise. Jeg har desuden vedhæftet det kildemateriale, som svaret henviser til.

Skulle der være problemer med en fil eller lignende, må du meget gerne kontakte mig, så skal jeg sørge for at I får en ny udgave.

Har I spørgsmål til selve substansen, kan I kontakte Jens Christian Eskjær Jensen, der er teknisk direktør for Pfizers arbejde med svin.

Jens kan træffes telefonisk på +33 (60) 80 57 431 eller på mail jens.chr.jensen@pfizer.com.

Venlig hilsen/Kind regards

Peter Andreas Münster
 Konsulent for Pfizer Animal Health

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2008 NR. 5440-0017

Akt.nr. 6

22-08-2008

Hørings svar

vedr.

**Udtalelse om kastration af pattegrise og den
dermed forbundne smertefølelse**

Fra

**Pfizer Animal Health
23-25 Avenue du Dr Lannelongue
F-75668 Paris cedex 14**

Erklæring fra Dyreværnsrådet om kastration af pattegrise og den dermed forbundne smerte

Den 14. marts 2008 bad Justitsministeriet Dyreværnsrådet om en udtalelse vedrørende kastration af pattegrise og den smerte, de følte i forbindelse med denne procedure. Justitsministeriet bad også Rådet om at overveje mulige alternativer til kastration af pattegrise i sin gennemgang. I forbindelse med undersøgelsen overvejede Dyreværnsrådet kastration under bedøvelse og modtog også information fra Pfizer Animal Health om brugen af vaccination mod ornelugt som et alternativ til kirurgisk kastration.

Udtalelsen fra Dyreværnsrådet blev afleveret til justitsminister Lene Espersen i juni, hvorefter ministeren sendte udtalelsen i høring hos relevante myndigheder og organisationer.

Kommentarer fra Pfizer Animal Health

Pfizer er glad for det initiativ, Justitsministeriet har taget med hensyn til at undersøge de velfærdsmæssige aspekter af kirurgisk kastration af pattegrise og at overveje dyrevenlige alternativer til kirurgisk kastration.

Dyreværnsrådet bemærker helt korrekt, at der ikke umiddelbart kan gives nogen anbefalinger om alternativer til kirurgisk kastration, fordi der ikke findes nogen i øjeblikket. Men vi mener, at anbefalingen om at forskningen fortsætter, og at spørgsmålet om kastration af pattegrise tages op igen inden for maks. fem år, er en noget konservativ tidshorisont.

I Rådets erklæring står der endvidere, at Improvac, Pfizers vaccine mod ornelugt, endnu ikke er godkendt til brug i Danmark (og i EU), og det rejser en række spørgsmål, som skal afklares, "før det kan vurderes, om denne metode kan bruges som et alternativ til kirurgisk kastration". Disse spørgsmål handler om sikkerheden for den person, som vaccinerer grisene, forbrugernes holdning og også omfanget af aggressiv adfærd hos ikke kastrerede, men vaccinerede grise og konsekvenserne med hensyn til dyrevelfærd og håndtering af grisene. Vi vil gerne benytte denne lejlighed til at formidle yderligere information til behandling af disse vigtige spørgsmål.

1. Sikkerhed for den person, der vaccinerer grisene

Der er i 2007 blevet indsendt en anmodning til Det Europæiske Lægemiddelagentur (EMA) under EUs centraliserede procedure om tilladelse til markedsføring i EU af Improvac. Udvalget for Veterinærlægemidler (CVMP) fortager den videnskabelige evaluering. Forudsat at CVMP er tilfreds med de fremlagte data, forventes en godkendelse af Improvac som et immuniserende lægemiddel til dyr inden midten af 2009. Et kritisk aspekt af denne gennemgang er sikkerheden for den person, der vaccinerer grisene, og det skal sikres tilstrækkeligt, før godkendelse af produktet kan overvejes.

Risikoen for denne person består i sandsynligheden for uforsætlig selvinjektion, faremomenter (helbredsmæssige konsekvenser, behandlingsmuligheder og

helbredelse) og i hvilken grad disse kan afhjælpes ved passende forholdsregler for at mindske risikoen.

Muligheden for uforsætlig selvinjektion minimeres ved at sikre, at produktet indgives af en kvalificeret person med en sikkerhedssprøjte (med en nål, der kan trækkes tilbage og låses). Den foreslåede produktmærkning giver råd til lægerne i tilfælde af uforsætlig selvinjektion og anbefaler, at når en person har været udsat for selvinjektion, skal denne ikke længere anvende produktet for at undgå risikoen for yderligere eksponering.

Improvac er allerede godkendt og i brug i flere lande i hele verden, og over 3,5 mio. grise er blevet vaccineret til dato, og antallet stiger hastigt. Tre tilfælde af hudkontakt med nåle eller mistanke om selvinjektion er rapporteret, og de var alle enten helt symptomfri eller medførte i et tilfælde forbigående hormonale ændringer uden klinisk manifestering, som normaliseredes igen uden behandling.

Alle aspekter af sikkerhed for de personer, der indgiver vaccinen vil blive gennemgået i detaljer og blive taget med i betragtning i den endelige vurdering af risiko/fordel, der foretages af CVMP, når de skal afgøre, om Improvac kan anbefales til godkendelse i EU.

2. Forbrugernes holdning

Ud fra et videnskabeligt synspunkt er fødevarerisikoen ved brug af Improvac klar. Improvac indeholder et proteinantigen, som ikke har nogen hormonel eller farmakologisk aktivitet og ikke er aktivt, når det indtages gennem munden (1). Det efterlader ingen rester i kødet, som kan påvirke mennesker, og ligesom de fleste andre vacciner er Improvac tildelt en tilbageholdelsestid på 0 (nul) dage i de 18 lande, hvor den er godkendt i øjeblikket, hvilket afspejler fødevarerisikoen ved brug af Improvac.

Med hensyn til kødkvaliteten har flere sensoriske undersøgelser i en række lande klart vist, at svinekød fra orner, der har fået Improvac, er af samme sensoriske kvalitet (lugt, smag, saftighed, mørhed og generel kvalitet) som svinekød fra hungrise eller kastrerede grise (2-5).

Ud fra et forbrugerpsykologisk perspektiv er de videnskabelige data alene imidlertid ikke altid tilstrækkelige til at dæmpe bekymringer. Med Improvac kan forbrugerbekymringer eller usikkerhed afklares ikke blot med videnskabelige fakta, men også ved at pege på de positive fordele for en række interessenter, herunder fordelene for de behandlede grise. Man har fået bevis for dette gennem forbrugerundersøgelser foretaget i Australien, Korea, Schweiz og også i fire EU-medlemslande: Sverige, Holland, Tyskland og Frankrig (1, 6-9).

Undersøgelserne bad forbrugerne give udtryk for deres holdning med hensyn til fjernelse af ornelugt ved brug af vaccination eller fysisk kastration. Resultaterne fra alle landene angav klart forbrugernes præference med en overvældende majoritet for brug af en vaccine til at forhindre ornelugt fra de over 5300 deltagere, så længe kødsmagen var den samme, som den man fik ved kastration. Denne tendens forstærkes jo mere information omkring mulighederne for kontrol af ornelugt

forbrugerne har til rådighed. Bekymring om dyrevelfærd var den primære faktor, der fik forbrugerne til at foretrække vaccination mod ornelugt frem for kastration. Resultaterne viste, at vaccination mod ornelugt ikke blot er acceptabel for forbrugerne, men foretrækkes frem for kastration. Respondenterne i Frankrig, Tyskland og Holland blev oven i købet spurgt specifikt til deres holdning til vaccination versus kastration *med* bedøvelse og i disse lande var holdningen den samme, nemlig at vaccination var den foretrukne metode til at bekæmpe ornelugt.

3. De vaccinerede hangrises adfærd

Selvom det er muligt at opdrætte intakte hangrise til slagtevægt uden adfærdsproblemer, og man har nogen erfaring hermed i Danmark, er der ingen tvivl om, at problemer med aggressiv og seksuel adfærd blandt orner somme tider kan opstå, og at disse kan udgøre et velfærdsproblem i den sene opvækstfase. Det kan også være et problem, hvis grisene flyttes og blandes, når de skal slagtes.

Improvacs virkning taget i betragtning kan kontrol af hangrisenes adfærd forventes efter vaccinationen, hvilket er blevet bekræftet. I forbindelse med undersøgelser af hangrises adfærd, der sammenlignede virkningerne af vaccination med Improvac mod kirurgisk kastration på hangrisene, når de opstaldes i grupper, udviste vaccinerede grise de samme lave niveauer af aggressiv adfærd som kirurgisk kastrerede hanner (begge væsentligt lavere end intakte hanner) ved 21 uger (10).

Da vaccinationen foretages i den sene opvækstfase, er en af de potentielle fordele ved Improvac, at det giver svineproducenten mulighed for at udnytte den økonomiske fordel ved hangrisenes naturlige tilvækst, lavere foderforbrug og mere kødholdige slagtekrop, samtidig med at hangrisenes adfærd når de er omkring puberteten er kontrolleret fordi vaccinnens effekt er indtrådt på dette tidspunkt. Herved forbedres velfærden for grisene, de bliver nemmere at håndtere (som var de kirurgisk kastrerede), risikoen for skader reduceres (som følge af slagsmål og bedækningsadfærd) og dermed forbedres også slagtekroppens kvalitet. (11).

Afsluttende bemærkninger

Vi er glade for at Dyreværnsrådet er blevet bedt om at gennemgå dette emne og sætter stor pris på muligheden for at kommentere indholdet af rådets udtalelse. Vi håber, at ovennævnte punkter og de oplysninger, der er givet, kan bidrage til at belyse nogle vigtige aspekter og fordele ved vaccination mod ornelugt som et alternativ til kirurgisk kastration. EMEAs behandling af ansøgningen om tilladelse til markedsføring i EU er igangværende og skulle være afsluttet i starten af 2009. Forudsat at resultatet af denne behandling er positivt, forventer vi, at vaccination mod ornelugt vil være en mulighed for svineproducenterne i hele EU næste år, og det vil således være et praktisk alternativ til den nuværende kirurgiske kastration med positive resultater og fordele for producenter, for dyrevelfærden og af forbrugernes accept samt præference.

Vi håber, afhængig af EU-myndighedernes godkendelse af vaccination mod ornelugt, at Dyreværnsrådet vil genoptage dette emne på et passende tidspunkt og endnu engang overveje anbefalingerne med hensyn til alternative metoder til kirurgisk kastration.

Referencer

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Inherent Food Safety of a Synthetic Gonadotropin-Releasing Factor (GnRF) Vaccine for the Control of Boar Taint in Entire Male Pigs

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KEY WORDS: pig, sex, gonadotropin-releasing factor, vaccine, boar taint, immunisation, food safety

ABSTRACT

Compared to compounds with a pharmacological mode of action, where the possible presence of drug residues in food is a public health concern, vaccines are generally considered safe from a food quality perspective. This is due to the intrinsic lability of these complex biological molecules, both in the body of the vaccinated animal and, if they should ever get so far, in the cooking process and/or intestinal tract of a consumer. The inherent food safety of a novel gonadotropin-releasing factor (GnRF) vaccine, intended to be administered by injection to male pigs for the control of boar taint, was confirmed using several animal models. In addition to conventional oral bioavailability studies, an experiment was also performed

to check for the presence of a direct hormonal effect of the vaccine antigen. The vaccine antigen comprises a synthetic analogue of mammalian GnRF covalently coupled to a carrier protein. Intravenous administration of this antigen in sheep had no effect on luteinizing hormone secretion from the pituitary gland, demonstrating that the vaccine itself has no hormonal activity. Repeated oral dosing of the vaccine to pigs failed to stimulate production of detectable circulating antibodies against GnRF and did not affect serum testosterone levels. This lack of oral activity was further confirmed by the oral administration to laboratory rats of graduated doses of the vaccine up to 70 times (on a weight for weight basis) the recommended injectable dose in pigs. There were no quantifiable vaccine antigen levels or anti-GnRF antibodies detectable in the sera of these rats at any dosage level, or any secondary effects on sex hormone levels, in-

dicating that vaccine given orally is neither systemically bioavailable nor immunogenic. These studies confirm that there is no risk to human health from the consumption of pork from pigs administered this boar taint vaccine.

INTRODUCTION

Boar taint, caused principally by accumulation of androstene and skatole in fatty tissue, is a significant food quality problem in sexually maturing male pigs. Androstene is a pheromone steroid produced in the testes, and skatole is a by-product of the bacterial degradation of tryptophan in the large intestine. Both substances are highly lipophilic and are sequestered in the adipose tissue of the pig. Due to relatively high volatility, both compounds are readily released upon heating and cooking of pork and can give rise to an offensive odour (boar taint).¹⁻⁴

There are 2 traditional management approaches to this meat quality problem. Slaughter prior to sexual maturity and, much more commonly, surgical castration prior to weaning. Both practices have significant drawbacks however. Slaughter of pigs at relatively light weights results in significant production losses. Castration of very young pigs prevents endogenous production of male steroids that give rise to androstene and skatole accumulation but causes increased fat deposition in the carcass, less lean meat yield, and statistically significant reductions in growth efficiency.^{5,6} Because of poorer feed conversion efficiency, castrated pigs are significantly more expensive to raise than intact pigs. Aside from direct production losses, castration is also associated with increased mortality from post-castration complications such as infections and hernias. Anecdotally, this increase in mortality can be as high as 0.5 to 1.5 percentage points. Additionally, castration is criticised by animal welfare groups because it is generally practised without anaesthesia and is associated with pain-related behaviour⁷ and significant increases in serum cortisol concentrations indicative of stress.⁸

The economic and welfare drawbacks of surgical castration prompted the development of a parenteral vaccine (Improvac[®]/Vivax[®]; Pfizer Animal Health) that stimulates neutralizing antibodies directed against endogenous gonadotropin-releasing factor (GnRF).⁹ Endogenous GnRF stimulates the pituitary-gonadal axis, which, in the boar, results in the synthesis of testicular steroids, including testosterone and androstene. Suppressing testicular steroid synthesis not only prevents androstene production but also accelerates hepatic clearance of skatole.¹⁰ Thus, the net effect of inducing antibodies against circulating GnRF is the inhibition of testicular function and the consistent reduction of both androstene and skatole to levels below consumer detection.

The immunizing antigen in the commercial vaccine comprises a synthetic analogue of endogenous mammalian GnRF conjugated to a carrier protein. Instead of having 10 amino acids like endogenous GnRF, the synthetic GnRF peptide lacks 1 amino acid and is thus foreign to the GnRF gonadotropin receptors in the pituitary gland. Covalent linkage of the GnRF analogue to the carrier protein results in an antigen that is even more foreign to the pituitary GnRF receptors but, together with the aqueous adjuvant in the vaccine formulation, allows stimulation of the immune system to transiently produce high levels of circulating antibodies to GnRF.

The studies described in this paper were conducted, firstly, to determine if the synthetic GnRF analogue or the vaccine antigen have any hormonal activity (Study 1) and, secondly, to see if orally administered vaccine antigen is systemically bioavailable or immunogenic (Studies 2 and 3). Negative results would confirm that there are no immunologic or endocrinologic safety hazards for humans consuming meat from vaccinated pigs.

MATERIALS AND METHODS

All experiments involving animals were carried out in compliance with national legislation and subject to local ethical review.

Study 1. Evaluation of Hormone Activity of the GnRF Analogue and Antigen Conjugate

A controlled experiment was performed to determine if either the GnRF analogue or the protein conjugate (vaccine antigen) have any direct hormonal activity when administered parenterally. As GnRF is highly conserved across mammalian species,¹¹ and because of extensive experience with a sheep model, the sheep was used as the test animal.

Twelve post-pubertal female crossbred sheep were randomly assigned to 1 of 4 groups (n = 3 each). The jugular vein was cannulated for blood sampling and intravenous (IV) injection of the test articles. On Day 8 of their respective oestrus cycles, when luteinizing hormone (LH) pulse frequency was low, sheep were given 3 IV injections of 20 mg of morphine at half-hour intervals to suppress synthesis of endogenous GnRF.¹² After the third morphine injection, the respective test groups were given either a single IV injection of saline, natural GnRF peptide (1 µg), synthetic GnRF peptide analogue (50 µg), or sufficient vaccine antigen to provide the equivalent amount of 50 µg of covalently bound GnRF peptide analogue. The 50-fold larger dose of GnRF peptide analogue compared with natural GnRF was estimated from the sequence of the analogue peptide and potency comparisons with other characterized peptide analogues. Baseline blood samples were obtained prior to treatment and at 10 intervals up to 240 minutes after injection (Figure 1). Plasma concentrations of LH were assayed using a standard radioimmunoassay previously described¹³ with a detection limit of 0.11 ng/mL.

Study 2. Systemic Effects of Oral Administration of Vaccine in Pigs

To evaluate the effects of oral ingestion of the vaccine, a controlled experiment was performed to determine the antibody and hormonal response in pigs following multiple vaccine doses given orally.

Pigs were chosen as the test animal for this study since the gastrointestinal tract of the pig is similar to that of humans and their

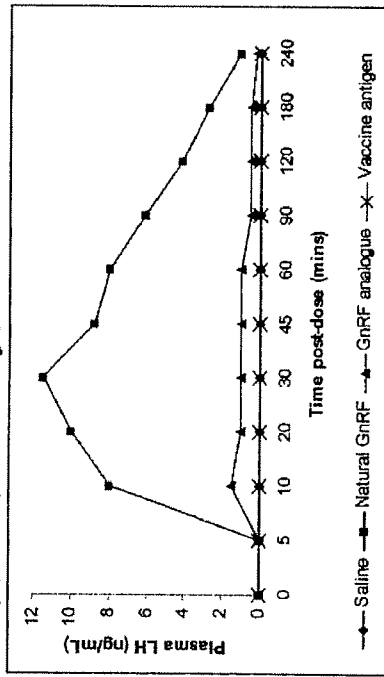
size allows simple administration of a full dose of the vaccine.

Twelve 12- to 13-week-old male pigs were randomly assigned to a treatment group or untreated control group (n = 6 each). Commercial vaccine was given to the treated group as a 2-mL oral dose by mixing with a small amount of pelleted feed, prior to normal feeding. This was similarly followed by a second oral dose 28 days later. Blood samples were obtained at 14, 28 and 42 days after the first oral treatment and assayed for serum testosterone and antibodies against GnRF. The sample taken 28 days after the first dose was obtained just prior to administration of the second dose. The sample taken 42 days after the second dose was obtained 14 days after the second dose; an interval that would normally allow an anamnestic immune response to be detected if it occurred. Samples were taken between 10 AM and noon to minimize diurnal variation in testosterone concentrations. Serum testosterone was measured using a commercial radioimmunoassay kit (Direct Testosterone Kit, Cat No. 135; Pantex, Santa Monica, CA, USA), expressed as ng/mL, and analysis of variance (ANOVA) used to compare results. Titers of antibody against GnRF were measured by a validated in-house radioimmunoassay, with titers expressed as reciprocals of the dilution that bound 30% of a commercial tritium-labeled GnRF tracer available from Amersham Inc (Piscataway, NJ, USA). Separation of bound from free GnRF was achieved with precipitation using bovine gamma globulin and 18% polyethylene glycol. The limit of quantification (LOQ) of this assay was 20 titer units.

Study 3. Oral Bioavailability and Systemic Effects of Vaccine in Rats

A controlled study was conducted to evaluate systemic bioavailability, immunogenicity, and any indirect hormonal effects of the vaccine following oral and parenteral administration to Sprague-Dawley rats (a well-characterized laboratory animal model routinely used in toxicology studies). Table 1 summarizes the test groups, vaccine dos-

Figure 1. Mean plasma luteinizing hormone (LH) concentrations following IV injection of sheep with either saline, 1 µg natural gonadotropin releasing factor (GnRF), 50 µg synthetic GnRF analogue, or vaccine conjugate antigen (sufficient to provide the equivalent amount of 50 µg of covalently bound GnRF peptide analogue). Limit of LH quantification = 0.11 ng/mL.



ages, and toxicological/immunological and other outcome parameters. Serum anti-GnRF antibody levels and systemic bioavailability of the antigen were determined by electrochemiluminescent immunoassays (ECLIA) with an LOQ of 4.7 pmol/mL for anti-GnRF antibodies and 1.4 pmol/mL or 0.098 µg/mL for vaccine antigen.

Commercial vaccine was administered orally by gavage once on Day 1 and on Day 29 to 3/sex/group male and female Sprague-Dawley rats at doses of 11.4 µg/kg, 272 µg/kg, and 462 µg/kg. These doses represented approximations of 1.7x, 41.2x, and 70x, respectively, of hypothetical oral consumption of a full 2-mL vaccine dose by a 60-kg human. An additional 2 groups of 5 males and 5 females were given either saline or formulation vehicle at the same dosing

volume and dosing interval. A positive control group was also included that consisted of 5 males and 5 females given 27.5 µg/kg subcutaneously also on Day 1 and Day 29. Parameters for evaluation included daily clinical observations, weekly body weight, weekly food consumption, and terminal hematology, coagulation, clinical chemistry, and hormone analysis. Hormone analysis

included LH (all animals), progesterone (females only), estradiol-17β (females only), and testosterone (males only). Rats in the oral groups and in the SC injection positive control groups (Table 1) were necropsied on Day 58 of the study (ie, 29 days after the second dose). Organ weights on heart, liver, kidneys, adrenal glands, pituitary, and brain were obtained and representative sections of 47 tissues were collected for histological evaluation. Hormone data were analyzed using a mixed model ANOVA.

Systemic exposure and antibody response were assessed in toxicokinetic (TK) satellite groups in which 3/sex/group were dosed with 462 and 27.5 µg/kg for the high-dose oral dose and positive control SC dose groups, respectively, on Day 1 and Day 29. Blood samples were taken at 0 (pre-treatment), 1, 4, 8, 12, and 24 hours and 2, 7, 14, and 21 days after the first dose and at 0 (pre-treatment), 1, 4, 8, 12, and 24 hours and 2, 7, 14, and 21 days after the second dose from all animals in both TK treatment groups. The blood samples were processed into serum and were assayed for the vaccine antigen and anti-GnRF antibodies. The vaccine antigen and log₁₀ transformed anti-GnRF

Table 1. Rat Bioavailability Study Test Groups.

Test Group	Antigen Dose	Dosing Regimen	Toxicity Parameters
Sterile water control (n = 5/sex)	0 µg/kg	PO, day 1 and 29	1, 2
Vehicle control (n = 5/sex)	0 µg/kg	PO, day 1 and 29	1, 2
Oral-toxicity low dose (n = 5/sex)	11.4 µg/kg	PO, day 1 and 29	1, 2
Oral-toxicity mid dose (n = 5/sex)	27.2 µg/kg	PO, day 1 and 29	1, 2
Oral-toxicity high dose (n = 5/sex)	462 µg/kg	PO, day 1 and 29	1, 2
Positive control (n = 5/sex)	27.5 mg/kg	SC, day 1 and 29	1, 2
TK (n = 3/sex)	462 mg/kg	PO, day 1 and 29	2, 3, 4
TK positive control (n = 3/sex)	27.5 mg/kg	SC, day 1 and 29	2, 3, 4

PO = per os; SC = subcutaneous injection; TK = toxicologic.
 Toxicity parameter key: (1) mortality, food consumption, body weight, terminal hematology and coagulation, clinical chemistry, gross necropsy, Day 56 histopathology, (2) hormone response; (3) anti-GnRF antibody; (4) GnRF analogue protein conjugate bioavailability.

values were analyzed with a mixed model ANOVA for repeated measures.

RESULTS

Study 1. Evaluation of Hormone Activity of the GnRF Analogue and Antigen Conjugate

The mean temporal responses for the 4 treatment groups are shown in Figure 1. Luteinizing hormone was not detectable in any of the 12 sheep prior to administration of their respective treatments, indicating that morphine effectively blocked LH secretion. All 3 sheep given 1 µg of natural GnRF had a rapid, marked increase in LH with a mean peak value of 11.63 ± 5.03 ng/mL. The 3 sheep given unconjugated GnRF peptide analogue at a dosage 50 times greater than

that for natural GnRF had a relatively small increase in LH, with a mean value approximately 10-fold less than that for sheep given natural GnRF at a 50 times lower dose. Sheep given either the GnRF analogue-protein conjugate (vaccine antigen) or saline produced no quantifiable LH response. The test peptide analogue had a relative activity of only 0.2% compared to natural GnRF (mean GnRF analogue response + mean GnRF response + 50 x 100%), while the vaccine conjugate antigen had no LH stimulating activity.

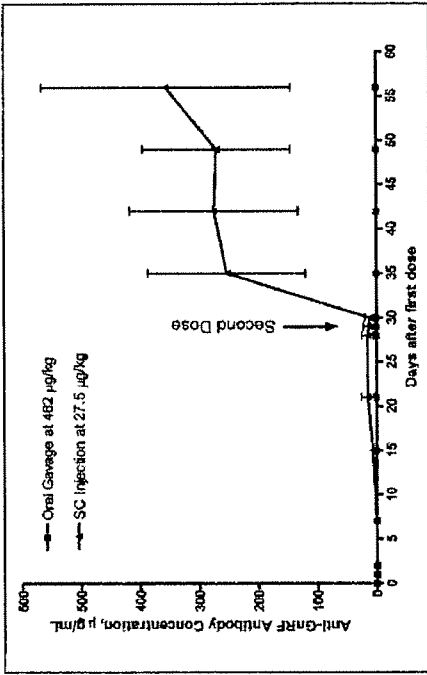
Study 2. Systemic Effects of Oral Administration of Vaccine in Pigs

The serum anti-GnRF antibody titer for all samples was <20, the minimum detectable level, following both the first and second oral vaccine doses. Mean serum testosterone levels at the 3 sampling intervals are shown in Table 2. All pigs had measurable testosterone levels that were within normal reference ranges for animals of that age. There were no significant differences in testosterone levels between orally dosed pigs and untreated control pigs at any sampling interval. Throughout the trial, daily observations of the test animals revealed no abnormal clinical signs or adverse events in any of the pigs.

Table 2. Mean Serum Testosterone Concentration in Pigs Given Oral GnRF Analogue Protein Conjugate Vaccine.

Test Group (n = 6 each)	Mean Serum Testosterone (ng/mL) ± SD		
	Day 14	Day 28	Day 42
Untreated controls	0.69 (± 0.35)	1.04 (± 0.35)	1.18 (± 0.49)
Vaccine treated	1.33 (± 0.84)	1.15 (± 0.49)	0.92 (± 0.26)
P-value	0.44	0.59	0.57

Figure 2. Antibody response after oral and subcutaneous administration of vaccine in rats.



survived to termination of the study and there were no significant differences in body weight or food consumption. Post-treatment hematology, coagulation, and clinical chemistry values were not affected by treatment. Occasional individual variations in these parameters were random, generally small, and were not associated with vaccination route, dosage size, or other parameters or with histological findings. Orally treated rats had no test article-related histopathological effects. There were no quantifiable anti-GnRF antibody responses in any of the rats in the TK group given vaccine orally. There were also no quantifiable antigen levels in the serum of any rat in the TK groups at any of the sampling times, whether the vaccine was administered orally or by SC injection. Unfortunately, because of instability of the GnRF conjugate in frozen serum, the effective LOQ of the assay was estimated to be ~1 µg/mL rather than the 0.098 µg/mL determined during method validation.

As expected, parenterally vaccinated (positive control) rats had significant anti-GnRF antibody responses as compared to the orally treated rats (Figure 2, $P = 0.033$) and significant decreases in serum hor-

DISCUSSION

Intravenous administration to sheep of the GnRF conjugate antigen used in the commercial vaccine demonstrated that this antigen has no innate hormonal activity. The minor LH-stimulating effect of the unconjugated GnRF analogue (approximately 0.2% the effect of natural GnRF) was completely

mones, testosterone in male and progesterone in female rats (Table 3) relative to the control and the orally treated rats. Serum levels of LH and estradiol-17β in the parenterally vaccinated were not significantly different from the serum levels of these hormones in the control and orally treated rats. At necropsy, the parenterally vaccinated rats had undersized sex glands/reproductive organs, i.e. testes, seminal vesicles, prostate glands, or uteri.

Based on these results, an oral no-observed-effect level (NOEL) for the GnRF analogue conjugate (vaccine antigen) was considered to be 462 µg/kg, the highest oral dosage level given. On a weight-for-weight basis, this oral NOEL is approximately 70-fold greater than the recommended 2 mL injectable vaccine dose in pigs.

Table 3. Rat Bioavailability Study Mean Serum Hormone Assay Results.

Treat Group	Antigen Dose (Route)	Testosterone (Male) ng/mL	Progesterone (Female) ng/mL
Shed water control	0 µg/kg (PO)	78.0 ± 27.0	6.10 ± 1.05
Vehicle control	0 µg/kg (PO)	67.3 ± 23.9	6.87 ± 2.24
Oral-toxicity low dose	11.4 µg/kg (PO)	74.2 ± 26.4	10.3 ± 2.63
Oral-toxicity mid dose	272 µg/kg (PO)	103 ± 36.5	11.4 ± 2.88
Oral-toxicity high dose	462 µg/kg (PO)	53.3 ± 19.1	7.20 ± 1.90
Positive control	27.5 mg/kg (SC)	13.5 ± 5.1*	2.34 ± 0.77*
TK high dose	482 mg/kg (PO)	120 ± 40.1	5.00 ± 1.34
TK positive control	27.5 mg/kg (SC)	16.2 ± 5.7†	1.45 ± 0.55†

PO = per os; SC = subcutaneous injection; TK = toxicokinetic.

*P < 0.05 vs all other mean study treatment groups.

†P < 0.05 vs oral TK treatment group.

eliminated after conjugation with the carrier protein. This experiment was designed to test an extreme challenge in the test animal, by direct injection into the blood stream of a high dose of peptide, and of the equivalent amount of peptide presented as conjugate. The complete lack of hormonal activity of the antigen provides compelling evidence that no direct hormonal effect could occur from the hypothetical human consumption of antigen in the meat from a vaccinated animal.

Pigs that were administered the vaccine orally had no detectable antibody response or interference with normal testosterone levels (Table 2). As may be expected with a protein, these results demonstrate an absence of bioavailability following oral ingestion of the GnRF analogue-protein conjugate (vaccine antigen). Negative serum antibody results 14 days after the second oral vaccine dose were noteworthy because an anamnestic response would have occurred within that time period if oral administration were capable of eliciting a systemic immune response. In terms of human food safety, this feeding experiment, which was designed to be sensitive for the detection of an immune response, provides strong evidence that hypothetical human consumption of vaccine residues would not induce antibodies to GnRF or have any secondary endocrinological effect.

As evidenced by the contrasting se-

rologic response of laboratory rats given the vaccine orally or by SC injection, an immune response occurs only when the vaccine is given by injection (Figure 2). Oral administration of the vaccine to rats failed to stimulate anti-GnRF antibodies, corroborating the results of the pig oral administration experiment. Furthermore, oral administration was toxicologically innocuous even when vaccine was given at a relative dose of 70 times that recommended by SC injection for pigs. Administration of vaccine by SC injection had no toxicological effect in rats, either clinically or by objective biochemical parameters. Quantifiable levels of the antigen (LOQ = 1 µg/mL) could not be found in any of the rats in either the orally dosed groups or the subcutaneously dosed group. In summary, the experiments in laboratory animals indicate that the vaccine administered orally is neither toxic nor systemically available nor immunogenic.

As far as we are aware, oral absorption of active residues in meat from any protein subunit vaccine given parenterally to food-producing animals has never been demonstrated. Given the protein composition of vaccine antigens, expected rapid metabolism in the animal host after injection, the fact that slaughter almost always occurs weeks or even months after vaccination, and that meat is usually cooked prior to eating, consumption of intact vaccine antigens is highly unlikely. Nevertheless, consumer insistence

on food safety for any product that is used in livestock is rightfully placed. These considerations justify the safety studies described in this report. The results, demonstrating that the antigen in this boar taint vaccine has no intrinsic hormonal activity and is neither systemically available nor immunogenic by the oral route, affirm the food safety of a product concept that has been safely and effectively used in the field for nearly a decade.^{14,15}

ACKNOWLEDGEMENTS

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EATING QUALITY AND ACCEPTABILITY OF PORK FROM IMPROVAC IMMUNIZED BOARS

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Introduction and Objectives

Global population growth and continued demand for pig meat will continue to place pressure on the world's pork supply. To meet demand the pig industry must become more efficient. One way to increase production efficiency significantly (1) is to raise boars rather than castrates.

However, pork from some boars can have an offensive odour and flavour - "boar taint". Thus, most of the world's male pigs are surgically castrated. However, there are problems with castration that make it undesirable. Compared to boars, castrates are less feed efficient, often grow slower, are less lean, and produce more effluent. There are also growing animal welfare concerns with castration (2). If society is to continue raising animals for food we must become more energy efficient, produce less effluent and continue to improve animal welfare.

Improvac[®], a vaccine to control boar taint, gives pig producers a powerful new tool. By providing an animal welfare and environmentally friendly alternative to castration, Improvac allows producers to benefit from the natural growth and carcass quality advantages associated with non-castrated male pigs while controlling boar taint. The aim of this study was to compare the sensory attributes and consumer acceptability of pork from Improvac boars compared to pork from female and castrated male pigs.

Material and Methods

Twenty boars were immunized with Improvac at 12 and 18 weeks of age and slaughtered at 23 weeks of age. Twenty surgical castrates and 20 female pigs (randomly selected, age matched) served as controls. Approximate carcass weight at slaughter for all groups was 70-75 kg. The left loin (*Longissimus dorsi*) from each pig was removed 24 hours after slaughter, deskinmed, boned, sliced into 12-15 mm steaks and individually packed and frozen at -20°C until required for the sensory evaluation.

Loin steaks from each treatment were provided in a random, blind manner to 122 female and 43 male randomly selected consumers from the Manila area. Steaks were cooked on a double sided hot-plate for 2-3 minutes until they were cooked but still a little pink in the middle. Using a 100-point line scale, each consumer assessed in random sequence six separate samples of pork for aroma, flavour, aftertaste, tenderness, and juiciness. Overall acceptability and intent to purchase were also evaluated. Depending on the measured parameter, the data were analysed using either a balanced ANOVA, regression analysis, Friedman's Rank Correlation Test or Wilcoxon Signed Rank Tests.

Results

The key results are summarised in Tables 1 and 2. For the key sensory attributes (Table 1), there were no significant differences between the three types of pork (P>0.05). Pork

chance that pork purchased in most supermarket stores was male. The key findings from the focus groups were:

- Consumers in Australia had no recognition of the term "boar taint".
- All participants had experienced pork with "off" odour and flavour - this was often attributed to pork being a "bit funny".
- Many participants blamed the retailer for selling old spoiled pork.
- The Asian group had less bad experiences with odour and flavour because they purchased their pork mainly from Asian butchers who sold only female pigs.
- The explanation of "boar taint" as the cause of the odour/flavour problems was understood and did not alter the participants overall perception of pork.
- Vaccination was seen as a natural process, a highly acceptable part of animal production.
- The concept of vaccination to control boar taint intuitively made sense to the groups.
- When it was explained that Improvac was not a hormone, not a chemical and contained no genetically modified organisms or process but was rather a natural vaccine working with the pigs immune system all participants were undeterred by it use.
- The use of Improvac was seen as a favourable alternative to surgical castration.
- All participants volunteered to serve Improvac pork to their families.
- 86% of respondents rated the Improvac pork as having an excellent flavour and cooking odour compared to the pork they normally purchased.
- The results clearly showed that the Improvac pork was highly preferred to boar pork.
- No consumers had any concern over the use of Improvac for the routine control of boar taint - it was preferred to surgical castration.

Summary

Improvac is a natural, non-hormonal vaccine that works in harmony with the pig's immune system to block the compounds that cause boar taint in certain male pigs. The result is the delivery of a consistently fresh full flavoured pork which is totally safe for human consumption. Improvac is also an animal welfare friendly and environmentally friendly alternative to surgical castration.

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Introduction and Objectives

If, as a society, we are to continue raising animals for food we must become more energy efficient, producing less effluent and continue to improve animal welfare. The first commercial boar taint vaccine, Improvac, gives pig producers a powerful new tool to achieve those goals without jeopardising eating quality. Improvac is a vaccine against the animal's own gonadotropin releasing factor (GnRF) it stimulates specific antibodies which inhibit natural GnRF activity, temporarily inhibiting testes function. As a consequence the accumulation of all boar taint compounds is suppressed and; any taint already present at the time of vaccination is eliminated. This paper reports the key findings from market research on consumer attitudes to boar taint and immunocastration.

Material and Methods

Four separate in-depth focus group sessions were conducted by an independent market research company. Each session of around 2 hours involved 12 participants. All participants were female aged between 30 to 55 years and were the main grocery buyer in the household. The broad aim was to gain an understanding of consumers reaction to the issue of boar taint and the use of Improvac to control it; and to understand how knowledge of Improvac may affect consumers attitude to pork.

The demographics of the 4 focus groups was as follows:

1. An Asian background and a regular pork consumers
2. A non-Asian background and regular pork consumers
3. A non-Asian background, occasional pork consumers
4. A non-Asian background, lapsed pork consumers

Regular pork consumption was a frequency of at least once every 2 weeks. Occasional pork consumption was at least once per month; and lapsed pork consumption was about once per 3 months but less than previously because of bad experiences with flavour and smell. At the conclusion each participant was offered a small (-1 kg) loin sample to cook for friends or family. They were fully aware the pork was from Improvac vaccinated pigs. They were given a questionnaire to assess their attitudes to the quality of the pork compared to the pork they usually purchased. All participants willingly volunteered to serve Improvac pork to their family, in total about 80 people provided feedback.

Results and Discussion

Remembering that most male pigs in Australia are not castrated and thus the participants had at least a 50%

Table 1 Key sensory attributes ranked on a 100-point line scale (the higher the score the better the liking).

	Improvac	Castrate	Female
Aroma	72.0	71.3	74.5
Flavour	65.5	64.5	66.3
After taste	64.6	64.4	65.7
Tenderness	72.9	71.3	70.5
Juiciness	69.4	68.6	66.8
Overall liking	68.8	67.5	68.5

Consumers were forced to rank the samples (1=best to 3=least) and were asked to state if they would be likely to purchase that quality of pork (Table 2). Consistent with the results for the key sensory attributes (Table 1), there were no appreciable differences between the three types of pork for overall preference or intent to purchase.

Table 2 Mean forced ranking preference and percent intent to purchase.

	Improvac	Castrate	Female
Overall rank preference	1.94	2.08	1.94
Intent to purchase (%)	82.1	79.7	80.0

Summary: In this randomly selected group of Filipinos there was no demonstrated difference in the sensory quality of pork from Improvac boars compared to pork from either female or castrated male pigs. The ability to use Improvac immunization to control boar taint by the international pig industry will result in improved efficiency of pork production, lower pollution pressures on the environment and improve animal welfare. As shown, these goals can now be achieved without jeopardising eating quality and consumer acceptability.

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The effects of immunocastration on meat quality and sensory properties of pork loins

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Introduction and Objectives

Bor taint is a sensory defect of pork and occurs mainly in pork from non-castrated male pigs. It is predominantly caused by two compounds, skatole and androstene. Because the elimination of bor taint is critical to consumer acceptance of pork, surgical castration of the young male pig is generally practiced. An emerging new alternative method of bor taint control is vaccination or immunocastration. Studies have demonstrated that pork from boars vaccinated to control bor taint was of the same quality as pork from female or surgically castrated pigs (1). According to Dikeman (2), immunocastration showed very good potential for preventing bor taint and improving marbling as well as being able to capitalize on the growth, feed efficiency and carcass leanness of boars. The aim of this study was to compare the meat quality and sensory characteristics of pork loins from immunocastrated boars with loins from surgically castrated boars, non-castrated boars and gilts.

Material and Methods

A total of 99 pigs, from the same farm and genetic origin, were systematically divided into four groups (39 surgically castrated pigs, 40 immunocastrated pigs (Improve[®]; Pfizer Animal Health Korea Ltd.), 10 non-castrated intact boars, and 10 gilts). Improve[®] was administered subcutaneously as 2 x 2 mL doses; the first dose at about 9 weeks of age and the second dose at about 20 weeks of age. Pigs were slaughtered at 26 weeks of age and processed using normal practices for the commercial slaughterhouse. After overnight chilling, pork loins were removed from left side of each carcass, vacuum-packed and transported to the Meat Science Laboratory, Konkuk University. The area between the 5th through 7th ribs from all pigs was cut from the whole loin to determine the meat quality traits while samples from between the 8th and 9th ribs of the immunocastrated and surgically castrated groups were used for the sensory evaluation. The cooked loins were assessed by trained, selected panelists for smell (bor odor), visual appearance, color, taste, tenderness, juiciness, overall appeal. Smell was scored on follows: 10= extremely intense and 1= extremely bland. Other traits were scored on follows: 10= extremely acceptable and 1 = extremely unacceptable. Data were analyzed using SAS program. Analysis of variance was performed using the PROC GLM procedure with treatment groups as the main effect (P < 0.05).

Results and Discussion

The results are summarized in Table 1 and 2. The pH of the four treatments ranged between 5.62-5.71 and no significant differences were observed between the treatments. Similarly there were no differences in photographic color, CIE L* (lightness) and b* (yellowness) measured using the color standard (MPPC). However, the non-castrated boars showed higher a* (redness) value than the surgically castrated boars and gilts. For water-holding capacity (WHC) and drip loss, immunocastrated boars did not show any significant difference from the other treatments. In shear-

force, only the gilts showed a significant difference compared with non-castrated boars. Marbling score was not significantly different among the groups.

In the sensory evaluation, loins from the immunocastrated boars were judged to be the same as loins from surgically castrated boars for bor odor, appearance, color, taste, tenderness, juiciness and overall palatability.

Table 1: Meat quality assessments. Attributes in the same row with different superscripts are statistically different (P<0.05).

Traits	Surgically castrated	Immuno castrated	Non-castrated	Gilts
pH	5.66	5.62	5.68	5.71
Color	1 ^c 53.93	55.47	54.95	55.20
a*	13.70 ^b	13.84 ^{ab}	14.19 ^a	13.73 ^a
b*	3.22	2.88	3.20	2.87
Photographic color	2.04	1.95	1.96	2.21
WHC (%)	41.24	40.48	42.97	42.21
Cooking loss (%)	33.14	32.723	32.82	32.51
Shear force (kg)	4.30 ^{ab}	4.48 ^{ab}	5.02 ^a	3.93 ^b

Table 2: Visual and sensory evaluations. Attributes in the same row with different superscripts are statistically different (P<0.05).

Traits	Surgically castrated	Immuno castrated
Smell (bor odor)	2.07	2.03
Visual appearance	7.64	7.57
Color	7.60	7.56
Taste	7.50	7.43
Tenderness	7.44	7.52
Juiciness	7.34	7.30
Overall appeal	7.53	7.54

Conclusion

This study demonstrated that using vaccination to control bor taint in non-castrated male pigs (immunocastration) can be used without any negative effects on either the objective meat quality or the sensory properties of pork loins. Utilization of this technology will enable the Korean swine industry to increase its competitiveness by the raising of more efficient boars, rather than surgical castrates, with no negative effect on pork quality.

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ABSTRACT

BIOMIMICRY - A STRATEGY TO PRODUCE TAIN-FREE, HIGH QUALITY PORK FROM INTACT BOARS. V. JOSHIOSSIAN, D. HENNESSY, J. MORSEBY, L. SALVATORE, L. SAU, P. JACKSON, J. REYNOLDS and R. MAMSON.

Key words: meat quality, intact boars, carcass characteristics, tenderness, water holding capacity, pH, drip loss, cooking loss, sensory attributes.

WHAT IS ROAR TAIN AND HOW DOES IT REDUCE MEAT QUALITY? Boar taint is a distinct unpleasant odour, flavour, or unpleasent taste, which is present in meat from some entire boars. It is caused by the presence of 3-mercapto-3-methylbutanoic acid (skatole) and 3-methyl-3-mercapto-3-butanone (androstano).

A PROMISING NEW STRATEGY FOR ENSURING HIGH MEAT QUALITY AND IMPROVING PRODUCTION EFFICIENCY One method of improving production efficiency, whilst maintaining high meat quality by controlling boar taint, is to raise intact boars and to vaccinate against LHRR. We have previously reported on the development of a 'user-friendly' vaccine which allows boars to be raised as functionally intact males for the majority of their life.

MEAT An unaltered control group of intact boars was used in the present study. The samples in each group were taken from the neck, at 8 weeks and 8 weeks prior to slaughter. No adverse reactions to either vaccination were noted at any time throughout the trial.

COOKING AND PRESENTATION OF PORK The pork was cooked at 70°C for 6 minutes and on the 2.5 cm square pieces. Each porklet was assessed for its tenderness, juiciness and eating quality by a panel of 10 assessors. A randomized complete block design was used to allocate samples to pan-frying. In addition, the six corresponding raw samples were evaluated by each assessor, however, different blending codes were used for the raw samples. It was ensured that all samples were not during the evaluations so that the boar odour and flavour could be easily detected.

RESULTS AND DISCUSSION RENT analysis (Patterson and Thompson, 1971) was carried out on the response scores to determine any significant differences between treatments. Student's test for homogeneity of variance was used to compare the variation in animals within each treatment group. All comparisons were at the 5% level.

CONCLUSIONS AND INDUSTRY SIGNIFICANCE Our studies have shown that the meat quality of intact boars can be satisfactorily improved by using an LHRR vaccine to eliminate boar taint. We have demonstrated a user-friendly, injectable vaccine against LHRR which allows boars to be raised as functionally intact males for the majority of their life. When the vaccine is administered a few weeks prior to slaughter, the consequences of stopping testis function is that boar taint is eliminated (Hennessy et al., 2004). We report here the effects of vaccination of heavy boars on the chemical and sensory evaluation of meat.

Consistent with our previous findings, the response scores for the vaccinated boars were significantly higher than those of the control boars. On these parameters the response scores for the vaccinated boars were significantly higher than those of the control boars.

Table 1. Mean and standard deviation of carcass characteristics, meat quality and sensory attributes of the vaccinated and control boars.

Table with 5 columns: Parameter, Live weight (kg), Carcass weight (kg), Testosterone (nmol/L), Skatole (µg/g), Androstano (µg/g). Rows include Vaccinated and Control groups.

In the sensory evaluation of the meat pan-frying, a significantly stronger unpleasant odour and unpleasant flavour was observed for the non-vaccinated boars than in those from the vaccinated boars and sows. There were no significant differences between the three groups in the acceptability of meat flavour. However, the non-vaccinated boar meat had the lowest mean (A low score indicates lower acceptability). For acceptability of odour, the control boar group had a significantly lower mean score than the sows, but the mean score of the vaccinated boars was not significantly different from the non-vaccinated boars or the sows.

The evaluations of the raw meat showed that pan-frying did not perceive any significant differences in odour and colour between the three groups.

The variation of the testosterone was significantly lower than that of the non-vaccinated boars for strength of meat flavour. With respect to unpleasant odour, the variance of the sows was significantly lower than the other two groups. It should be noted that although the difference between the vaccinated and non-vaccinated boars was not significant for unpleasant odour flavour, the variance of the vaccinated boars was lower than that of the non-vaccinated control boars.

Although the test for homogeneity of variance was not significant (p>0.10), for either the acceptability of odour or the acceptability of meat flavour, the variance of the vaccinated boars was significantly lower than that of the non-vaccinated boars for both these attributes (p<0.05).

CONCLUSIONS AND INDUSTRY SIGNIFICANCE

Our studies have shown that the meat quality of intact boars can be satisfactorily improved by using an LHRR vaccine to eliminate boar taint. We have demonstrated a user-friendly, injectable vaccine against LHRR which allows boars to be raised as functionally intact males for the majority of their life. When the vaccine is administered a few weeks prior to slaughter, the consequences of stopping testis function is that boar taint is eliminated (Hennessy et al., 2004). We report here the effects of vaccination of heavy boars on the chemical and sensory evaluation of meat.

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Swedish Consumer Preferences for Animal Welfare and Biotech: A Choice Experiment

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This paper compares consumer preferences for immunocastration versus surgical castration and no castration using willingness-to-pay estimates from a choice experiment. Results suggest that consumers place a higher value on pork from immunocastrated pigs than pork from surgically castrated pigs. In contrast, consumers reveal negative valuations of pork from intact boars as compared to pork from surgical castrates. We also show how a binary heteroskedastic logit model can be used to accommodate a larger variance for later choice sets within a choice experiment.

Key words: animal welfare, boar taint, choice experiment, consumer, hormone, immunocastration, surgical castration.

Introduction

Means-end chain theory (e.g., Guman, 1982) and the theory of planned behavior (e.g., Ajzen, 1991) suggest that an implicative relation between product attributes and physiological or psychological consequences and between these consequences and values governs consumer behavior. A product is regarded as a bundle of attributes; people select products that involve desired consequences while trading off with any undesirable consequences.

Product differentiation strategies are increasingly used in food marketing to attract the interest of consumers for various product characteristics. Product differentiation is achieved through distinct product attributes and is often communicated through product labels or other marketing activities. Long-run competitiveness of food products requires that consumers attribute a value to the product. The attributed value may originate from a plethora of product attributes and/or from conditions in the production process. These attributes and conditions, however, may differ with respect to consumer desirability.

This study investigates the consumer tradeoff for pork meat between consequences related to product attributes characterized by various levels of animal welfare, taste quality, and use of biotechnology in production of pork. Evaluated by personal values, these tradeoffs will reflect which consequences consumers try to achieve in a consumption situation. The specific focus in this study is on castration of male pigs.

Castration of male pigs is routinely performed worldwide in order to prevent the occurrence of the objectionable odor or flavor of boar taint in pig carcasses. Boar taint is caused mainly by androstenone, a testicular steroid, and skatole (3-methylindole from

castration makes it possible to exploit the growth potential of male pigs for most of their productive life. These studies also found that the meat percentage was higher for boars and immunocastrates than for surgical castrates. For immunocastrates, the energy conversion ratio was lower than that of boars but higher than that of surgical castrates (Zeng et al., 2002). Vaccine for immunocastration is currently approved in Australia and pending approval in Taiwan and China. It is not, however, currently approved in the EU or in the United States. Several new vaccines are also under development (e.g., Wang & Wolfeld, 2005).

The role of public acceptance of immunocastration as an alternative to surgical castration is largely unexplored. Such an acceptance likely involves tradeoffs between animal welfare concerns, food safety risks through use of biotechnology, and food (e.g., taste) quality. Potential food safety risks include possible residues in meat (European Food Safety Authority, 2004). A recent study of the use of biotechnology in food production found consumer preferences for food produced without biotechnology. Use of recombinant growth hormone was found to constitute an undesirable characteristic (Kiese, Buschena, & Smith, 2005). In light of this, this paper investigates consumers' preferences for immunocastration by comparing willingness-to-pay (WTP) estimates obtained from a choice experiment (CE). The primary finding is that people seem to accept potential food safety risks to alleviate animal welfare problems related to surgical castration. Hence, biotechnology is found to be a "good" rather than a "bad" when castration compared to surgical castration) that are equal with respect to taste quality. On the other hand, people prefer pork from surgical castrates over pork from intact boars. This suggests that taste quality dominates animal welfare concerns as product attributes. Our findings are indicative of a Pareto criterion that extends to include the well-being of the animals in production agriculture.

Market data for sales of pork where male pigs were either not castrated or immunocastrated are not available in Sweden, because there is no market for boars and immunocastration is not yet approved there. Primary data for the evaluation of alternatives for surgical castration were instead collected through a mail survey developed and mailed to consumers in Sweden. The survey contained a CE in which consumers were asked to make choices between pork chops with varying levels of

The Choice Experiment

price, type of housing system, castration, tainting, and fixation. The use of a CE in this analysis is motivated as the method allows for a multivariate valuation and allows estimation of marginal rates of substitution between different attributes and levels of given attributes. CEs have recently been extensively used to assess consumer's choices among food product attributes including food safety (e.g., growth hormones and fat genetic corn in beef) and animal welfare (e.g., Alfnes, 2004; Alfnes & Røckertsen, 2003; Baker & Burnham, 2001; Carlsson, Fryklund, & Lagerkvist, 2005a; Lusk, Roosen, & Fox, 2003). Attributes and levels used in the CE (besides castration) were selected due to policy relevance and results from previous Swedish studies on factors important in consumer valuation of pork meat (Carlsson et al., 2005a; Liljenstolpe, 2003). Table 1 reports attributes and levels in the CE.

Survey Design

The questionnaire used for the CE was devised together with veterinarians at the Swedish Animal Welfare Agency. The definitive questionnaire was preceded by a pretest using two focus groups (each comprising five individuals). The resulting questionnaire consisted of three parts. The first part included questions about the respondent's and the household's buying habits for pork. The CE constituted the second part. In the introduction to the CE, the purpose of the survey was explained briefly, followed by a "cheap-talk" script suggested by Carlsson, Fryklund, and Lagerkvist (2005b) to reduce the probability of hypothetical bias. Furthermore, an information sheet was included in the questionnaire to describe the process quality variables and provide a short explanation of the choices offered (see Appendix). The third part of the questionnaire contained questions regarding the respondent's socioeconomic and demographic status.

Consumers were asked to make binary choices between various pork chop alternatives. Each alternative was described by four quality attributes and one price variable in a set of six choices. Table 2 provides an example of a choice situation. The choice sets were created using a cyclical design principle (Bunch, Louvière, & Aideron, 1996).¹ One potential criticism of the experiment is a potential lack of realism, in that a food manufacturer or reseller may not label products with, say, "no castration of pigs" or "no fixation." However, even though this might be true, the use of a CE here is motivated, as it closely resembles an actual purchase situation—specifically, the tradeoffs between attributes

Table 1. Attributes and levels in the choice experiment.

Attribute	Levels
1. Type of housing system	1.1 Pigs kept indoors in boxes with little straw. 1.2 Pigs kept indoors in boxes with plenty of straw. 1.3 Possibilities for pigs to be outdoors.
2. Castration	2.1 Surgically castrated pigs (no risk for boar taint, suffering for the piglet). 2.2 No castration of the pigs (more meaty; lower fat content but risk for boar taint). 2.3 Immunocastration of pigs (more meaty; less fat content but a low risk for boar taint).
3. Tail docking	3.1 The pig has been tail docked. 3.2 The pig has not been tail docked but tail bling can occur. 3.3 The pig has not been tail docked. The pig has been raised in a more expensive way to prevent tail bling.
4. Fixation	4.1 Keeping sows permanently fixated is allowed. 4.2 Keeping sows fixated at delivery is allowed. 4.3 Fixation of sows is banned.
5. Price* (SEK/kg)	0 (75); +4 (79); +8 (83); +12 (87); -24 (99)

* At the time the survey was carried out, 1 Swedish Krona (SEK) = 80.13.

where a product is chosen from several competing options. This mimicking will be an advantage in reducing problems of incentive compatibility. In addition, even if not labelled, any product or process characteristics can still be communicated through means other than a label.

The CE did not include an opt-out alternative. However, each respondent was instructed to answer the CE only if he or she actually consumes the product. Furthermore, for all attributes, the current level was included when designing the choice sets (see Table 1). The comparison between the levels of the attributes in a CE does not require an outside option or an opt-out alternative. This is because we are primarily interested in the comparison between different clearly defined alternatives, such as if the pig has been castrated or not. If we want to

compare these it is, from a welfare theory point of view, not necessary to include an opt-out. There could be other arguments for and against including an opt-out alternative. For example, an opt-out alternative could make the choice situation more realistic in providing a no-purchase option, but some respondents could also use it as a simple choice heuristic.

As with other valuation methods, there are several potential disadvantages associated with CEs; see for example Lusk and Hudson (2004) for a comparison of valuation methods. The hypothetical nature of the experiments may induce respondents to exaggerate their stated WTP; see for example Carlsson and Martinsson (2001) and Lusk and Schroeder (2004). In order to reduce the potential problem of hypothetical bias, we therefore included the above-mentioned cheap-talk script in the survey.

Lagerkvist et al. — Swedish Consumer Preferences for Animal Welfare and Biotech. A Choice Experiment

Model

The households' choices can be described using a random utility model framework. We assume a linear random utility function; in particular, utility is a linear function of money. This means that we assume that the utility of a particular alternative i can be described as

$$U_i = v_i + \epsilon_i = \beta x_i - \gamma c_i + \epsilon_i \quad (1)$$

where x_i is a vector of the attributes in alternative i , β is the corresponding parameter, c_i is the cost associated with alternative i , γ is the marginal utility of money, and ϵ_i is an error term. If the error terms are extreme value distributed, then the probability that a particular alternative is chosen can be formulated as the standard logit probability. Thus, the probability that alternative A is chosen when there is a choice between A and B can be expressed as

$$P(A) = 1 / (1 + \exp[-\beta(c_A - c_B) + \gamma(c_A - c_B)]) \quad (2)$$

In the literature there is an increasing concern about the role of the scale parameter in discrete choice models and also increasing empirical evidence of the importance of modeling the scale parameter in an appropriate way. In particular, attributes may have effects both on the behavior in terms of affecting the level of the utility but also in terms of affecting the variance of the utility. In order to assess the potential effect on the level of utility (e.g., for a welfare analysis), it is important to make sure that one is not capturing effects on the variance instead; see for example Louvière, Hensler, and Swait (2000), Swait and Adamowicz (2001), and Islam and Louvière (2004). We therefore use a binary heteroscedastic logit model, where the error term has a logistic distribution with mean zero and variance $\exp(\delta_i)^2$, where δ_i is vector of choice set specific characteristics and δ is the corresponding parameter vector. The question remains what to include in the variance function. One obvious candidate is of course the attribute levels. However, note that the variance function is exponential, and because the discrete choice model depends on differences in attribute levels, it is not advisable to directly include the attribute levels directly in the variance function.² Therefore, we include two other characteristics in the variance function. The first one is the value of the difference in cost; the second is a dummy variable for the second half of the total number of choice sets.

Because the utility function is linear in money, the marginal willingness to pay for an attribute is the ratio

between the parameter of the attribute and the cost parameter, such that

$$MWTP = \beta / \gamma \quad (3)$$

In order to allow for heterogeneity in preferences regarding the attribute levels, we will interact the attribute levels with a set of socioeconomic characteristics.

Results

In the autumn of 2005, 700 surveys were mailed to a random sample of Swedish citizens and legal aliens, drawn from the Swedish census registry, between 20 and 75 years of age. Two reminders were sent out within a three-week period to those who had not replied. Altogether 347 (49.6 %) individuals returned the questionnaire, of whom 285 were available for analysis because of nonresponse to various questions. Although not all of these respondents answered all six choice sets, we still chose to include them in the analysis. Table 3 presents demographic and socioeconomic statistics of the sample.

The primary results of this paper are reported in Tables 4 and 5. Table 4 reports the estimated model. All attribute coefficients are found significant. As expected, the cost coefficient is negative, suggesting that a price increase would reduce the probability that respondents choose the improved attributes in question. The coefficient of the variance function of the absolute cost difference is negative but insignificant. The positive sign of the coefficient of the second half of the experiment implies that the variance is higher for the second half of the experiment. A plausible explanation of this is that respondent gets fatigued and loses interest by the end of the experiment. It is therefore important to control for this effect, because it otherwise could affect the reliability of estimated marginal WTPs.

A number of socioeconomic characteristics were interacted with the various attributes. The socioeconomic variables were income, age, educational level, shopping experience, own consumption frequency (of

2. For example, we would believe that the effect on the variance is the same for a choice set where the cost of alternative A is 200 Swedish Krona (SEK) and the cost of B is 250 SEK as it is for a choice set where the cost for A is 250 SEK and the cost for B is 200 SEK. However, because only the difference in attribute levels matter, the exponential variance function will not treat them as the same unless we use the absolute difference between them.

Lagerkvist et al. — Swedish Consumer Preferences for Animal Welfare and Biotech. A Choice Experiment

Table 3. Descriptive statistics of respondents.

Variable	Mean	Standard deviation
Experience	0.45	0.50
Sex	0.5487	0.4988
Age	48.04	15.06
Members	2.54	1.25
Children	0.77	1.32
Highest standard of education	0.37	0.48
Income	0.42	0.49
Household income net of taxes (SEK) per month	24,454	10,381

Note: According to Statistics Sweden on December 31, 2002, there were 50.24% men and 49.76% women in the population of people between 20 and 75 years old, and with this part of the population the mean age was 45.8 years (standard deviation 15.06). The official statistics (available only for December 31, 2001) report an average of 2.69 individuals per household (standard deviation 1.39). Official statistics report that 27.7% has university or college education, and 48.6% to have no more than high school. The average disposable income (net of taxes and social transfers) for all households in Sweden in 2004 was 17,142 SEK/month, while the average disposable income for cohabitants with one child amounted to 30,526 SEK/month.

Table 4. Estimated binary heteroskedastic logit model.

Attribute	Indoors	Indoors, plenty of straw	Outdoors	Outdoors * female	Indoors, plenty of straw * female	Outdoors * female	No castration	Immunocastration	No tail docking, tail-biting prevented	At delivery	Banned	At delivery * female	Banned * female	Coat	Variance function	Abs (difference in cost)	Second half of the experiment	Log likelihood	Restricted log likelihood	No. of observations	
Type of housing system (base = indoor, little straw)	0.355	0.0001	0.821	0.0000	0.472	0.0102	0.559	0.0027	0.295	0.0514	0.0853	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Castration (base = surgical castration)	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Tailing docking (base = tail docked)	-0.297	0.0008	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Fixation (base = permanent)	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Coat	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Variance function	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Abs (difference in cost)	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Second half of the experiment	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Log likelihood	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
Restricted log likelihood	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002
No. of observations	-0.496	0.0066	-0.297	0.0008	-0.373	0.0289	-0.297	0.0000	-0.200	0.0514	0.148	0.0600	0.0600	0.754	0.711	0.292	0.572	0.0433	0.0000	0.1380	0.0002

* Female and experience (of the shopping by themselves) represent socioeconomic interaction variables.

Coat, household consumption frequency (of pork), husbandry and fixation, were female and experienced farming background, household size by number of family members, and number of dependants under the age of 20 years. Due to space limitations, the final model includes only those socioeconomic interaction variables that had a significant effect at the 10% level. The only characteristics that had a significant effect, for type of

Table 5. Mean marginal WTP, Swedish Krona (SEK) per kg.

Type of housing system (base = indoor, little straw)	Indoors, plenty of straw	WTP
Castration (base = surgical castration)	No castration	34.4 (8.4)
Tail docking (base = tail docked)	No tail docking; tail biting can occur	47.8 (8.6)
Fixation (base = permanent)	At delivery	-15.9 (5.34)
	Banned	15.7 (5.3)
	At delivery	-10.6 (5.8)
	Banned	7.8 (4.4)
	At delivery	48.5 (10.8)
	Banned	54.3 (10.8)

Note: The base price was set at 75 SEK/kg. Standard errors are shown in parentheses.

respondents classified as experienced, were found to derive negative utilities from indoor housing systems with plenty of straw as well as for outdoor production systems. The disparity in utility levels between experienced and inexperienced respondents is substantial for these attribute levels.

Table 5 reports estimates and standard errors for the mean marginal WTP for the various attribute levels, standard errors are calculated using the Delta method (Greene, 2000). Mean marginal WTP is estimated according to Equation 3. Note that these are WTP measures compared to the base case for each attribute. The hypotheses $H_0: WTP_{surgical\ castration} = WTP_{immunocastration}$ and $H_0: WTP_{no\ tail\ docking} = WTP_{tail\ docking}$ can be rejected at any conventional level. The hypotheses and negative price premiums are possible a priori. Hence a significant positive WTP for immunocastration and a significant negative WTP for no castration was found. This implies that consumers associate a positive utility from consumption of immunocastrated pork compared to pork originating from surgical castrates and negative utility from pork originating from intact boars compared to pork from surgical castrates. The negative WTP for the no-castration alternative is similar to the results presented by Liljenstolpe (2003). The latter study included castration with anesthesia and no castration together with six other attributes in a CE directed to Swedish consumers, in which pork fillers of various characteristics were evaluated. Using a mixed logit estimation, Liljenstolpe reported a price discount of 13.8% for no castration and a price premium of 39% for castration with anesthesia.

The estimates in Table 5 are also instructive for comparing the ranking of attributes and levels. Consumers associated higher WTP for fixation of sows and type of housing system for fattening pigs than for castration. Interestingly, when comparing mean WTP for ban on fixation with fixation at delivery, the hypothesis that they are equal cannot be rejected at any conventional levels. However, there is a significant difference between the WTP for outdoor production and indoor production with plenty of straw.

Tail docking of fattening pigs was regarded as the least important attribute among those included in the study. Note that the results related to the various levels of the tail-docking alternative are similar to the results for the castration attribute. In relation to the base case (where tail docking is performed), respondents associated a negative WTP for the alternative with no tail docking but where tail biting can occur. This implies that tail biting, which induces pain, suffering, and possible infections to animals, is viewed as a more important animal welfare problem than tail docking. This is a reasonable result, as tail biting is an indicator of a poor environment or other types of stress. We interpret this result as indicating that consumers prefer pork from pigs that have been tail docked if there are chances that tail biting can occur. Consistently, a positive WTP is found for the alternative with no tail docking but where tail biting is prevented.

Conclusions

Europeans are in general more reluctant to the combination of biotechnology and food. It is debatable whether this is due to recent food scares (such as bovine spongiform encephalopathy), successful campaigns by environmental lobbyists, or the central role of food and cooking in European culture. Swedes have been shown to be relatively more averse towards genetically modified organisms (for example) than many other Europeans (Hoban, 1997).

Using a choice experiment, we estimated the WTP for several process attributes for pork meat. Included attributes related to potential animal welfare enhancing measures in pork production. Our results confirm the results from studies of Carlsson et al. (2003a) and Liljenstolpe (2003) in finding that consumers placed high values in allowing fattening pigs to be outdoors. In addition, consumers strongly opposed fixation of sows. Based on our results, however, we cannot say that a ban on fixation would reduce negative external effects from pork production.

The sexual development of the pigs will thus be delayed and boar taint can be avoided. Uncastrated pigs grow faster and develop more muscles and lower fat content in the meat.

- Possible alternatives are:
 - surgical castration of pigs (no risk of boar taint, suffering for the piglet);
 - no castration of pigs (meatier, lower fat content, risk of boar taint); or
 - immunocastration of pigs (meatier, lower fat content, low risk of boar taint).

3. Tail Docking

Fattening pigs can develop a type of behavioral disorder called *tail biting*, in which the pigs bite on and finally bite off each other's tails. Tail biting can be caused by a poor environment, inferior fodder, or other types of stress. It causes pain, suffering, and infections. Tail biting is prevented in other countries by docking the piglets' tails. Tail docking is currently banned in Sweden.

Possible alternatives are:

- the pig has been tail docked;
- the pig has not been tail docked and tail biting can occur; or
- the pig has not been tail docked but has been raised in a more expensive way to prevent tail biting.

4. Fixation

During delivery there is a risk that the sow may by mistake lie down on her piglets, causing their deaths. This is especially a problem if the barn is noisy and the sow has difficulty hearing her piglets. This problem is prevented in many countries by keeping the sow fixated, which prevents her from turning around. Sows are usually fixated during their entire life. Fixation causes suffering, because sows have a strong natural behavior to move around and to settle before delivery. In Sweden, sows are allowed to be fixated during one week around the time of delivery and also around the time of covering.

Possible alternatives are:

- sows are permanently fixated;
- sows are allowed to be fixated at delivery and around the time of covering; or
- fixation of sows is banned.

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Our results also indicate that consumers associate a benefit from the consumption of pork from immunocastrated pigs compared with pork from surgically castrated pigs. In contrast, consumers reveal negative valuations of pork from intact boars. These findings imply that animal welfare concerns are more emphasized than biotechnology aversion or food safety risk when consumers compare immunocastration and surgical castration. With a low risk for boar taint, these alternatives are identical with respect to taste quality. In addition, consumers place higher values on pork from surgically castrated pigs than on pork from intact boars. Hence, food quality concerns apparently dominate animal welfare concerns in avoiding boar taint. Taken together, our findings suggest that immunocastration of male pigs represents a Pareto-efficient improvement in pork production. Consumers will be able to maintain taste quality while improving the well-being of pigs and avoiding the problems related to surgical castration. The use of biotechnology in this setting, therefore, is regarded as a desired production attribute.

If consumers in other countries share the same type of values, there are important policy implications to be drawn from this study. Under current legislation in many countries surgical castration has been accepted, lacking reasonable alternatives, as many markets for pork do not accept boar meat, even though surgical castration impedes the well-being of animals. Immunocastration provides several potential public as well as agribusiness advantages over surgical castration, including animal welfare improvements, potential cost savings in procedures, and gains from higher growth rates for pigs. Our findings suggest that immunocastration is a socially viable alternative. Therefore, the abolition of surgical castration of pigs should be supported.

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Appendix: Information Sheet—Pork Meat

To facilitate your choices, this sheet provides short presentations of product attributes of pork.

1. Type of Housing System

Fattening pigs that have the opportunity to be outdoors or are kept outdoors usually have a larger chance of satisfying their natural behavior compared to pigs kept indoors. This is especially the case for pigs in indoor production systems that allow for only a minimum level of straw. Outdoor production as well as handling of straw is related to greater costs for the producer.

Possible alternatives are:

- pigs kept indoors in boxes with little straw;
- pigs kept indoors in boxes with plenty of straw; or
- possibilities for pigs to be outdoors.

2. Castration

Pork from uncastrated male pigs can have a strong boar taint, which will appear as an odor mainly during heating. Different people have different sensibilities towards boar taint.

In Sweden, almost all male pigs are castrated in order to avoid boar taint. Castration is done without anesthesia during the first week, the piglet suffers from development alternatives to surgical castration. One method that is used in Australia (for example) is that pigs are vaccinated against an endogenous substance that affects hormone development. This is called *immunocastration*.

CONSUMER ATTITUDES TO BOAR TAIN[†] & IMMUNOCASTRATION

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Keywords: Improvac, Vivax[®], immunological castration, boar taint, consumer acceptability.

Introduction

Four separate in-depth focus groups were conducted by an independent market research company. Each session lasted around 2 hours and involved 12 participants. All participants were female aged between 30 to 55 years and were the main grocery buyer in the household. The broad objective was to gain an understanding of the consumer's reaction to the issue of boar taint and the use of Improvac to control it, and to examine how knowledge of Improvac may affect consumer's attitude to pork.

Material and Methods

The demographics of the 4 focus groups were as follows:

1. An Asian background, regular pork consumers
2. A non-Asian background, regular pork consumers
3. A non-Asian background, occasional pork consumers
4. A non-Asian background, lapsed pork consumers

Regular pork consumption was a frequency of at least once every 2 weeks. Occasional pork consumption was at least once per month; and lapsed pork consumption was about once per 3 months but less than previously because of bad experiences with flavour and smell. At the conclusion each participant was offered a small (~1 kg) loin sample to cook for friends or family. They were fully aware the pork was from Improvac vaccinated pigs. They were given a questionnaire to assess their attitudes to the quality of the pork compared to the pork they usually purchased. All participants volunteered to serve the pork from immunocastrated boars to their family, in total about 80 people (participants, family or friends) provided feedback.

Results and Discussion

In Australia most male pigs are not castrated and thus the participants had at least a 50% chance that pork purchased in retail stores was from a male pig and thus may have high levels of boar taint.

The key findings from the focus groups were:

- All participants acknowledged that they had experienced pork with "off" odour and flavour – this was often attributed to pork being a "bit odd" or a "bit strong".
- The Asian group had less bad experiences with odour and flavour primarily because they purchased their pork mainly from Asian butchers who sold only female pigs.
- The explanation of "boar taint" as the cause of the odour/flavour problems they had experienced was understood by the participants as a plausible explanation.
- Vaccination in general was seen as a natural process, a highly acceptable part of animal production and was ranked highly compared to other invasive animal husbandry procedures such as castration, and tail docking. The concept of vaccination to control boar taint intuitively made sense to all participants.
- After explaining that Improvac was not a hormone or a chemical and contained no genetically modified organisms, but that it was simply a vaccine working with the pig's immune system, all the participants were comfortable with its use and importantly all volunteered to feed pork from Improvac-vaccinated pigs to their families.
- The use of Improvac was seen as a favourable alternative to surgical castration.
- The results clearly showed that the pork from Improvac vaccinated pigs was highly preferred to boar pork.

Summary

Improvac is a proven efficacious and safe vaccine that works in harmony with the pig's immune system to block the compounds that cause boar taint in male pigs. The use of Improvac to produce pork free from boar taint was readily accepted as a favourable alternative to surgical castration by the Australian consumers polled in this survey. Pork from Improvac vaccinated pigs was also highly preferred to boar pork.

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The effects of immuno- and surgical-castration on the behaviour and consequently growth of group-housed, male finisher pigs

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Abstract

An experiment was conducted to compare behaviour, in particular social and feeding behaviour, and consequently growth performance of group-housed entire and castrated male pigs during the finisher stage of production. Three treatments: (1) entire males, (2) immuno-castrated males, treated with Improvac[®] at 14 and 18 weeks of age, and (3) surgically-castrated males, castrated at 14-days old, were compared to assess whether castration affected feeding and social behaviours. Twelve groups of 15 male pigs were formed at 14 weeks of age (47.1 ± 5.50 kg). Pigs had ad libitum access to pelleted, commercial feed from two single space feeders per pen. Pig behaviour and feeder utilisation were compared during 24-h periods at 17 and 21 weeks of age, using time-lapse video recording. At 17 weeks, entire males and immuno-castrated males were more active ($P < 0.05$) than surgically-castrated males (21.9, 19.8 and 16.1% of 24 h), but at 21 weeks there were no differences among the treatments (pooled mean 16.4% of 24 h). As expected, social behaviour at 17 weeks was greater ($P < 0.01$) for entire males and immuno-castrated than surgically-castrated males (3.8, 1.8 and 0.1% of 24 h), but not at 21 weeks, when it was greater ($P < 0.01$) for entire males than immuno- and surgically-castrated males (1.8, 0.5 and 0.4% of 24 h). While the mean time pigs spent in the feeders at 17 weeks did not differ among the treatments (100 min/pig/24 h), at 21 weeks entire males spent less time ($P < 0.05$) in the feeders (76 min/pig/24 h) than immuno- and surgically-castrated males (110 and 107 min, respectively). On both the observation occasions, the "sexually-active" treatments (entire males and immuno-castrated males at 17 weeks and entire males at 21 weeks of age) on average allocated about one-third of active time to feeding, whereas castrated males spent almost one-half of

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active time in the feeder, assumed to represent feeding behaviour ($P < 0.05$). At 23 weeks, there was a trend for entire males to be lighter ($F = 0.061$) than immuno-castrated males, with surgically-castrated males in between (102.3, 108.9 and 103.9 kg). Thus, castration, reduced social behaviour and increased feeding behaviour in group-housed finisher pigs. The results of the experiment also suggest that the social and feeding behaviours of immuno-castrated males at 21 weeks were similar to surgically-castrated males.

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Keywords: Finisher pigs; Feeding; Aggression; Mounting behaviour; Time budgets; Castration; Immuno-castration; Growth; Improvac[®]

1. Introduction

Until recently, Australia was one of only a few pork-producing countries that did not routinely castrate male grower or finisher pigs (Moore, 2001). Indeed, the Australian Model Code of Practice for the Welfare of Pigs reflects this situation and currently recommends that (surgical) castration should be avoided wherever possible (Anon., 1998). However, with the increase in exports of Australian pork to the Asian region, to markets that have a strong preference for meat from gilts and barrows (surgically-castrated male pigs), some Australian farmers have reverted to surgical castration of male pigs (Higgins and Currier, 1999). Surgical castration of male pigs typically occurs when pigs are about 14–days old. A consequence of the procedure is increased body fat content and reduced growth performance (Campbell and Taverner, 1988; Dunshea et al., 1993). A relatively new technology, immuno-castration, has been developed and involves using a vaccine (Improvac[®], CSL Ltd., Parkville, Vic., Australia) against gonadotrophin-releasing hormone (GnRH) to chemically “castrate” male pigs in the latter stage of the finisher phase of production, thereby eliminating the need for surgical removal of the testes (Dunshea et al., 2001). Blocking GnRH release from the hypothalamus with a vaccine inhibits production of luteinising hormone (LH) and follicle stimulating hormone (FSH) by the pituitary gland and prevents testicular development; this effectively castrates the pigs at around 18 weeks of age, after they have had the benefit of growing as entire males to that point.

The nutritional requirements for efficient growth, and the characteristics of feeding behaviour, of individually-housed surgical castrates and entire males are quite well understood (see Campbell and Taverner, 1988; Quintou et al., 1999). Commercial growing pigs, however, are housed in groups and do not grow as fast and, or as efficiently as expected, compared to their individually-housed counterparts. Clearly, group housing introduces additional variables including stocking density/space allowance, group size and social behaviour. Further, towards the end of the finisher phase of growth, entire males in groups often grow slower than castrates (Paterson, 1985; De Haer and Mierks, 1992; De Haer and de Vries, 1993), possibly due to increased sexual activity (courting behaviour and mounting events) and aggression between males; these behaviours are controlled by endocrine factors (Gray, 1971). Thus, the use of a non-surgical method for castration of males late in the growth phase of production may improve the efficiency of growth by reducing undesirable male characteristics that limit growth.

The objectives of this experiment were to record the behaviour of group-housed, male pigs over 24-h periods towards the end of the growth phase of production to examine whether castration per se affected: (1) the animal's time budget in relation to feeding behaviour and activity, and (2) social behaviour. The hypothesis tested was that castration decreases the time group-housed, male pigs allocate to social behaviour and increases the time allocated to feeding behaviour. Two alternative methods of castration were compared: traditional surgical castration and the new technology of immuno-castration.

2. Materials and methods

The experiment was conducted at a large commercial pig farm near Corowa, New South Wales (longitude 146.4°E, latitude 36.0°S, altitude 143 m) in south-east Australia. For each of the two replicates in time, a pool of 150 male piglets was selected. About one-third of the pigs, chosen on an ad hoc basis, were surgically castrated at 14 days of age. At 14 weeks of age, 12 groups of 15 male pigs (Large White × Landrace commercial line) were formed. Average pig weight was 47.1 ± 5.50 kg. Each time replicate involved six pens of pigs (two pens of each of the three treatments) located in the same shed with natural lighting; time replicates were conducted in November–December and March–April, respectively. Mean minimum and maximum ambient temperatures during these periods were approximately 12–28 and 11–25 °C, respectively.

Pig behaviour and feeder utilisation were compared among groups of entire males, immuno-castrated males (entire males treated with Improvac[®] at 14 and 18 weeks of age, i.e. the recommended ages when pigs should be treated) and surgically-castrated males (castrated at 14-days old). Each pen measured 5.7 m wide × 3.5 m deep and contained two electronic, single space feeders that provided a pelleted, commercial diet ad libitum. The two feeders, which were developed and constructed in-house by OAF Meat Industries Ltd., were located at the front of the pen as shown in Fig. 1. Pigs fed from the individual feed troughs while standing in a 0.4 m wide × 0.9 m long feeder race which had solid side walls. A bar placed 0.15 m above floor level, mid-way along the race, prevented pigs from lying in the race and only one pig could occupy a feeder race at a time. All pigs were fitted with a uniquely coded ear-tag transponder that allowed individual identification whilst at the feeder, i.e. inside the feeder race. A computer registered the feed allocated to each pig (and assumed eaten by that pig) per 24 h period commencing at midnight each day. Pelleted food was delivered at a rate of about 1 g/s. The computer provided a print out each morning detailing any pig that either: (i) did not register as eating, or (ii) registered eating <0.5 kg, in the previous 24 h, which assisted in identifying any transponders that failed or pigs that may have been ill. Transponders that failed were immediately replaced by 08:00 h each day.

Fifteen of the 18.1 m² available to the pigs for lying was concrete slabs (100 mm wide solid surface to 20 mm void). The remainder of the floor surface available for lying was solid concrete and was predominantly the space between the entrances to the two feeder races. Each pen contained three bite drinkers attached to the pen walls (panels of horizontal metal bars) and situated over slatted floor. Water was not provided in the feeder. A 24-h time-lapse video record was made for each pen of pigs at 17 and 21 weeks of age. Video recording of the six pens of pigs per time replicate occurred over two consecutive days each

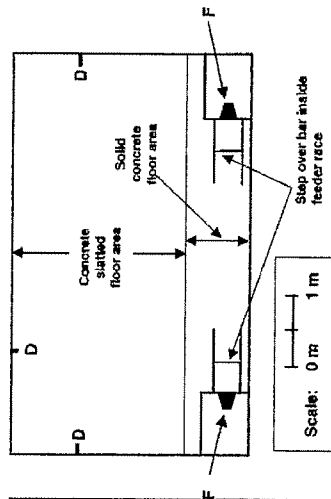


Fig. 1. Pen lay out. D indicates position of drinkers. F indicates feed trough within the electronic single space feeder.

week with the use of three time-lapse video cassette recorders (Panasonic AG-6124). The order of video-recording of pens was randomised in the experiment. Each pig was weighed weekly, at which time it was also spray-painted on its back with a numeral from 1 to 15 for individual identification on the video record. A low-light, colour video camera with wide-angle, auto-iris lens was mounted above each pen. Night time video recording was assisted by a 20 W fluorescent light attached to the roof, between 3.5 and 5 m above each feeder.

Behaviour data were transcribed from the video records using The Observer behaviour recording program, supplemented with the Support Package for Video Analysis (version 4.0 for Windows; Noldus Information Technology, 1997). A Panasonic AG-7355 video cassette recorder with jog and shuttle control which enabled frame by frame analysis of the video record, was linked directly to a computer which could then read the time track on the video tape record. To transcribe the video-recorded data, an observer replayed the video tape, commencing at the pre-determined start time for the 24-h period, and followed the image of each pig individually on the video monitor for the entire 24-h period.

A continuous record (duration and frequency) of each pig's location in the pen and behaviour was obtained according to the list shown in Table 1. As indicated in Table 1, pigs were recorded as being "idle" if they occupied a sitting or lying posture. The complement of "idle" was "active", which was recorded when pigs occupied a standing posture. The major activities of interest in this experiment were "feeding behaviour" and "social behaviour". Feeding behaviour was assumed when the focal pig was standing in the feeder race and defined by the pig having its head and front legs within the feeder race. Social behaviour was the combination of aggressive behaviour, which included aspects of courtship behaviour but which were difficult to distinguish on the time-lapse video record from aggression *per se*, and mounting events, while "other behaviour" constituted the remaining time that pigs stood. In addition, the circumstances at the time the focal pig entered or exited a feeder were also recorded as a modifier to feeding behaviour (Table 1).

Table 1
List of locations and behaviours recorded from the time-lapse video records

Classes	Elements	Modifiers
Location in pen	Left feeder Right feeder Front area of pen between the feeders Mid-pen Rear-pen	Entry/exit circumstances ¹ Entry/exit circumstances ¹
General behaviour	Idle: sitting and lying postures—including resting/sleeping (duration). Mounting events: the focal pig is mounted on the back of another pig with one front leg on either side of the other pig's back enabling the focal pig to hold onto the other pig should it move about (frequency and duration). Attempted mount: the focal pig mounts another pig but is unable to achieve a stable mount position, as described above (frequency). Aggressive behaviour: including root, nose, lever, bite another pig, parallel pressing against another pig (frequency and duration). Other activity: none of the above-listed general behaviours (frequency and duration).	

¹Modifiers—subjective evaluation of circumstance at: (A) entry to a feeder: (i) was the feeder vacant? (ii) was a pig leaving the feeder? (iii) did the pig displace another pig from the feeder? (B) exit from a feeder: (i) was the exit voluntary with (a) no other pig nearby or (b) another pig waiting to enter? (ii) was the focal pig displaced?

The experimental unit was the pen of pigs and differences due to the treatments (entire males, immuno- and surgical-castrated males) were determined using analysis of variance with time considered as a blocking effect (GenStat, 2000). This gave 8 d.f. for residual error. The pen means for the different variates subjected to statistical analysis were computed for the number of pigs per pen. Data were transformed using either the angular transformation of percentage values or log_e transformation when appropriate. When comparing situational factors around the feeders, the analysis was modified to a split-plot analysis with a situational × pen mean as the experimental unit. As the 24 h periods for measuring feed intake and behaviour had different start times (midnight compared to 08:00–09:00 h, respectively), the 24 h feed intake data did not align with the full 24 h of behaviour recording. For the statistical analysis, the feed intake data were averaged over 3 days—the date of the behaviour observation plus 1 day either side of that date.

3. Results

A total of six pigs were removed during the course of the experiment: one from each of the entire male and immuno-castrated male treatments and four from the surgical-castrated male treatment; two pigs were withdrawn from each of the two pens. The removal of all but

one surgical-castrated male pig occurred prior to the week 17 video recordings. The transponders of two surgical-castrated pigs failed the day prior to video recording; there was one occurrence in each time replicate. The respective transponders were replaced prior to the start of video observations and the subsequent daily feed intakes of the pigs appeared to be normal. No transponders were reported to fail on the days when pigs were video recorded nor on the day of post-observation.

3.1. Growth and feed intake

Although mean pig live weights at 14 weeks were not significantly different due to the treatments, surgical-castrated males on average were 1 kg lighter than entire males and immuno-castrated males (49.4, 49.5 and 48.3 kg, respectively, for entire, immuno- and surgical-castrated males; $P > 0.05$).

Differences due to treatment in the 3-day average feed intake of pigs around the days of video recording were found. At 17 weeks, the 3-day average feed intake tended to be lower for entire and immuno-castrated males compared to surgical-castrated males (2.31, 2.29 and 2.61 kg/24 h, respectively; $P = 0.055$, $sed = 0.121$), but at 21 weeks was higher for immuno-castrated than either entire or surgical-castrated males (2.69, 3.32 and 2.90 kg/24 h, for entire, immuno- and surgical-castrated males, respectively; $P < 0.02$, $sed = 0.171$). While there were no effects of treatment ($P > 0.05$) on the mean live weight of pigs (based on pen means) at 17 weeks (64.1, 64.8 and 64.5 kg, respectively, for entire, immuno- and surgical-castrated males) or 21 weeks (89.6, 93.9 and 91.5 kg, respectively, for entire, immuno- and surgical-castrated males), by 23 weeks entire males tended to be lighter ($P = 0.061$) than immuno-castrated males, with surgical-castrated males in between (101.9, 108.3 and 104.9 kg, respectively, for entire, immuno- and surgical-castrated males; $sed = 2.44$). Similarly, live weight gain was not affected by treatment in week 17 (average daily gains were 943, 947 and 935 g, respectively, for entire, immuno- and surgical-castrated males; $P > 0.05$, $sed = 44.6$), but there was a tendency in week 21 for immuno-castrated males to gain more weight than the other treatments (average daily gains were 932, 1177 and 954 g, respectively, for entire, immuno- and surgical-castrated males; $P = 0.10$, $sed = 107.8$).

3.2. Behaviour

The predominant behaviour of pigs was "idle", which accounted for 80.7 and 85.6% of pigs' time per 24 h, respectively, in weeks 17 and 21. During the remaining time pigs were considered "active". The entire and immuno-castrated males treatments were more active than the surgical-castrated male treatment at 17 weeks ($P < 0.05$, Table 2). At 21 weeks, however, there were no differences in activity due to the treatments ($P > 0.05$). The diurnal pattern of activity by pigs in the different treatments at the two observation ages is presented in Fig. 2.

3.3. Social behaviour

Entire and immuno-castrated males at 17 weeks performed more social behaviour than surgical-castrated males ($P < 0.01$, Table 2). Expressed in terms of the animals' time

Table 2
The effects of treatment on pig behaviour at 17 and 21 weeks of age

Age class	Behaviour variables	Unit	Entire males	Immuno- castrated males	Surgical- castrated males	sed	<i>P</i> -value	
17 weeks	Activity (time spent standing)	Percentage of time	21.9a	19.8a	16.1b	1.87	0.04	
	Feeding behaviour	Percentage of time spent to feeders	7.0	6.7	7.4	0.67	0.54	
	Visits to the feeders	Percentage of time	16.4	15.3	17.7	3.23	0.76	
	Social behaviour	Duration (untransformed)	Percentage of time	3.8	1.8	0.1	1.8x	0.5y
	Duration (after angular transformation)	Degrees	10.69x	7.40x	1.90y	2.094	0.009	
	Aggressive behaviour	Frequency	27.4x	28.6x	4.5y	6.23	0.008	
	Mouthing events	Frequency	9.4x	5.3xy	0.1y	1.71	0.002	
	Attempted mounts	Frequency	5.8a	7.8a	0.1b	1.98	0.012	
	Attempts mounts (after log _e transformation)	Frequency	1.77a	0.20ab	1.52	1.77a	0.012	
	Log _e transformation)	Frequency	0.880	0.04	0.5	1.47	0.002	
21 weeks	Activity (time spent standing)	Percentage of time	15.3	16.2	17.6	1.87	0.04	
	Feeding behaviour	Percentage of time spent to feeders	7.2b	7.7b	5.3a	0.67	0.54	
	Visits to the feeders	Percentage of time	17.3	12.4	13.6	3.23	0.76	
	Social behaviour	Duration (untransformed)	Percentage of time	0.4y	0.5y	1.8x	1.8x	0.5y
	Duration (after angular transformation)	Degrees	9.5y	9.5y	27.9x	2.094	0.009	
	Aggressive behaviour	Frequency	4.66	0.006	0.1y	1.71	0.002	
	Mouthing events	Frequency	1.47	0.002	0.5	1.47	0.002	
	Attempted mounts	Frequency	0.880	0.04	0.5	1.47	0.002	
	Attempts mounts (after log _e transformation)	Frequency	0.880	0.04	0.5	1.47	0.002	
	Log _e transformation)	Frequency	0.880	0.04	0.5	1.47	0.002	

Values shown are means per pig per pen over 24 h period; within age classes, a,b: $P < 0.05$; x,y: $P < 0.01$, using least significant difference; sed: standard error of difference between the means; $P = 0.05$.

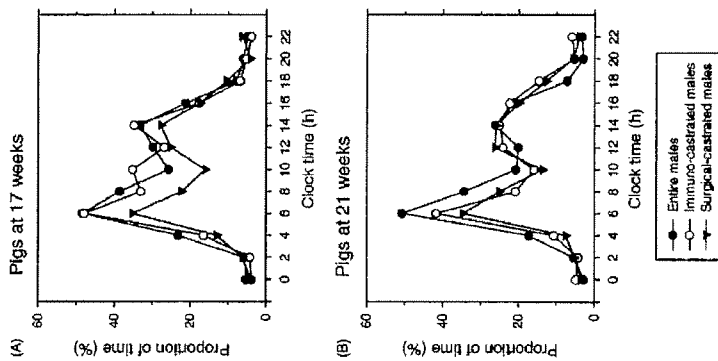


Fig. 2. Changes in the proportion of time (per 2 h period) that pigs in the different treatments stood (assumed to estimate activity). Graphs A and B, respectively, are for pens of pigs at 17 and 21 weeks of age. Values shown are the means of four pens per treatment.

budget allocation, pigs in the entire male treatment allocated more ($P < 0.05$) of their active time to social behaviour than surgical-castrated males, with the immuno-castrated males intermediate between these two treatments (16.6, 9.0 and 0.8% of active time, respectively, for entire, immuno- and surgical-castrated males; $P < 0.05$, *see* 3.60). In week 21, pigs in the entire male treatment performed significantly more social behaviour than the immuno- and surgical-castrated males treatments, both in absolute terms

($P < 0.001$, Table 2) and as a proportion of active time (10.6, 3.2 and 2.4% of active time, respectively, $P < 0.01$, *see* 1.64).

3.4. Aggressive behaviour

Aggressive behaviour was the predominant behaviour class contributing to social behaviour (~90% based on pooled means) and the effects of the treatments on time spent in aggressive behaviour were therefore, similar to those shown in Table 2 for social behaviour. Table 2 also indicates the frequency of aggressive behaviour. At 17 weeks, entire and immuno-castrated males compared to surgical-castrated males and, at 21 weeks, entire males compared to immuno- and surgical-castrated males, had a higher frequency of aggressive behaviour ($P < 0.01$) during the 24 h observation period (Table 2).

3.5. Mounting events

While mounting events accounted for about 10% of social behaviour across treatments, there were effects of treatment on the incidence of mounting. The mean number of mounts per pig was greater at 17 weeks for entire and immuno-castrated males than surgical-castrated males ($P < 0.01$), whereas at 21 weeks, entire males performed the greatest incidence of mounts and immuno-castrated males were similar to surgical-castrated males ($P < 0.01$; Table 2).

Behaviour variables describing mounting events captured from the observation records were the average duration of mounts, the number of mounts by individuals within groups and the occurrence of attempted mounts. The mean duration of individual mounts by pigs in the different treatments at 17 weeks were 30, 27 and 8 s, and 21 weeks were 42, 25 and 20 s, respectively, for the entire, immuno- and surgical-castrated males. Fig. 3 shows for each treatment at the two observation times, the mean proportion of pigs that were: (i) not observed to mount, or mounted between (ii) 1 and 5 times, (iii) 6 and 10 times, or (iv) more than 10 times, during the 24-h observation period. As suggested in Fig. 3, the distributions of pigs in the entire and surgical-castrated males treatments across the different mounting frequency classes were similar within-treatments at 17 compared to 21 weeks of age. In the immuno-castrated male treatment, however, a shift in the distribution pattern occurred between 17 and 21 weeks of age. A similar pattern was recorded for attempted mounts. At 17 weeks, more attempted mounts were performed by entire and immuno-castrated than surgical-castrated males ($P < 0.05$, Table 2), whereas at 21 weeks entire males performed more attempted mounts than immuno- and surgical-castrated males ($P < 0.05$, Table 2).

3.6. Feeding behaviour

The average number of visits to and the proportion of time spent in feeders by pigs in the different treatments per 24 h period, are shown in Table 2. The pooled mean frequency of visiting feeders per 24 h was 16.4 and 14.5 times, respectively, at 17 and 21 weeks and there were no differences due to the treatments in this parameter. The number of visits to feeders by individual pigs ranged from 4 to 82 visits per pig over 24 h. Although there was no difference ($P > 0.05$) due to treatments at 17 weeks in the time pigs spent in feeders (mean

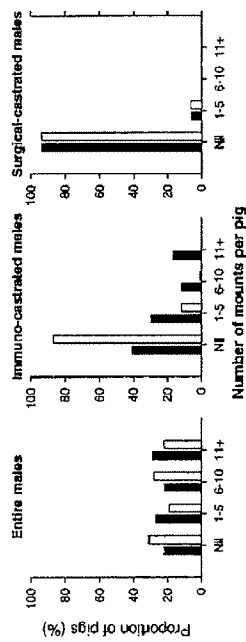


Fig. 3. The proportion of pigs in each treatment that (1) did not mount another pig in the pen, or that mounted between (2) 1 to 5 times or (3) 6 to 10 times or (4) more than 10 times, in 24 h. Solid columns signify pigs aged 17 weeks and open columns represent pigs at 21 weeks of age. Values shown are the means of four pens per treatment.

values: 101, 96 and 107 min/pig/24 h), at 21 weeks, entire males spent less time in the feeders compared to immuno- and surgical-castrated males (77, 110 and 103 min/24 h, respectively; $P < 0.05$, $sed = 10.4$). Overall, the time individual pigs spent in the feeders per day ranged from 11.7 to 171.4 min; individual duration of occupying the feeder (the pig was assumed to be feeding) ranged from 1 s to 53 min. The proportion of active time that pigs allocated to feeding behaviour was affected by treatment at both 17 weeks, when the entire and immuno-castrated males compared to surgical-castrated males spent a lower proportion of their active time in feeding behaviour (32.2, 33.3 and 46.8% of active time for entire, immuno- and surgical-castrated males, respectively; $P < 0.05$, $sed = 4.12$) and, at 21 weeks, when the entire males compared to immuno- and surgical-castrated males spent a lower proportion of active time in feeding behaviour (30.1, 47.7 and 46.7% of active time, respectively; $P < 0.01$, $sed = 4.56$).

3.7. Feeder occupancy

Feeder occupancy was calculated from the mean proportion of time pigs spent in the feeder multiplied by the number of pigs per pen, divided by 2 (the number of feeders per pen). While there was no effect of treatment on feeder occupancy by pens of pigs at 17 weeks (51.4, 49.3 and 52.7% of 24 h, respectively, for entire, immuno- and surgical-castrated males; $P > 0.05$, $sed = 3.44$), there was a difference at 21 weeks. Feeders were used less ($P = 0.05$) in the entire male than immuno- and surgical-castrated males treatments at 21 weeks (39.5, 56.4 and 50.0% of 24 h, respectively; $sed = 5.72$). The diurnal patterns in the use of feeders by pens of pigs at 17 and 21 weeks of age are shown in Fig. 4.

3.8. Situational factors at entry to feeders

The mean numbers of visits by pigs to feeders are shown in Table 3 for the different treatments at the two video-recording ages. For the majority of visits (~70–80% of visits

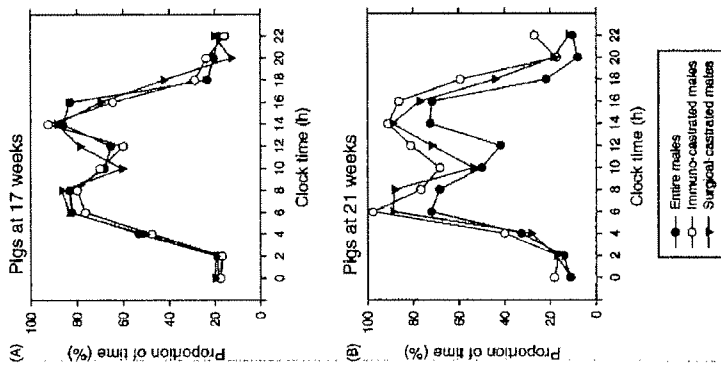


Fig. 4. Changes in the proportion of time (per 2 h period) that pigs in the different treatments utilized the feeders in their pens. Graphs A and B, respectively, are for pens of pigs at 17 and 21 weeks of age. Values shown are the means of four pens per treatment.

by pigs to feeders), pigs entered a feeder that was unoccupied when the pig approached the entrance to the feeder. Less frequently, pigs would "queue" at an occupied feeder and enter the feeder once the occupant exited, or alternatively in a minority of cases, forcibly displaced the occupant. For pigs at 21-weeks old, entire males were more likely ($P < 0.0001$) to enter a vacant feeder than pigs in the other treatments (81 versus 69% of feeder visits, respectively; Table 3). Conversely, entire males were less likely ($P < 0.01$)

Table 3
Situational differences at the time of entry to the feeder by entire, immuno- and surgical-castrated male pigs at 17 and 21 weeks of age

Treatment	Entire males	Immuno-castrated males	Surgical-castrated males	sed	P-value
17-weeks old					
Number of visits represented	16.5	15.3	17.6	3.29	0.79
<i>Situation prior to pig entering:</i>					
(1) Feeder was vacant (%)	78.9	76.7	71.0	5.39	0.39
(2) A pig was leaving feeder (%)	18.6	19.6	27.4	5.76	0.31
(3) Occupant was displaced (%)	2.5	3.7	1.6	1.23	0.29
Total (%)	100.0	100.0	100.0		
21-weeks old					
Number of visits represented	13.6	12.3	17.5	3.56	0.37
<i>Situation prior to pig entering:</i>					
(1) Feeder was vacant (%)	81.1 _a	69.6 _b	68.1 _b	1.89	<0.001
(2) A pig was leaving feeder (%)	16.4 _b	25.7 _a	24.6 _a	2.29	0.007
(3) Occupant was displaced (%)	2.5	4.7	7.3	2.91	0.32
Total (%)	100.0	100.0	100.0		

Values shown are the total number of visits per 24 h to the feeder and the proportion of entries to the feeder in which: (1) the feeder was vacant when the focal pig arrived, (2) a pig was leaving the feeder and the focal pig then entered, and (3) the focal pig displaced the occupant from the feeder. Data for focal pigs that were in the feeder at the commencement of the observation period, were excluded. Within age classes, χ^2 ; $P < 0.01$; pig; $P < 0.001$, using least significant difference; sed: standard error of difference between the means.

to "queue" for access to a feeder, based on the proportion of visits to the feeder in which pigs entered the feeder shortly after the occupant left the feeder, and not including situations in which pigs were displaced from the feeder by a pen mate.

An interesting observation was that pigs stayed longer in the feeder on the occasions they entered a feeder that had been recently vacated by another pig. While there were no differences due to treatment in the time pigs spent in the feeder per visit at either 17 or 21 weeks of age, there were significant differences due to the circumstance existing prior to the pig entering the feeder (log_e means with untransformed mean values shown in parentheses were: 17 weeks, 5.793 (343 s) and 6.267 (565 s), respectively, for feeder vacant compared to feeder occupied; sed = 0.0314, $P < 0.05$; 21 weeks, 5.381 (395 s) and 6.324 (612 s), respectively, for feeder vacant compared to feeder occupied; sed = 0.0242, $P < 0.05$).

3.9. Situational factors at exit from feeders

There were no differences between the treatments in the proportion of times that pigs exited from the feeders under the three different circumstances that were recognised—pig exited "voluntarily" and either (i) no other pig was located nearby (pooled means for weeks 17 and 21, respectively, were 68 and 74% of occasions) or (ii) pig nearby (28 and

21%), or (iii) the pig was displaced from the feeder (4 and 5%). At 17 weeks, the average duration of visits to a feeder was shorter ($P < 0.05$) in situations in which pigs voluntarily exited from the feeder and no other pig was waiting to enter (423 s) or the pig was displaced from the feeder (369 s) compared to the situation in which another pig was waiting to enter the feeder (566 s; sed = 31.4). At 21 weeks, there were no differences (499, 682 and 656 s, respectively, $P > 0.05$).

4. Discussion

This experiment showed that castration reduced social behaviour and increased feeding behaviour in group-housed finisher pigs. While immuno-castration had a similar effect on behaviour to surgical castration, there were clear benefits to production such as increased feed intake and a trend for faster growth. Immuno-castrates were effectively castrated at 18 weeks of age, after they had had the benefit of growing as entire males to that point and had increased feed intakes beyond this age when feed intakes of entire males declined. Entire males in the latter part of the finisher stage of production, however, appeared more easily distracted from feeding, reducing feed intake, and spent more time in social behaviour including aggressive behaviour and mounting. Despite the relatively large differences in feeding behaviour parameters, treatment effects on growth were less pronounced, possibly due to the limited number of replicates.

Time spent in a feeder, assumed to represent feeding behaviour, was not affected by treatment at 17 weeks of age. However, surgical-castrated males at 17 weeks had 13% higher daily feed intake compared to entire and immuno-castrated males. While it is possible that the surgical castrates could eat faster and thus increase feed intake without increased time in the feeder (De Haer and Merks, 1992), this was unlikely as the rate of feed supply in the electronic feeders in the present experiment was restricted (1 g/s). The discrepancy between time in the feeder and feed intake may be associated with entire males and immuno-castrates using the feeder rate as a hide area to avoid aggression, which has been reported previously by McGlone and Curtis (1985). Treatment differences were found in the time pigs spent in the feeder at 21 weeks of age. Entire males spent less time in the feeder than immuno-castrates and surgical castrates, which was reflected in reduced feed intake. For example, entire males spent least amount of time per 24 h in the feeder (5.3%) and ate least (2.68 kg), whereas the immuno-castrates spent most time feeding (7.7%) and ate most per day (3.33 kg). Surgical-castrates were intermediate to the other treatments (7.2% of time and 2.90 kg feed intake per day). Surgical castration (at 14 days of age) resulted in an increase of 8.1% in feed intake in week 21 compared to entire males. Immuno-castrates on the other hand, increased feed intakes in week 21 by 14.1% compared to surgical-castrates and 23.4% compared to entire males. Thus, immuno-castration offers pork producers a means to significantly improve feed intakes of group-housed male finisher pigs. As reported in the results, live weights of immuno-castrates were correspondingly heavier than entire males. Presumably as a consequence of the removal of endogenous hormones influencing aggression and sexual activity, more time was spent feeding.

The time spent in feeding behaviour and feed intake in the present experiment for group-housed entire males were higher than those reported by Nielsen and Lawrence (1993) for

groups of 15 entire males with one feeder space (3.7% of time and 1.42 kg per day), Nielsen et al. (1995) for groups of nine entire males (4.1% of time and 1.96 kg per day) and Labrousse et al. (1999) for groups of 8–13 Large White entire males (3.9% of time and 2.12 kg/day). For castrates, however, our data were intermediate between other results. For example, Gonyou et al. (1992) reported that surgical castrates and gilts in groups of five at the end of the finisher phase spent 8.8% of time feeding per 24 h and consumed 3.16 kg feed per day, whereas De Haer and Merks (1992) reported 4.4% of time feeding and 2.04 kg intake per day. Differences between the results of experiments may be due to breed, genotypes, group size, feeder design (the feeders used in this experiment were designed and made by the piggery), method of providing feed (e.g. availability or rate of delivery of feed was limited to 1 g/s in this experiment) which could affect rate of eating and method of recording data.

Interestingly, on average, groups of entire males at 17 and 21 weeks and immuno-castrated males at 17 weeks allocated about one-third of their active time to feeding behaviour. These classes/ages of boars had a high incidence of mounting. In contrast, the groups of immuno-castrates at 21 weeks and surgical-castrates at 17 and 21 weeks allocated about 46% of their activity to feeding behaviour. The only other report in the literature of time budgets of finisher pigs is by Gonyou et al. (1992). Gilts and surgical-castrates housed in groups of five spent about 55% of their active time feeding. The finding in the present experiment that entire males had a different time-budget allotment for feeding than castrated males has not been previously reported. Further, that feeding behaviour by entire males decreased between 17 and 21 weeks of age may have been at least partly attributable, therefore, to a general reduction in activity levels by entire males, as feeding motivation may have been regulated by the time budget.

A characteristic of feeding behaviour in pigs is the high degree of variability in parameters such as the number of visits to feeders per 24 h, the average duration of visits to feeders and total time spent feeding per day (De Haer and de Vries, 1993; Young and Lawrence, 1994; Gonyou, 1999). Based on the raw data from this experiment, we found the number of visits to feeders per pig ranged from 4 to 82 per day. The total time spent feeding per 24-h period ranged from 11.7 to 171.4 min and the duration of individual visits to a feeder ranged from 1 s to 53 min. While access to the feeders did not seem to be a limiting factor to feed intake compared to other experiments (e.g. Nielsen and Lawrence, 1993; Gonyou and Stricklin, 1998; Gonyou, 1999), a related issue that requires further investigation is the variability of feeder use by individual pigs and impact on feed intake.

In the present experiment, there was a clear diurnal pattern of utilisation of the feeders by the groups of pigs in all treatments and at both ages (see Fig. 4). This result supports earlier findings by De Haer and Merks (1992), Nielsen and Lawrence (1993) and Young and Lawrence (1994) that pigs display an early morning and a late afternoon peak in feeding behaviour. Deviations from this pattern could occur if access to the feeders became limiting, which may have occurred, for example had there been more pigs, only one feeder or restricted access to feed in each pen. The average activity pattern of pigs, as presented in Fig. 2, indicated pigs were highly active between 06:00 and 08:00 h, which corresponded to a period of high feeder use. A second, lower peak of activity occurred between 14:00 and 16:00 h. Another finding indicative that feeder space was not limiting was that on about 80% of occasions when pigs entered a feeder, the feeder was vacant as the pig approached

to enter the feeder race. The results of the experiment also suggest that some pigs “queued” for access to a feeder. These pigs tended to remain longer in the feeder and may have been hungrier. Also, the longer a pig remained in the feeder, the more likely other pigs were to “queue” for the feeder, unless the “queuing” pig was able to reduce the waiting period by displacing the occupant from the feeder. This only occurred in a minority of cases (2.7 and 4.8% of occasions at 17 and 21 weeks of age, respectively).

The finding that entire males at 21 weeks of age were less likely to “queue” for a feeder than immuno- and surgical-castrates may have been a consequence of the feeders being more often vacant in the entire male treatment compared to the other treatments. Entire males at 21 weeks of age performed more aggressive and sexual activity than castrated males. On average, in this experiment, entire males spent 10% of their active time (time budget) in sexual and aggressive behaviour compared to only 3% by castrates. Castrates, on the other hand, spent more time feeding. Thus, the increase in social behaviour displayed by entire males may have been at the expense of feeding behaviour.

By increasing the rate of flow of feed pellets in the feeder or alternatively by increasing the amount of feed available in the feed receptacle, feed intake in entire males may be increased. Other possible strategies to encourage group-housed entire boars to visit the feeder more often may be the provision of more feeder spaces compared to castrates, the positioning of visual barriers in the pen and around the entrance to the feeder race or the relocation of the feeder to the centre of the pen rather than at the periphery. The rationale for the latter ideas is to increase feeding behaviour in entire boars by reducing opportunity for social interaction.

Thus, immuno-castration had a similar effect to surgical castration on reducing the incidence of social behaviour in group-housed male pigs. Castration resulted in an increase in feeding. While the decrease in social behaviour following castration had a clear benefit to production parameters (feed intake and growth rate), there are also potential welfare and meat quality benefits from a reduction in aggression and mounting events, through reduced injury, less carcass bruising and DFD meat.

5. Conclusion

Castration reduced social behaviour and increased feeding behaviour in group-housed male finisher pigs and altered the time-budget allocations for these activities. The 21-week-old entire male pigs that were administered Improvac® at 14 and 18 weeks of age performed social and feeding behaviours in similar proportions to males surgically castrated at 14-day-old. Immuno-castrated males had higher feed intakes and tended to grow faster to slaughter weight than entire males.

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IMPROVAC[®] (PFIZER ANIMAL HEALTH): AN IMMUNOLOGICAL PRODUCT FOR THE CONTROL OF BOAR TAIN IN MALE PIGS

(1) BOAR TAIN AND ITS CONTROL AND THE MODE OF ACTION, SAFETY AND EFFICACY OF IMPROVAC[™]

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Summary

Boar tain is caused primarily by the male steroid androstosterone, and skatole - a bacterial metabolite of tryptophan. Potentially, tain is a major limiting factor to the marketing of pig meat derived from carcasses of entire male pigs. Androstosterone can only be detected by sensitive subjects who generally find the smell highly offensive, whilst skatole can probably be detected by nearly everyone. The occurrence of boar tain shows national, regional and seasonal differences which can be influenced, but not eliminated, by feeding and management practices. The most effective and widely practised method of controlling boar tain currently is the painful and undesirable procedure of surgical castration. However, the new technology of immunocastration, utilising the product Improvac[™], offers a real and welfare friendly alternative.

Introduction

In recent years, the global consumption of pig meat has increased at the rate of 1.3 per cent per annum (Ropke, 2006), which in turn places increasing pressure on the pig industry for greater efficiency of pig production. By the year 2015 it is predicted that the annual average consumption of pig meat per head worldwide will be 17.9 kg - almost twice that of 1970. Global production of pig meat in 2004 was estimated to be 100,907 million tonnes, 56 per cent of which was produced in Asia, 25.8 per cent in Europe and 17.1 per cent in the Americas. The medium to long term outlook for pig meat consumption in Europe is generally positive (Aron, 2005), but there is strong and increasing competition from the poultry sector. In 2004, European consumers ate an average of 43.5 kg of pig meat and 23 kg of poultry meat per person, which represented 50 and 26 per cent respectively of their total average annual meat consumption of 87.4 kg. Although slow growth in pig meat consumption until

of the Improvac[®]. The technical support provided by Elaine Leeson and Dr. Rebecca Morrison with the video equipment, Maurie Miles with the computer software and hardware and Dr. D. Suster, Dr. K. Breuer, A. Cassar, T. Chamberlain and T. Moyes for video read-outs are also acknowledged. The experiment was co-funded by grants from the Department of Natural Resources and Environment and the Pig Research and Development Corporation (now Australian Pork Limited).

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at least 2012 is expected, the increase in consumption of poultry meat is expected to rise most steeply as consumers begin to show greater preference for it. Greater efficiency and competitiveness could be achieved by finishing entire male pigs but, unless controlled, the presence of compounds in the fat of such animals, primarily androstosterone and skatole which are released upon heating or cooking, could limit the development of pig meat production as consumers change to meat from other species in which the equivalent of boar taint does not exist.

The rearing of entire male pigs for meat is strongly resisted in most pig-producing countries because there is very low consumer tolerance of boar taint. However, future welfare legislation may prohibit surgical castration without anaesthesia, particularly in Europe. As routine use of anaesthesia would pose severe practical difficulties, other means of controlling boar taint must be found. Slaughter of male pigs before they reach sexual maturity has proven an acceptable solution in some markets, but this reduces production efficiency. Adoption of this practice in other countries would necessitate a substantial increase in the number of pigs reared to maintain pork production at current levels, and would prevent producers from supplying the types and quality of pig meat currently demanded by their markets. There are husbandry and processing techniques that can reduce the intensity of boar taint and these provide a possible solution if carcasses that are still affected can be easily identified on the slaughter line and diverted to an acceptable use (Babal and Squires, 1995; Bonneau and Squires, 2000). It is possible to dilute tainted meat in certain products such as sausages and salami (Williams *et al.*, 1993; Walstra, 1974), providing a commercial outlet for a limited number of tainted carcasses. Nerveless, banding and processing alone cannot provide a high level of boar taint control and occasions will arise when consumers are exposed to its undesirable odour and, as a result, will not readily purchase pig meat products again. Until recently, the only means of controlling boar taint was by the surgical removal of at least the testicular parenchyma (Rhodes and Paterson, 1971), but the advent of vaccination against gonadotrophin-releasing factor (GnRF) has provided the pig industry with a welfare friendly and effective alternative to surgical castration (Falvo *et al.*, 1986; Canary and Bonneau, 1986; Bonneau *et al.*, 1994; Onik *et al.*, 1998; Beckman *et al.*, 1999; Dunstree *et al.*, 2001; Zeng *et al.*, 2001; Metz *et al.*, 2002; Jirov *et al.*, 2005).

This review describes the problem of boar taint and the rationale behind the use of a new technology for effective control of taint in entire male pigs which would obviate the need for surgical castration. This in turn would allow pig producers to achieve the growth efficiencies necessary for pig production to remain competitive.

CAUSE OF BOAR TAIN

Several chemical substances are thought to be responsible for causing boar taint of which androstosterone and skatole are regarded as the most important (Hansson *et al.*, 1986; Dijksterhuis *et al.*, 2000). Other chemicals thought to contribute to taint include androstenediol (Brennan *et al.*, 1986; Brooks and Pearson, 1989) and indole (Garcia-Regueiro and Diaz 1989; Moss *et al.*, 1993; Aanon-Freempong *et al.*, 1997; Rius and Garcia-Regueiro, 2001), but they seem to be of lesser importance because of their relatively weak odour and different lipophilic properties.

Androstosterone

Gonadotrophin releasing factor (GnRF), which is produced in the hypothalamus, stimulates the secretion of luteinising hormone (LH) and follicle stimulating hormone (FSH) from the anterior pituitary gland. In turn, LH stimulates the Leydig cells in the interstitial tissue of the testes to produce androgens including testosterone and androstosterone. (6 α -androst-16-en-3-one) (Garner and Hafez, 1987). The testis of the boar has a high number of LH-binding sites; each Leydig cell in the adult has about 35,000 binding sites (Peyrat *et al.*, 1981). In contrast with other mammals, the boar possesses a relatively large amount of testicular interstitial tissue (Fawcett *et al.*, 1973) of which 70 per cent is composed of Leydig cells (Peyrat *et al.*, 1981). This explains the high output of steroid hormones in the boar. Androstosterone is one of the main causes of boar taint (Patterson, 1968) and is perceived as a characteristic and unpleasant smell of urine or sweat by those individuals who are sensitive to it. Other descriptions include odour that is onion-like, ammonia-like, faecal, musk-like or animal-like. The boar is unique among mammals in that it specifically produces high quantities of androstosterone, the output of the mature testes being some ten times that of testosterone (Claus *et al.*, 1971).

In addition to androstosterone, other steroids and non-steroids have been identified in pig fat (Bonneau, 1982; Rius Solé and Garcia-Regueiro, 2001; Rius *et al.*, 2005). These include androsteneol (5 α -androst-16-en-3-ol), various short-chain aldehydes and fatty acids, and phenolic compounds such as 4-phenyl-3-buten-2-one. The latter is thought to be derived from phenylalanine, and may account for the description of fruity, perfumed or "mouhball" (naphthalene) given by some individuals to boar taint. Three- α -androstenediol has a musk-like or floral odour (Labrows and Wysocki, 1984).

Skatole

Skatole (3-methyl-indole) has been identified as a cause of faecal odour that may be associated with pig fat (Vold, 1970). Skatole is produced in the large intestine by microbial breakdown of the amino-acid tryptophan (Yokoyama and

Carlson, 1979). The concentration of skatole in pig fat varies considerably from pig to pig and is related not only to production in the gut, but also to factors that influence skatole absorption and elimination from the body. Skatole can be influenced, but not reliably eliminated by diet (Jensen *et al.*, 1993). The addition of fibre, such as pectin or sugar-beet pulp to the diet, tends to reduce levels formed in the gut (Gill *et al.*, 1993; Wood *et al.*, 1994).

Relationship between Androstosterone and Skatole

Androstosterone may be found in low concentrations in females (Claus, 1976) but is only significant in entire males. In contrast, skatole may occur in significant concentrations in both males and females, although it has a much lower tendency to accumulate in the latter (Williams *et al.*, 1963; Claus *et al.*, 1996). In male pigs, levels of androstosterone and skatole are often correlated with each other (Bonneau *et al.*, 1992; Anner-Frempong *et al.*, 1997) and high levels of both are found in fat from some boars aged around 110 days and weighing around 75 kg or more (Whitington *et al.*, 2004; Aldat *et al.*, 2005). A peak in steroid hormones also occurs in male piglets aged 2-4 weeks, but not in female or castrated piglets. However, skatole peaks occur in all three groups at this age, suggesting a relationship to increased microbial action associated with changes in the gut flora when pigs are weaned (Lanthier *et al.*, 2006).

Increased levels of androstosterone in older, post-pubertal boars can be attributed to the increased synthesis of steroids in the increasing mass of testicular interstitial tissue (Bonneau, 1962; Claus *et al.*, 1994). Skatole levels vary substantially with age (Babol *et al.*, 2004). Beyond around 140 days of age, levels increase markedly in some males to very high levels, which are maintained until at least 240-260 days of age. Although skatole levels are to some extent correlated with anatomical and endocrinological indicators of sexual maturity, Babol *et al.* (2004) concluded that the increase is temporary and after reaching a maximum, levels tend to decline with age. Nevertheless, the time at which high levels tend to be present coincides with the average age of slaughter. Because high levels of skatole tend not to be found in gilts and castrated males, it is logical to assume that they are related to puberty in the entire male.

Skatole levels in fat are related to its metabolism in the liver (Fris, 1995; Squires and Lundström, 1997; Babol *et al.*, 1998a; Babol *et al.*, 1998b). Elevated levels of sex steroids reduce the hepatic metabolism of skatole and subsequent clearance from the body, resulting in increased accumulation of skatole in the fat (Babol *et al.*, 1999).

HUMAN SENSITIVITY TO BOAR TAINT

A major European study sampling 4,313 entire male carcasses and 223 gilt carcasses from pigs reared under normal commercial conditions showed that,

despite significant national differences in liking for meat from entire males, the degree of dislike increases as levels of both androstosterone and skatole increase (Bonneau *et al.*, 2000; Marcheva *et al.*, 2000). Skatole and androstosterone levels in fat are, respectively, significantly correlated with scores produced by sensory taste panels for skatole odour, but not with scores for androstosterone odour. Fat content of androstosterone will not necessarily predict the odour of boar taint (Cameron *et al.*, 2000) probably because some people are unable to detect it (Wysocki and Beauchamp, 1984) or have become desensitized to it by frequent exposure and therefore do not find it unpleasant (Font i Fumols, 2003). Responses to different combinations of androstosterone and skatole can sometimes be similar (Anner-Frempong *et al.*, 1997).

A taste panel composed entirely of women detected androstosterone in 100 per cent of samples taken from 49 boars and none in samples from gilts of the same slaughter weight; the odour intensity was found to increase as the slaughter weight increased from 100 kg to 130 kg (Brennum *et al.*, 1986). Female consumers are known to be more critical than their male counterparts (Marcheva *et al.*, 2000), and the ratio of men to women who are unable to smell androstosterone is relatively uniform throughout the world (Table 1) (Gilbert and Wysocki, 1987).

Table 1 - Percentage of people who cannot smell androstosterone, by region (adapted from Gilbert and Wysocki, 1987)

Region	Men	Women	Men : Women
Asia	25.5	17.2	1.48
Africa	21.6	14.7	1.47
Europe	24.1	15.8	1.53
U.K.	30.0	20.9	1.44
Latin America	24.6	17.7	1.39
Caribbean	29.2	17.5	1.67
USA	37.2	29.5	1.26

In a major study of large populations of people, around 27.46% of men and 19.04% of women could not smell androstosterone; a ratio of around 1.44 men for every woman. However, when detected, the proportion of men and women who correctly identified the smell as "sweaty" was roughly equal. A male bias for the inability to detect androstosterone has also been reported by Baydar *et al.* (1993) but a recent study (Brenner *et al.*, 2003) suggests that true androstosterone anosmia in the human population may be significantly lower than previously

estimated. Complete, specific androstosterone anaemia was found to occur in 1.8 to 5.96 per cent of young, healthy adults. In assessing boar taint, it is important to realise that results of sensory panel studies are only valid if panelists are known to be able to detect androstosterone. Weiler *et al.* (2000) found that individuals highly sensitive to androstosterone reacted to both androstosterone and skatole, whereas individuals with mild sensitivity for androstosterone reacted to skatole only. Without differentiation according to individual sensitivity, the importance of androstosterone might therefore be underestimated using this technique.

Detection Thresholds of Androstosterone and Skatole

It has been proposed that levels above which meat can be considered to be tainted should be 1 ppm for androstosterone and 250 ng/g for skatole (Montsen *et al.*, 1986), although some national legislation has adopted a threshold of 500 ng/g for androstosterone, as measured by heating salivary glands (German Meat Hygiene Ordinance, Annex 1, Chapter 4, 2-3). For skatole, it is now generally accepted that the threshold should be 200 ng/g (Babal *et al.*, 2004).

TAINT DETECTION AT SLAUGHTER

There is clear potential value in a simple, objective slaughter-side screening test to identify tainted carcasses rapidly (Babal and Squires, 1995). Sorting of carcasses on the basis of androstosterone and skatole can reduce, but not eliminate the problem, given current technology (Bonneau *et al.*, 2000). Tests based on human perception do not necessarily detect androstosterone accurately and they would certainly be unable to keep pace with slaughter lines and carcass distribution. Laboratory analytical methods such as photoluminescence, high-pressure liquid chromatography and gas chromatography are all highly effective in detecting both androstosterone and skatole, but do not have a slaughter-site application. Photoluminescence has been specifically assessed as a potential means of screening (Mortensen and Sorensen, 1984). Initially it was considered to be too slow, too expensive and was able to detect only one compound at a time. The system has been adapted in Denmark for the routine detection of skatole on-line in one slaughterhouse only, since most male pigs produced there are castrated (F. Andersen, personal communication, 2007). Squires (1990) described a similar system for the detection of androstosterone, but to date this has not been validated in slaughterhouses.

A monoclonal antibody-based ELISA has been developed for the rapid detection of androstosterone in boar sera (Abouzied *et al.*, 1990) and good correlation has been demonstrated between serum levels and fat levels (Tuomola *et al.*, 1997). Good correlation has also been demonstrated between serum and fat levels of skatole (Tuomola *et al.*, 1996) so routine slaughter-side serum ELISA screening for boar taint is a distinct possibility.

Perhaps the most promising means of slaughter-side boar taint detection is the development of an electronic nose based on gas sensor array technology that can discriminate between different levels of taint (Amor-Frempong *et al.*, 1998).

If identified quickly on the slaughter line, carcasses could either be rejected or handled and processed differently. Results from taste panels reported by Williams *et al.* (1963) indicate that it may be possible to use meat with boar taint in highly spiced comminuted preparations such as salami, but these should be for consumption without heating, or in preparations that contain pork liver since the smell of liver tends to mask the smell of boar taint. If any control system is eventually developed based on management changes to reduce the incidence of boar taint and testing to identify any remaining affected carcasses, its economic viability will depend on the proportion of rejected carcasses and whether any commercial use can be found for them.

CONTROL OF BOAR TAIN

Apart from surgical castration, most of the world has, until now, had no effective method by which boar taint can be controlled in post-pubertal pigs. Some management practices can reduce its presence, but not eliminate it. The new technology of vaccination against GnRH has been used for some time in Australia and New Zealand and is now becoming more widely available. It provides a highly effective alternative to surgical castration.

Management and Hygiene

Improved standards of piggy hygiene aimed at reducing the overall contact of pigs with faecal material, particularly in summer months, would be expected to reduce skatole levels in carcasses of both males and females by reducing transcutaneous absorption. It is thought that, in high temperatures, skatole may pass through the skin as pigs wallow or it may be absorbed in gaseous form through the lungs. Pigs allowed to lie in pens with solid floors that were heavily soiled with faeces and urine and that were kept at high stocking densities (0.6 m² per pig) for a week or more, had higher levels of skatole in their subcutaneous fat than pigs from clean pens with low stocking densities (1.2 m² per pig). Within a week of slaughter, it was possible to increase or lower skatole levels by reversing the conditions (Hansen *et al.*, 1994). The findings of Waltra *et al.* (1999) confirmed these results on a wider scale. Attention to stocking rates, ventilation and hygiene, particularly in summer, is therefore potentially important in mitigating skatole levels, as is the keeping of pigs on slatted floors (Kjeldsen, 1993).

By reducing the slaughter weight of pigs, it may be possible to avoid high levels of boar taint. This is done in some countries such as the U.K. and Ireland, but it is unlikely to be viable commercially for most other countries.

Androstosterone levels rise at puberty in the male pig, commencing at around 100 days of age. At approximately 120 days of age, the development of the Leydig cells is maximal (Coltenbrander *et al.*, 1982) but the liveweight of the pig would be about 75 kg and therefore too light for the majority of markets. Maintaining current levels of pork production, but with lighter slaughter weights, would require a substantial increase in the number of pigs slaughtered with increased production costs and additional physical resource input.

Social interactions may influence levels of androstosterone in groups of pigs. Fredriksen *et al.* (2006) raised 1,353 entire males in stable social groups and compared the effects of keeping pigs in the same litter from birth to slaughter, mixing pigs at 25 kg bodyweight. At slaughter, the mean levels of androstosterone in fat were 820 and 1,000 ng/g respectively, but although androstosterone was lower in the unmixed group, 45 per cent of pigs still had concentrations above the threshold value of 1,000 ng/g.

From 107 days of age, plasma androstosterone levels were shown to increase in individually housed boars (Narendran *et al.*, 1982). When sows in oestrus were introduced into the boar pens, plasma androstosterone increased by 247 ± 27 per cent in the ensuing 24 hours. A control boar showed an increase of similar magnitude (221%), probably because of auditory and olfactory stimulation. It is therefore possible that in mixed-sex rearing, androstosterone levels may rise in males as females in the group come into oestrus. Paterson and Lightfoot (1984) demonstrated that some boars indeed had high androstosterone levels when reared with gilts, when slaughtered at weights above 100 kg. Thus the rearing of stable groups of the same sex is to be advocated when attempting to reduce the potential for boar taint in entire males.

Nutrition

High skatole levels can be induced by the feeding of brewers' yeast, presumed to be as a result of poor ileal digestibility and therefore a higher level of fermentation of protein in the hindgut (Jensen *et al.*, 1995). The incorporation of fibre in the diet as either wheat-bran or sugar-beet pulp, or the replacement of yeast with casein, reduced the backfat levels of skatole. It was concluded that skatole production depended on the amount of protein entering the hindgut and the preferential proteolytic activity of the intestinal flora.

Feeding a wet feed with whey as the liquid fraction rather than water reduced backfat skatole levels in comparison with the feeding of dry feed (Anderson *et al.*, 1997). There were no effects from differing levels of lysine in this study, presumably because of its high ileal digestibility, but Lundström *et al.* (1994) found that entire male pigs fed a low protein diet and slaughtered at 103 kg had lower skatole levels than either those fed on a high protein diet or females on both diets.

Antibiotics

Since skatole is primarily a product of microbial proteolysis in the hindgut, it is possible that the addition of antibiotics to the feed of finishing pigs might suppress production (Mackinnon, 1985), but there would be no anticipated effect on androstosterone. Using low levels of tylosin and virginiamycin (20 ppm in each case), Hansen and Larsen (1994) were unable to demonstrate a significant reduction in the skatole concentration in the neck fat of entire male pigs. However, Allen *et al.* (2001) reported lower skatole levels in entire boars fed wet feed containing virginiamycin. The addition of zinc bacitracin to fermented liquid feed has also been shown to be effective in reducing skatole levels (Hansen *et al.*, 1997). In Europe, the routine use of antibiotics in feed for purposes other than the treatment and control of disease under veterinary supervision is not permitted and it would therefore not be an option for the control of boar taint.

Breeding and Genetic Selection

The heritability of androstosterone levels in the carcass ranges from 0.25 to 0.82 (Willeke, 1993) and selection of boars has shown that it is possible to reduce the levels of androstosterone below accepted thresholds (Willeke *et al.*, 1987). The main influencing factor is likely to be the age at which the males reach puberty, there being differences between breeds in the levels of androstosterone in carcass fat by the time pigs reach slaughter weight. The Duroc breed has much higher levels of androstosterone than the Yorkshire, Landrace or Hampshire breeds (Xue *et al.*, 1996) and the Large White has higher levels than the Landrace (Willeke, 1993). Genetics also influence the accumulation of skatole in boar fat. Lundström *et al.* (1994) have suggested that a recessive gene is responsible for high skatole levels, especially when intestinal levels are high. A distinct age-related distribution of plasma skatole levels has been found in Yorkshire, Landrace, Hampshire and Duroc boars (Babol *et al.*, 2004). Maximum levels were observed at approximately 180–200 days of age in all boars. Levels decreased in the Yorkshire and Landrace at approximately 240–260 days, but persisted in the Hampshire and Duroc until 310–360 days. It is possible that age-related levels are determined by the activity of specific enzymes responsible for hepatic metabolism (Whittington *et al.*, 2004).

Lee *et al.* (2005) have detected quantitative trait loci for androstosterone and skatole in Large White x Meishan pigs. Thus far, genetic selection specifically for the reduction of boar taint has not been a practical option, perhaps because high androstosterone levels could reflect libido and male fertility. However, simulation studies based on assumptions about the heritability of boar taint indicate that significant reductions could be made over five years (Ducro-Steverink, 2006). Boar taint is highly heritable and a number of candidate genes for it have been identified (Squires, 2006). Work is currently in progress on genetic markers for low boar taint based on these genes.

Artificial Insemination Using Sexed Semen

For elimination of androstereone and reduction of static levels alone, there would be enormous advantages in breeding female slaughter pigs only. Flow cytometry has successfully led to the birth of normal offspring from sexed sperm of at least seven mammalian species, the sperm of the ox and the pig being particularly well suited to such separation techniques (Gamer, 2006). In one study, the mean pregnancy rate in multiparous sows using sexed semen was only 33.3 per cent, but all but one piglet born were of the predicted sex (Grossfeld *et al.*, 2005). Sexed semen has the potential for increasing the rate of genetic progress, especially when insemination technology can capitalise on methods using low sperm numbers (Gerrits *et al.*, 2005). There is, however, some way to go before sexed semen for the production of slaughter pigs becomes a commercial reality (Johnson *et al.*, 2005; Heinritz *et al.*, 2006), although recent commercial announcements have been made in the farming press. Flow cytometry allows the sorting of approximately 15 million sperm per hour, which does not compare favourably with the typical sperm concentration of a single commercial semen dose which contains between two and three billion viable sperm. Speed of separation and viability of sorted sperm need to be improved and equipment costs must be reduced for sexed sexing to become a viable economic consideration. Furthermore, the disadvantage of rearing predominantly female pigs is that production efficiency will be reduced.

Suppression of Male Characteristics

Surgical Castration

Until recently, surgical castration was the only way of eliminating androstereone and reducing skatole in carcasses of post-pubertal male pigs that was sufficiently reliable for routine use. It should be noted, however, that even surgical castration is not completely effective in practice. A recent US field survey reported a 1-2 per cent prevalence of significant androstereone concentrations in apparently castrated pigs and, occasionally, in gilts. Possible explanations are cryptorchidism, intersex pigs and adrenal malfunction (Nederveeld *et al.*, 2006). Additionally, in environments heavily contaminated with faeces, skatole can accumulate to levels above target thresholds in both castrated males and female pigs. In practical terms though, surgical castration offers an effective solution to the problem of boar taint. Unfortunately, there are serious welfare concerns related to this procedure and disadvantages related to growth performance and lean meat content of castrated males when compared with entire males.

Pain-related vocalisation during castration has been analysed by Marx *et al.* (2003). Castration compared with simple restraint resulted in comprehensive changes in vocalisation: vocalisations were more extended and powerful,

The Pig Journal - Referred Section

indicating that pain-related changes in calls of piglets can be identified. It is important to distinguish the differences between "honest" signalling and other vocalisations because piglets tend to respond to handling with high frequency calls at maximum levels. The stress characteristics of vocalisations in terms of pitchness and entropy are most pronounced during the surgical period of the process of handling and castration (Puppe *et al.*, 2005). The way in which pigs are restrained does not affect the pain caused by castration (Weary *et al.*, 1998). Taylor *et al.* (2001) concluded that the assumption that neonatal animals are less sensitive to pain than older animals is incorrect.

Physiological responses are also potential indicators of pain. White *et al.* (1995) found, when comparing responses of pigs during castration with and without local anaesthesia, that the highest heart rates and energy of vocalisations came from pigs castrated without local anaesthesia. Incision of the scrotum and severing of the spermatic cord elicited a greater increase in heart rate than removal of the testicles and ligation of the cord. McGlone *et al.* (1993) and Taylor *et al.* (2001) found no differences in behaviour and perception of pain when piglets were castrated at different ages from one to 20 days but 14 days was optimum for subsequent growth and weaning weight (McGlone *et al.*, 1993). Under EU legislation (Anon, 2001a), the administration of local anaesthesia would be required beyond the age of seven days.

Local anaesthesia can mitigate pain-induced behaviour in young pigs from two to four weeks of age, but apparently not in older pigs at seven weeks of age (McGlone and Hellmann, 1988; Horn *et al.*, 1999; Haga and Ruckheim, 2005). There is no demonstrable difference in effect between injection of the local anaesthetic into testicular tissue or into the spermatic cord (Haga and Nambain, 2005), or with sub-cutaneous infiltration prior to injection into the testicular tissue. Mean arterial blood pressure, electroencephalogram readings and pulse rate all showed significantly smaller responses to castration with local anaesthetic compared with the administration of the anaesthetic itself (Haga and Ruckheim, 2005), suggesting physiological stress in addition to pain. Significant increases in adrenocorticotrophic hormone (ACTH), cortisol and lactate induced by castration (Pruiter *et al.*, 2005) indicates potential for tissue damage as well as stress.

General anaesthesia during castration has been attempted, but it has been associated with high mortality and subsequent suppression of nursing behaviour (McGlone and Hellmann, 1988). Castration of piglets using CO₂ anaesthesia has also been reported (Svendsen, 2006).

In addition to castration being a painful mutilation, the open wounds that are usually left to heal by second intention under typical farm conditions may become infected by pyogenic bacteria leading to chronic inflammation (de Krafj and Welling, 1988).

Surgical castration of piglets is performed routinely in most pig producing countries in the world. In the UK, whilst not illegal, the practice is considered undesirable on welfare grounds so quality assurance schemes do not permit the procedure as routine. The European Commission Directive 2001/93/EC (Anon, 2001a) sets out minimum standards for the protection of pigs, stating that any procedure carried out other than for reasons of treatment, diagnosis or identification that results in the loss of a sensitive part of the body or alteration of bone structure shall be prohibited. Castration, by means other than tearing of tissues, is listed as an exception, but after the age of seven days it should only be performed by a veterinary surgeon with anaesthesia and additional prolonged analgesia. An earlier scientific report prepared for the European Commission considered the procedure acceptable if it did not cause pain (Anon, 1997).

The European Commission will review welfare legislation again in 2009 and it is possible that routine castration will be banned and allowed only in exceptional circumstances with local anaesthesia and under veterinary supervision. In Norway, this approach has been mandatory since 2002. The views expressed by the European Commission (Anon, 1997) are supported by the Federation of Veterinarians of Europe (Anon, 2001b) who concluded that, in the future, the need to castrate male piglets surgically should be reduced by developing realistic ethical and practical alternatives.

CONTROL OF BOAR TAIN: IMMUNOCASTRATION

There are many opportunities for the use of immune modulation techniques in livestock that offer the potential to reduce use of chemicals and for the need for surgical procedures to be carried out (Lofthouse and Kemp, 2002). Vaccination against GnRF is a very attractive means of stimulating surgical castration in farm animals (Bomseu and Entwright, 1995), particularly in pigs, because their relatively short growth period limits the time for which efficacy is required. In addition to control of boar taint, the technology of immunocastration offers possibilities to reduce aggressive behaviour in males, to act as a contraceptive in domestic pets and wild-life and to treat steroid-related cancers such as cancer of the prostate (Thompson, 2000). Avoidance of surgical castration at a young age and its replacement with immunological castration closer to slaughter also offers potential production efficiency benefits in cattle, sheep, goats and pigs, with improved carcass characteristics compared with surgical castrates.

Vaccination of entire male pigs against GnRF reduces plasma gonadotropin and androgen levels and either inhibits the development or causes the regression of testicular parenchyma and the secondary male sex organs (Caray and Banneau, 1986; Falvo *et al.*, 1986; Onk *et al.*, 1998; Beckman *et al.*, 1999; McCauley *et al.*, 2000; Dunstun *et al.*, 2001; Metz *et al.*, 2002; Zeng *et al.*, 2001; Janos *et al.*, 2003). It suppresses sexual development in gilts as well as boars (Oliver *et al.*, 2005).

Concepts, Formulation and Administration of Improvac™

GnRF is a peptide neurohormone produced in the preoptic area of the hypothalamus (Schriener, 1990); it is secreted into the hypophysial portal bloodstream then carried to the pituitary gland. The gonatropic cell membranes contain GnRF receptors which, when activated, trigger the release of luteinising hormone (LH) and follicle-stimulating hormone (FSH) (McCann and Opeda, 1996). LH is also known as interstitial cell-stimulating hormone because it stimulates the Leydig cells of the testis to produce steroid hormones such as androstenedione and testosterone.

Immunocastration is achieved by successfully raising antibodies to endogenous GnRF, thereby blocking the above chain of events and removing the stimulus for testicular activity. For it to be a real alternative to surgical castration, an anti-GnRF vaccine must be reliable and safe to use. Melloen *et al.* (1994) described problems with the development of vaccination against GnRF because GnRF derived antigens may be recognised as "self," even after multiple vaccinations. They developed a 20-amino-acid tandem repeat of the GnRF peptide sequence to act as the antigen, which totally abolished the development and endocrinological function of the testes. To achieve successful vaccination against GnRF, it was found necessary to use Freund's complete adjuvant and to administer the vaccine in repeated high doses. Further modifications were developed in which the peptide sequence was conjugated with other components to enhance antigenicity and lower the frequency of administration (Onk *et al.*, 1998; Beckman *et al.*, 1999). Improvac™, the only commercially available GnRF vaccine, contains a synthetic, incomplete analogue of GnRF conjugated to an inert carrier protein to make up the complete antigen. This is then combined with an aqueous-based synthetic adjuvant to increase the level and duration of the immune response whilst avoiding excessive tissue reaction at the site of injection (Improvac™, Australian Product Information).

A dose titration study carried out with Improvac™ (Study G102; Pfizer Animal Health) compared the effects of increasing the dose of GnRF conjugate from 200µg to 2,000µg, with a saline control. Within this range, there were no significant differences between the different potencies on testis growth and function. To allow a margin for error, the commercial product contains 200µg/ml of the conjugate and thus provides 400µg of antigen per 2 ml dose, which is administered sub-cutaneously behind the ear. Two separate doses are required at least four weeks apart to achieve immunocastration. The timing of dosing is discussed further later in this review.

Efficacy of Improvac™

The effect of immunocastration can be measured by monitoring plasma androgen levels and the dimensions of the testicles (Onk *et al.*, 1995), although there is a high degree of natural variation in the testicular dimensions,

especially during puberty when testicular growth is rapid. At slaughter, efficacy of immunisation can be assessed by measuring testosterone and the weights and dimensions of the testes and the bulbo-urethral glands. Direct evidence of successful prevention of boar taint can be obtained by measuring androsteneone and skatole concentrations in fat.

Effect of ImprovacTM on Testes and Bulbo-urethral Glands

The priming dose of ImprovacTM has no physiological effect on the size of the testes or serum testosterone level by the time of administration of the second dose four weeks later (Dunshie *et al.*, 2001). However, within two weeks of administration of the second dose, suppression of testes growth and secretion of testosterone is evident and, at slaughter approximately four weeks after the second dose, the weight of the testes and the bulbo-urethral glands, trimmed of connective tissue, are approximately half that of unvaccinated entire males. Figures 1 and 2 show the impact of immunisation on the testes and bulbo-urethral glands. The effect of vaccination against GnRH on the testes and bulbo-urethral glands following the administration of two doses of ImprovacTM has been clearly demonstrated in several studies, which are summarised in Table 2.



Fig. 1 - Comparison of testes from a male pig vaccinated with ImprovacTM (left) with the testes from an unvaccinated male pig (right) (Photo courtesy of Pfizer Animal Health).

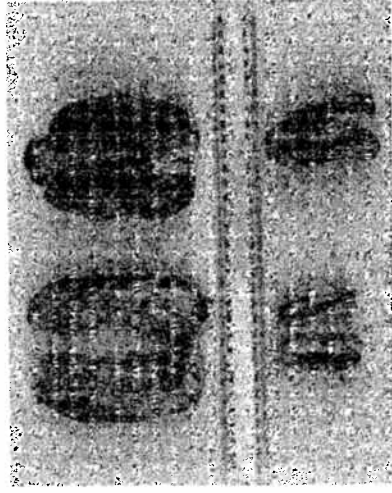


Fig. 2 - Comparison of bulbo-urethral glands from entire male pigs vaccinated with ImprovacTM (bottom) with unvaccinated pigs (top) (Photo courtesy of Pfizer Animal Health).

Table 2 - Weight and dimensions of the testes and bulbo-urethral glands of entire male pigs vaccinated against CIRF with Improvac™ and un-vaccinated entire males

Study	No boars per group		Testes			Bulbo-urethral glands		
	Not Vaccinated	Improvac	Mean weight (g)	Mean width (mm)	Mean length (mm)	Not Vaccinated	Improvac	Mean length (mm)
Dunhae et al (2001) Light slaughter ¹	50	50	421.6	182.6***	124.0	93.9***	137.4	52.9***
	50	50	509.8	254.4***	133.0	102.6***	148.0	75.1***
Dunhae et al (2001) Heavy slaughter ²	50	50	761.9	220.9***	n.a.	n.a.	n.a.	n.a.
	40	32	344.0	198.7***	111.0	95.9***	110.8	61.3***
Study G104 ³	17	19 ⁶	351.1	157.2***	118.8	85.3***	117.0	48.2***
Study G105 ⁵	17	19 ⁶	351.1	157.2***	118.8	85.3***	117.0	48.2***

1 Sternal width measured in vivo with engineering callipers 4 weeks after second dose of Improvac.
 2 Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.
 3 Improvac given at 18 and 22 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.
 4 Study G104: Pfizer Animal Health, Improvac given at weaning and at 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.
 5 Study G105: Pfizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.
 6 Eighteen animals for bulbo-urethral gland measurements.

Study	No boars per group		Testes			Bulbo-urethral glands		
	Not Vaccinated	Improvac	Mean weight (g)	Mean width (mm)	Mean length (mm)	Not Vaccinated	Improvac	Mean length (mm)
Study G105 ⁷	20 ⁸	20	443.1	210.4***	120.9	92.5***	120.0	58.1***
	46	50	450.8	198.5***	125.9	91.0***	n.a.	n.a.
Study G108 (silo 1) ⁹	47	48	380.3	222.4***	115.0	84.9***	n.a.	n.a.
	45	43	452.5	265.6***	118.2	96.7***	n.a.	n.a.
Study G108 (silo 2) ⁸	47	48	380.3	222.4***	115.0	84.9***	n.a.	n.a.
	45	43	452.5	265.6***	118.2	96.7***	n.a.	n.a.
Study G108 (silo 3) ⁹	47	48	380.3	222.4***	115.0	84.9***	n.a.	n.a.
	45	43	452.5	265.6***	118.2	96.7***	n.a.	n.a.

7 Study G105: Pfizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, six weeks after second vaccination.
 8 18 animals for bulbo-urethral gland measurements.
 9 Study G108: Pfizer Animal Health, Improvac given at 15 and 19 weeks. Measurements taken at slaughter, four weeks after second vaccination.
 n.a. not recorded or not tested.
 *** Significantly different from un-vaccinated pigs, P<0.001

Dunshen *et al.* (2001) vaccinated commercial Large White x Landrace pigs in Australia at either 15 and 19 weeks of age or 18 and 22 weeks of age to determine whether there were any differences in effect between light and heavy slaughter weights four weeks later at 23 (around 98 kg liveweight) and 26 weeks (around 120 kg liveweight) of age. The width of the testes was measured using engineering callipers prior to slaughter and after slaughter, the testes and bulbo-urethral glands were dissected out, trimmed of connective tissue, weighed and measured. In both age groups, Improvac™ significantly reduced weights and dimensions.

Jaros *et al.* (2005) vaccinated commercial Large White x Landrace crosses and Duroc crosses on two farms in Switzerland with two doses of Improvac™ at an interval of 4-5 weeks between doses, the second dose being given 4-6 weeks prior to slaughter. Pigs weighed approximately 48 and 77 kg at the time of vaccination on the first farm and 37 and 64 kg on the second. The slaughter weights ranged from 100 to 110 kg and vaccination was timed to take into account the growth rate of the pigs. After slaughter, the testes of the vaccinated pigs were compared with un-vaccinated controls and were found to be significantly lighter. Similar, highly significant, results were found in a study in Australia of pigs that were slaughtered either 4 or 6 weeks after the second dose (Study G105; Pfizer Animal Health).

In a further study in Australia (Study G104; Pfizer Animal Health), it was demonstrated that an anti-GnRF effect on the development of the testes and bulbo-urethral glands was achieved if pigs were vaccinated at weaning and again at 19 weeks of age. In a field study conducted at three different locations (one in New Zealand and two in Australia) (Study G106, sites 1-3; Pfizer Animal Health) using commercial crosses, highly significant suppression of the testicular growth was confirmed.

In effect, vaccination of entire males against endogenous GnRF appears to mimic experimental hypophysectomy, which has been shown to either halt the development or cause the regression of the male sex organs depending on age (Anderson, 1987).

Effect of Improvac™ on Boar Test Compounds

The testis of the boar has a high number of LH-binding sites (Peyrat *et al.*, 1981) and because of the relatively large testicular mass in this species (Fawcett *et al.*, 1973), the output of steroid hormones is potentially very high, especially of androstosterone (Claus *et al.*, 1971). There is a correlation between the levels of androstosterone and skatole in boars (Bonneau *et al.*, 1992), with high levels of both occurring naturally from around 110 days of age onwards (Whittington *et al.*, 2004; Aldai *et al.*, 2005). Studies with Improvac™ have demonstrated that the anti-GnRF effect significantly diminishes the size of the testes and, as might be expected, brings about a concomitant suppression of testosterone and androstosterone (Table 3).

Table 3 - Serum testosterone, and androstosterone and skatole levels in the fat of entire male pigs vaccinated against GnRF with Improvac™, Gn-vaccinated entire males and surgically castrated males

Study	Mean serum testosterone (ng/ml)			Mean fat androstosterone (ng/g)			Mean fat skatole (ng/g)		
	Hot Vaccinated, Entire	Castrates	Improvac	Hot Vaccinated, Entire	Castrates	Improvac	Hot Vaccinated, Entire	Castrates	Improvac
Dunshen <i>et al.</i> (2001) (Light slaughter)	10.5	0.27***	1.16***	1.210	1.06***	1.60***	133	48***	68***
Dunshen <i>et al.</i> (2001) (Heavy slaughter)	0.26	0.62***	1.050	1.03***	1.26***	95	46***	56***	
Jaros <i>et al.</i> (2005)	n.a.	n.a.	n.a.	42	58	n.a.	n.a.	n.a.	n.a.
Study G104 ¹	7.20	n.a.	1.30***	730	n.a.	120***	66	n.a.	42
Study G105 ²	8.20	n.a.	1.33***	715	n.a.	166***	94	n.a.	36*

Key:

1 Study G104: Pfizer Animal Health, Improvac given at weaning and at 19 weeks of age. Measurements taken four weeks after second vaccination.
 2 Study G105: Pfizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.

Table 3 cont'd. on next page

Serum testosterone levels in vaccinated entire male pigs were compared with un-vaccinated and surgically castrated males (Dunshiea *et al.*, 2001) slaughtered at either 23 or 26 weeks of age. Significantly less testosterone was found in castrated males; the amount detected was less than one-thirtieth of that detected in un-vaccinated entire males. ImprovacTM vaccination suppressed testosterone levels to almost the same degree with no significant difference between the vaccinated entire males and the surgically castrated males. Significant reductions in circulating testosterone were also found in pigs given the first vaccination at weaning (Study G104; Pfizer Animal Health), pigs slaughtered at either 4 or 6 weeks after the second dose (Study G105; Pfizer Animal Health) and in a commercial field study at three locations (Study G106 sites 1-3; Pfizer Animal Health).

Dunshiea *et al.* (2001) recorded significant reductions in the levels of androstenedione in fat from vaccinated entire males to below the accepted threshold of 1,000 ng/g compared with unvaccinated controls, and there were no significant differences between the androstenedione levels found in the vaccinated entire pigs and surgically castrated pigs. This effect on androstenedione was confirmed by Jacobs *et al.* (2005) who measured the level of androstenedione in the salivary glands. A significant reduction of androstenedione in the fat of vaccinated entire males has also been confirmed in field studies (Studies G104, G105 and G106; Pfizer Animal Health) in which comparisons were drawn with un-vaccinated entire males, regardless of whether the first dose was given at weaning, as in study G104, or later. These studies carried out by Dunshiea *et al.* (2001) and Pfizer Animal Health showed that there was also a highly significant reduction in skatole levels in the fat. Tables 4 and 5 show the numbers of pigs in controlled studies that were above and below the accepted thresholds for androstenedione and skatole. Nearly 35 per cent of pigs in the un-vaccinated entire male groups were above the threshold of 1,000 ng/g for androstenedione, with figures ranging from 10 to 59 per cent, depending on the study. A further 24 per cent of entire pigs had androstenedione concentrations between 500 and 1,000 ng/g, leaving only 41.5 per cent below 500 ng/g. Among male pigs vaccinated with ImprovacTM, only one pig was above the 1,000 ng/g limit for androstenedione, giving 99.8 per cent below this figure, and 98.3 per cent were below the lower androstenedione threshold of 500 ng/g. Just over 80 per cent of entire male pigs had concentrations of skatole below the 200 ng/g threshold, with figures ranging from 57 per cent to 100 per cent, depending on the study. In contrast, 97.4 per cent of vaccinated pigs were below the threshold for skatole. No pigs vaccinated with ImprovacTM were identified with high concentrations of both compounds - a situation that represents the highest risk for detectable taint.

Table 3 contd. - Serum testosterone, and androstenedione and skatole levels in the fat of entire male pigs vaccinated against GnRF with ImprovacTM, un-vaccinated entire males and surgically castrated males

Study	Mean serum testosterone (ng/ml)		Mean fat androstenedione (ng/g)		Mean fat skatole (ng/g)	
	Not Vaccinated/Entire	Castrated/Improvac	Not Vaccinated/Entire	Castrated/Improvac	Not Vaccinated/Entire	Castrated/Improvac
Study G105 ³	11.44	n.a.	2.21***	0.11	n.a.	131
Study G106 (site 1) ⁴	19.2	n.a.	0.06***	1.558	n.a.	119
Study G106 (site 2) ⁴	8.7	n.a.	0.87***	4.45	n.a.	120***
Study G106 (site 3) ⁴	7.9	n.a.	0.87***	7.07	n.a.	100***
Study G106 (site 3) ⁴					n.a.	245
Study G106 (site 3) ⁴					n.a.	130***

Key contd. -

3 Study G105: Pfizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, six weeks after second vaccination.

4 Study G106: Pfizer Animal Health, Improvac given at age 15 and 19 weeks. Measurements taken at slaughter, four weeks after second vaccination.

n.a. Not recorded or tested.

*, **, ***, **** Significantly different from un-vaccinated entire male pigs, P<0.05, P<0.01 and P<0.001 respectively.

Table 4 - Percentage and number of entire male pigs vaccinated against CARF with Improvac™, un-vaccinated entire males and surgically castrated males with androstosterone levels above the thresholds of 500 ng/g fat and 1,000 ng/g fat

Study

Study	< 500 ng/g				500-1,000 ng/g				> 1,000 ng/g			
	Per Cent Not Vaccinated	Per Cent Castrated	Per Cent Improvac	Per Cent Entire	Per Cent Not Vaccinated	Per Cent Castrated	Per Cent Improvac	Per Cent Entire	Per Cent Not Vaccinated	Per Cent Castrated	Per Cent Improvac	Per Cent Entire
Dunshie et al (2001) (Light slaughter)	12	47	45	10	0	0	0	0	0	0	0	0
Dunshie et al (2001) (Heavy slaughter)	27	100	100	25	0	0	0	0	0	0	0	0
Jarvis et al (2005)	13	48	46	12	0	0	0	0	0	0	0	0
Study G104 ¹	37	100	99.3	37	0	0	0	0	0	0	0	0
Study G104 ²	14	100	100	37	14	0	0	0	0	0	0	0
Study G105 ²	53	89	89	18	3	n.a.	n.a.	11	2	29	n.a.	5

Key:

1 Study G104: Pfizer Animal Health, Improvac given at weaning and at 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.

2 Study G105: Pfizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.

Table 4 contd. - Percentage and number of entire male pigs vaccinated against CARF with Improvac™, un-vaccinated entire males and surgically castrated males with androstosterone levels above the thresholds of 500 ng/g fat and 1,000 ng/g fat

Study

Study	< 500 ng/g				500-1,000 ng/g				> 1,000 ng/g			
	Per Cent Not Vaccinated	Per Cent Castrated	Per Cent Improvac	Per Cent Entire	Per Cent Not Vaccinated	Per Cent Castrated	Per Cent Improvac	Per Cent Entire	Per Cent Not Vaccinated	Per Cent Castrated	Per Cent Improvac	Per Cent Entire
Study G105 ³	12	18	18	4	20	5	n.a.	20	n.a.	0	n.a.	0
Study G105 (site 1) ⁴	26	98	98	16	2	n.a.	2	n.a.	0	0	n.a.	0
Study G105 (site 2) ⁴	89	98	98	21	2	n.a.	2	n.a.	0	0	n.a.	0
Study G106 (site 2) ⁴	69	98	98	21	2	n.a.	2	n.a.	0	0	n.a.	0
Study G106 (site 3) ⁴	48	100	100	29	0	n.a.	0	n.a.	0	0	n.a.	0
Overall	41.5	100	98.3	24	0	0	1.6	9	0	0	0	0.2

Key contd.

3 Study G105: Pfizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, six weeks after second vaccination.

4 Study G106: Pfizer Animal Health, Improvac given at age 15 and 19 weeks. Measurements taken at slaughter, four weeks after second vaccination.

n.a. not recorded or not tested.

Table 5 - Percentage and number of entire male pigs vaccinated against CRR with Improvac™, un-vaccinated entire males and surgically castrated males with skatole levels above the threshold of 200 ng/g.

Study	Fat Skatole Concentration			
	< 200 ng/g	> 200 ng/g	Per Cent Vaccinated, Castrated, Improved	Per Cent Not Vaccinated, Castrated, Improved
Dunham et al (2001)	84	100	47	18
	(38)	(47)	(47)	(18)
(Light slaughter)	94	100	46	6
	(45)	(46)	(46)	(6)
Dunham et al (2001)	94	100	47	0
	(45)	(46)	(47)	(0)
(Heavy slaughter)	100	100	46	0
	(39)	(46)	(46)	(0)
Pflizer G104 ¹	88	n.a.	n.a.	0
	(15)	(19)	(19)	(0)
Study G105 ²	88	n.a.	n.a.	0
	(39)	(32)	(32)	(0)

Key:
 1 Study G104: Pflizer Animal Health, Improvac given at weaning and at 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.
 2 Study G105: Pflizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, four weeks after second vaccination.

Table 5 contd. - Percentage and number of entire male pigs vaccinated against CRR with Improvac™, un-vaccinated entire males and surgically castrated males with skatole levels above the threshold of 200 ng/g.

Study	Fat Skatole Concentration			
	< 200 ng/g	> 200 ng/g	Per Cent Vaccinated, Castrated, Improved	Per Cent Not Vaccinated, Castrated, Improved
Study G105 ³	90	n.a.	100	0
	(18)	(20)	(20)	(0)
Study G106(a) 1 ⁴	88	n.a.	100	0
	(38)	(49)	(49)	(0)
Study G106(a) 2 ⁴	87	n.a.	92	8
	(26)	(45)	(45)	(4)
Study G106(a) 3 ⁴	82	n.a.	93	7
	(32)	(38)	(38)	(3)
Overall	90.6	100	97.4	2.6
	(253)	(95)	(298)	(8)

Key contd. -
 3 Study G105: Pflizer Animal Health, Improvac given at 15 and 19 weeks of age. Measurements taken at slaughter, six weeks after second vaccination.
 4 Study G106: Pflizer Animal Health, Improvac given at age 15 and 19 weeks. Measurements taken at slaughter, four weeks after second vaccination.
 n.a. not recorded or not tested.

These sensory studies confirm the chemical results that Improvac™ can effectively and consistently eliminate boar taint from meat from entire male pigs.

SAFETY OF IMPROVAC™

Injection Site Reactions

Improvac™ contains an aqueous adjuvant that is non-depot forming and rapidly clears from the injection site. In studies described earlier, carried out under commercial conditions, injection site reactions were closely monitored. Some reactions were detectable but there were no significant differences between groups given Improvac™ or a saline placebo (Dunshea *et al.*, 2001). Occasional abscesses were detected at slaughter in other studies, indicating that the standard advice given for the use of all vaccines on maintenance of hygienic conditions by the operator during administration should be followed (Data on file, Pfizer Animal Health). In the field studies, approximately 90 per cent of pigs had no detectable injection site reactions following either of the two doses, whilst the remaining 10 per cent had small but visible reactions that resolved within 7–10 days. Only two of 400 carcasses required trimming. Clinically, all pigs tolerated vaccination well.

Operator Safety

CnRF is common to all mammalian species, including humans. Therefore accidental injection of both male and female operators is to be avoided. A first accidental injection is unlikely to cause significant systemic effects, but it is likely to act as a priming dose, just as it does in pigs. A second accidental injection could then induce inhibition of testicular or ovarian function. Data from studies with pigs vaccinated with Improvac™ (Mackinnon and Pearce, 2007) and other studies of immunisation cited in this review suggest that the effect is temporary. However, time to recovery would be difficult to predict. For this reason, the following precautions should be taken when using Improvac™ in the field, viz.

1. Operators should use a safety vaccinator.
2. Operators should be fully trained on the correct procedures for handling and restraining pigs and injecting them.
3. Women who may be pregnant should not use Improvac™.
4. In the event of accidental self-injection, immediate medical advice should be sought and the operator should not handle or use Improvac™.

Tissue Residues and Carcass Meat Safety

Improvac™ has no intrinsic hormonal or pharmacological activity and, as would be expected from its protein nature, has no immunological activity when

It should be noted that clinical trial protocols inevitably create some artificiality. Greater attention to detail means that pigs are less likely to escape treatment than in a commercial setting, potentially improving results. Countering this bias, however, is the fact that none of the trials included the on-farm quality assurance procedures that are routinely associated with the commercial use of Improvac™. Re-vaccination is normally recommended for any pig suspected of having an incomplete response to the second vaccination, based on visible assessment of testicle size and observation of male sexual behaviour. In surgical castration groups, cryptorchid pigs are more likely to be identified and removed, eliminating the most common cause of failure to control boar taint with surgical castration.

Sensory Assessment of Meat from Improvac™ Vaccinated Pigs

In addition to chemical assay of androstenone and skatole concentrations, the presence or absence of boar taint can also be assessed in sensory tests, relying on human subjects to detect the taste and/or smell of boar taint in meat. Several of the studies already mentioned included this component. As would be expected, surgical castration effectively eliminated detectable boar taint in the studies carried out by Dunshea *et al.* (2001) and Jara *et al.* (2005) and the results for the pigs vaccinated with Improvac™ compared favourably.

D'Souza *et al.* (2000) reported results of a consumer taste panel assessment of boar odour and flavour of cooked loin steaks from entire males, surgically castrated males and entire males vaccinated with Improvac™, of two genotypes (A = fast growing lean type and B = a type with the propensity for increased fat deposition). The 'taste panel' was balanced for age and gender and ten individuals tasted each sample. From genotype A, the surgical castrates had the most acceptable odour and taste, whilst in genotype B, the immunocastrates were rated most acceptable. In a comparison of the acceptability of odour of meat from vaccinated and un-vaccinated entire males, Hennessy and Walker (2004) found that no samples from the Improvac™ vaccinated group were found to be unacceptable.

In a global assessment of human sensitivity to androstenone (Gilbert and Wysocki, 1987) people of Asian origin were found to be the most sensitive (Table 1). Hennessy and Newbold (2004) found that an Asian group of consumers had fewer bad experiences of undesirable sensory attributes of pork because they tend to source meat only from female carcasses. With this fact in mind, a further study assessing the sensory attributes of cooked loin steaks was carried out in The Philippines (Hennessy *et al.*, 2006) where comparisons were made between meat from female, castrated male and Improvac™ vaccinated entire male pigs. The assessment was made by 122 female and 43 male consumers chosen at random and they found that there were no sensory differences in odour and flavour between the three categories of meat.

given orally. Using the pig as a model for human gastric physiology, repeated oral doses of Improvac™ had no detectable effects. Similar studies in both rats and rabbits using repeated and/or single high oral doses confirmed this inherent safety (safety studies, Pfizer Animal Health). In common with most vaccines, Improvac™ has no withdrawal period in the markets where it is currently approved: there are national licences in Australia, Brazil, Chile, Korea, Mexico, New Zealand, Philippines, South Africa and Switzerland. Under normal circumstances, Improvac™ would be administered at least four weeks prior to slaughter.

SUMMARY ASSESSMENT OF DIFFERENT MEANS TO CONTROL BOAR TAINI

The authors' personal assessment of the potential relative values of the means by which boar taint can be controlled in current commercial circumstances is summarised in Table 6.

Table 6 - Potential relative value and current practicality of some production factors for the control of boar taint in entire male pigs

Reducing Factor	Androstenedione	Skatole
Reduction in stocking density	-	+
Improvement in hygiene	-	++
Lighter slaughter weights (where currently not practised)	+	-
Stable social groups	+	-
Separate sex rearing	++	-
Increased fura levels	-	++
Reduced protein levels	-	+
Feeding wet (weary) feed	-	++
Use of feed antibiotics	-	+
Genetic selection	+++	+++
Different breeds	+++	+
Slaughter detection and sorting	+++	+++
Dilution of tainted meat	++	+
Sexed semen	+	+
Surgical castration	++++	++++
Immunocastration	++++	++++

- No effect
+ Currently low value practical value
++++ Currently high value practical value

There is no demand for pig meat with boar taint. Thus, to preserve current markets or indeed expand them, effective control of taint is a pre-requisite. Manipulation of diet, management factors and adjustment of slaughter weights help to control boar taint, but are not always commercially viable. Genetic selection and developments in semen testing techniques have future potential, but are commercially some way off. The feeding of antibiotics to finishing pigs as a routine is heavily resisted in Europe and would potentially only affect skatole levels anyway. The sorting of carcasses on the basis of androstenedione and skatole is not entirely effective. It is clear that surgical castration is currently the most effective practical method of control, but there are serious welfare concerns about the technique. In Australia, immunocastration has been widely used in commercial pig production since the launch of Improvac™ in 1998, and it is estimated that several million pigs have been routinely and successfully vaccinated against OHRF. The practical considerations of the use of Improvac™ are the subjects of a further review in this volume (Mackinnon and Pearce, 2007).

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IMPROVACTM (PFIZER ANIMAL HEALTH): AN IMMUNOLOGICAL PRODUCT FOR THE CONTROL OF BOAR TAIN IN MALE PIGS

II. PRACTICAL APPLICATION IN PIG PRODUCTION AND POTENTIAL PRODUCTION BENEFITS

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Summary

This review examines the practical application and production benefits of Improvact (Pfizer Animal Health) - an anti-GnRF immunological product containing a GnRF peptide conjugate in an aqueous-based adjuvant. Vaccination of entire male pigs against naturally occurring gonadotrophin releasing factor (GnRF) provides a highly effective and welfare friendly alternative to surgical castration for the control of boar taint, with substantial additional benefits to pig producers. Because vaccination can be timed to occur close to slaughter, the use of this new technology enables the producer to capitalise on the natural growth and carcass characteristics of entire male pigs. Compared with surgically castrated males, pigs managed with Improvact™ utilize feed more efficiently and produce a leaner carcass. The suppression of characteristic peripubertal male behaviour improves terminal, growth performance, enhances welfare, and reduces the risk of injury and compromised carcass quality.

Introduction

Boar taint is potentially the main limiting factor to the marketing of pig meat derived from entire male pigs (Bonneau, 1998). The smell of boar taint can be highly offensive to sensitive individuals. It is caused mainly by the presence of androsteneone, a lipophilic sex steroid produced in the testes (Paterson, 1968) and skatole, a lipophilic indole produced by bacterial metabolism of tryptophane in the intestine (Vold, 1970). Both compounds are volatile and released during heating and cooking. Skatole may be present in carcasses of female pigs and both entire and castrated male pigs, but significant levels of androsteneone are confined to the carcasses of entire males, cryptorchids and intersex pigs with functional testes (Xue and Dial, 1997; Bonnaeu and Squires, 2000). Current approaches to the control of boar taint

have been summarised in an earlier review in this volume (Mackinnon and Pearce, 2007).

Not only is the presence of boar taint in meat a disadvantage when rearing entire male pigs; aggressive and sexual behaviour is an additional problem that can limit growth performance and affect meat quality. Such behaviour is particularly relevant when males are mixed before slaughter because of their stress-related predisposition to the development of dry, firm and dark (DFD) meat (Sather *et al.*, 1995; D'Souza *et al.*, 1999).

The advantages of rearing entire males for slaughter are well known and have been widely reviewed (Walstra and Kroeske, 1968; Xue *et al.*, 1997). When compared with castrated males, entire boars have lower feed intake, better feed efficiency, higher nitrogen retention and produce fewer carcasses with less backfat. When the level of dietary amino acids is not limiting, entire boars will usually grow faster than castrated males. Indeed, the efficiency of entire males was recognised by Sir Anthony Fitzherbert when in 1523 he advocated the cessation of castration (Sir Anthony Fitzherbert, 1470-1538. The Book of Husbandry, believed to be the first published work on agriculture in the English language). However, because of consumer sensitivity to boar taint, surgical castration has been widely practised for centuries, wherever pigs have been reared.

Surgical castration of piglets without anaesthesia is undoubtedly a painful procedure (Taylor *et al.*, 2001), and a serious welfare issue subject to increasing attention as society becomes more concerned about many aspects of livestock production. Recently, the subject of surgical castration has been reviewed (Prunier *et al.*, 2006) and it was concluded that although castration can be legally performed without analgesia or anaesthesia in the first seven days of life, available evidence shows that castration at any age is painful and may have a detrimental influence on health. Few anaesthetics or analgesics are licensed for use in piglets in Europe. Standard methods for general and epidural anaesthesia cannot be applied easily on commercial farms for practical, regulatory and economic reasons, and compliance would be very difficult to police. Although local anaesthesia is relatively straightforward, similar constraints exist. Immunocastration, which achieves castration by active vaccination against naturally occurring gonadotropin releasing factor (GnRF), is an effective alternative to surgical castration.

In Europe it has been recommended that the practice of surgical castration should be reviewed and, if possible, alternative means of controlling secondary male sexual characteristics found (Anon, 1997; Anon, 2001). Vaccination against GnRF is highly effective in suppressing boar taint and aggression, and represents an attractive alternative to surgical castration for the pig industry (Curry and Bonnaeu, 1986; Pávo *et al.*, 1986; Oook *et al.*, 1998; Beckman *et al.*, 1999; McCausley *et al.*, 2000; Dunstons *et al.*, 2001; Metz *et al.*,

2002; Zeng *et al.*, 2001; Zeng *et al.*, 2002; Jarvis *et al.*, 2005). Currently, Improvac[™] is the only anti-GnRH product licenced for immunocastration. Improvac[™] was developed for commercial use in Australia and New Zealand (Dunshiea *et al.*, 2001) where it has been used in more than 4 million finishing boars since 1998. The efficacy of Improvac[™] for suppression of secondary male sex characteristics including boar taint, boar taint was the subject of a previous review in this volume (Mackinnon and Pearce, 2007). This review explores the practical application of Improvac[™] in the pig industry and potential production benefits.

EFFICACY OF IMPROVAC[™] IN COMMERCIAL PIG PRODUCTION

Growth Performance

In their extensive reviews of the literature from the years 1942 to 1995, Walstra and Kroeske (1968) and Xue *et al.* (1997) found that entire males usually grow faster and more efficiently than surgically castrated males due to natural androgen driven growth which is absent in castrated males; and castrated males, in turn, tend to grow faster than females albeit with lower feed efficiency (Henry *et al.*, 1992; Whitmore, 1998; Latorre *et al.*, 2004). There are production advantages to growing entire males compared with castrates, but the occurrence of boar taint in meat and the effects of sexual and aggressive behaviour on growth rate are important disadvantages. It has already been shown (Mackinnon and Pearce, 2007) that Improvac[™] successfully controls boar taint. By reducing sexual behaviour and aggression late in the fattening period, immunocastration with Improvac[™] may improve growth performance. However, if immunocastration is to be acceptable economically, it must allow a rate and efficiency of growth that is at least equal to that of surgically castrated pigs.

In contrast to the comparison between Improvac[™] vaccinated pigs and surgically castrated pigs, any differences between Improvac[™] vaccinated pigs and entire males will arise only during the period between administration of the second dose of Improvac[™] and slaughter. This is because before the second dose of Improvac[™], there is no substantive physiological difference between vaccinated and unvaccinated boars.

Improvac[™] Vaccinated Pigs Compared with Surgically Castrated Pigs

Growth performance data comparing pigs vaccinated with Improvac[™] with surgically castrated pigs are summarised in Table 1. In the Australian studies conducted by Dunshiea *et al.* (2001), only performance during the four-week period following the second dose of Improvac[™] when pigs were transitioning to immune-castrates was examined. These results may therefore reflect residual male activity and possible compensatory effects following the onset of immunocastration. Dunshiea *et al.* (2001) computed results for pigs slaughtered

at 100 kg and 120 kg with surgically castrated pigs. Pigs slaughtered at the heavier weight of around 120 kg - and therefore given Improvac[™] later in the growth cycle - grew significantly faster than castrates during the four weeks prior to slaughter. In pigs slaughtered at 120 kg, average daily feed intake was higher in vaccinated pigs than surgically castrated pigs albeit not significantly, but the feed conversion ratio was significantly lower in vaccinated pigs. Conversely, in pigs slaughtered at 100 kg, average daily feed intake was marginally lower in vaccinated pigs than surgically castrated pigs although not significantly; however, the feed conversion ratio was also significantly lower in vaccinated pigs.

In contrast, a study by Jaros *et al.* (2005) examined performance from 25 kg bodyweight to slaughter and studies by Hennessy *et al.* (2006a, 2006b) considered performance from weaning to slaughter. Thus, the studies by Jaros *et al.* (2005) and Hennessy *et al.* (2006a, 2006b) included a period during which pigs were functional boars before Improvac™ treatment, so results from these studies are more indicative of the total difference in performance likely to be seen in practice. Jaros *et al.* (2005) in Switzerland demonstrated a trend towards better average daily gain in vaccinated pigs, while in Brazil, Hennessy *et al.* (2006b) showed that vaccinated pigs slaughtered at around 108 kg grew significantly faster than castrated males and had significantly improved mean feed efficiency. In Mexico, Hennessy *et al.* (2006a) found no difference in average daily gain but showed a significant reduction in average daily feed intake and, consequently, improved mean feed efficiency in vaccinated males compared with castrated males.

These data confirm that the growth of entire males vaccinated with Improvac™ can outperform the growth of surgically castrated males. The benefit of improved feed conversion efficiency appears to be a consistent finding, with a significant improvement in growth rates only apparent in some studies. This latter finding may be dependent on feeding practices especially in the late fattening period after the onset of immunocastration. An expected corollary of improved feed efficiency is reduced waste output per pig produced. This is an increasingly important environmental consideration.

Improvac™ Vaccinated Pigs Compared with Entire Male Pigs

Growth performance data comparing pigs vaccinated with Improvac with entire male pigs are summarised in Table 2. In the Australian studies conducted by Dunstree *et al.* (2001), only performance during the four-week period following the second dose of Improvac™ when pigs were transitioning to immunocastration was examined. Dunstree *et al.* (2001) found that vaccinated pigs slaughtered at the heavier weight of around 120 kg compared with around 100kg - and thus given Improvac™ later in the growth cycle - grew significantly faster than the un-vaccinated entire pigs. In a multi-centre field study conducted in Australia and New Zealand (Study G106, Pfizer Animal Health) pigs vaccinated with Improvac™ grew faster than entire boars during the four weeks from the time of second vaccination to slaughter: in two of the three sites this difference was statistically significant. In a window of slaughter study in Australia (Study G105, Pfizer Animal Health) using small groups of animals the same trend towards better average daily gain was seen in the groups slaughtered four weeks and six weeks after the second Improvac™ vaccination. These data show that the vaccination of entire males with Improvac™ can enhance growth performance during the late fattening period compared with un-vaccinated entire males; this is thought to be a consequence of the suppression of male sexual behaviour and aggression that follows the second vaccination with Improvac™.

Table 1 - Comparison of growth performance between entire male pigs vaccinated with Improvac™ and surgically castrated males

Study	Approximate Slaughter Weight (kg)	Average Daily Gain (g)		Average Daily Feed Intake (kg)		Feed Conversion Ratio
		Improvac	Surgically Castrated	Improvac	Surgically Castrated	
Dunstree <i>et al.</i> (2001)	98-100	869 [†]	888 [†]	2.91	2.81	3.06*
Dunstree <i>et al.</i> (2001)	117-121	847 [†]	1,119 [†] ***	3.13	3.40	3.10*
Jaros <i>et al.</i> (2005)	100-110	817	827	n.r.	n.r.	n.r.
Hennessy <i>et al.</i> (2006a)	124-138	851	844**	n.r.	n.r.	2.24***
Hennessy <i>et al.</i> (2006b)	n.r.	770	750	1.89	1.74***	2.47
Hennessy <i>et al.</i> (2006b)	n.r.	n.r.	n.r.	n.r.	n.r.	2.28***

† Average daily gain calculated from 2nd Improvac vaccination to slaughter.
 n.r. Not recorded or not tested.
 *, **, *** Significantly different from surgically castrated male pigs, P<0.05, P<0.01 and P<0.001 respectively.

Table 2 - Comparison of growth performance between entire male pigs vaccinated with Improvac™ and un-vaccinated entire males

Study	Approximate slaughter weight (kg)	Average Daily Gain (g)		Average Daily Feed Intake (kg)		Feed Conversion Ratio	
		Un-vaccinated Entire Male	Improved Entire Male	Un-vaccinated Entire Male	Improved Entire Male	Un-vaccinated Entire Male	Improved Entire Male
Dunham <i>et al.</i> (2001)	96-98	786 ¹	868 ¹	2.44	2.81 ^{**}	3.06	3.03
Dunham <i>et al.</i> (2001)	113-121	856 ¹	1,119 ^{***}	2.79	3.40	3.10	3.30
Pfizer G105 (4 weeks) ²	91-93	947 ¹	1,042 ¹	n.r.	n.r.	n.r.	n.r.
Pfizer G105 (8 weeks) ²	98-101	874 ¹	891 ¹	n.r.	n.r.	n.r.	n.r.
Pfizer G106 (SIm 1) ²	103-107	752	917 ^{**}	n.r.	n.r.	n.r.	n.r.
Pfizer G106 (SIm 2) ²	92-92	786	831	n.r.	n.r.	n.r.	n.r.
Pfizer G106 (SIm 3) ²	103-106	776	916 ^{**}	n.r.	n.r.	n.r.	n.r.

74

1 Average daily gain calculated from 2nd Improvac vaccination to slaughter
 2 Weeks between record Improvac vaccination and slaughter
 n.r. Not recorded or not sorted.
 *, **, *** Significantly different from surgically castrated male pigs, P<0.05, P<0.01 and P<0.001 respectively.

Carcass Characteristics

Walstra and Kroeske (1968) and Xue *et al.* (1997) concluded that the lean meat content of entire male carcasses is greater than that of castrates and the back-fat thickness is less. The back-fat thickness of gilts is usually less than that of castrated males (Henry *et al.*, 1992; Ellis *et al.*, 1996; Whitmore, 1998). Data from three previously cited Improvac™ studies in which carcass weight, dressing percentage and back-fat thickness of immunocastrated pigs were compared with surgically castrated pigs are shown in Table 3. Male pigs immunocastrated with Improvac™ had a significantly lower dressing percentage than surgically castrated male pigs slaughtered at 23 and 26 weeks of age (Dunham *et al.*, 2001), and in studies conducted by Dunham *et al.* (2001) and Hennessy *et al.* (2006a), back fat thickness of immunocastrated males was significantly lower than in surgically castrated pigs. Hennessy *et al.* (2006b) described increases in the amount of meat in some commercially important cuts including leg, tenderloin, shoulder, belly and ventral part of the belly in immunocastrated pigs compared with surgically castrated pigs, and in some of these cuts the difference was significant. Jaros *et al.* (2005) and Hennessy *et al.* (2006a) reported that significant increases in the percentage lean meat yield were found in immunocastrated males compared with surgically castrated pigs (54.5 compared with 53.8 per cent and 52.5 compared with 47.9 per cent, respectively).

Table 3 – Comparison of carcass weights, dressing percentages and back-fat thicknesses between entire male pigs vaccinated with Improvac™ and surgically castrated males

Study	Hot Carcass Weight (kg)	Dressing Percentage	Backfat Thickness (mm)
Dunshiea <i>et al.</i> (2001)	77.1	74.4	77.1
Dunshiea <i>et al.</i> (2001)	93.0	82.7	79.3
Dunshiea <i>et al.</i> (2001)	103.8	108.9	n.r.
Hennessy <i>et al.</i> (2006a)	87.5	87.5	n.r.
Hennessy <i>et al.</i> (2006b)	n.r.	n.r.	20.3

n.r. Not recorded or not tested.
 , *, *** Significantly different from surgically castrated male pigs, P<0.05, P<0.01 and P<0.001 respectively.

The Pig Journal – *Referred Section*

Data comparing pigs immunocastrated with Improvac™ with entire males in which carcass weight, dressing percentage and back fat thickness were measured are shown in Table 4. Dunshiea *et al.* (2001) reported that male pigs immunocastrated with Improvac™ had a significantly lower dressing percentage compared with un-vaccinated entire males slaughtered at 26 weeks of age. Pfizer field study G106 (Pfizer Animal Health) reported that average dressing percentage was 1–1.5 per cent lower in immunocastrated males compared with entire males. Dunshiea *et al.* (2001) also reported that in heavy pigs, back fat thickness was significantly higher in immunocastrated males compared with entire males. Likewise, in Pfizer study G106, immunocastrated males had significantly higher back fat than entire males at one site but, at another site, although back fat was higher in immunocastrated pigs compared with entire males it was not significantly so.

Table 4 - Comparisons of carcass weights, dressing percentages and back-fat thicknesses of entire male pigs vaccinated with Improvac™ with un-vaccinated entire and surgically castrated males

Study	Carcass weight (kg)		Dressing percentage (%)		Backfat thickness (mm)	
	Un-vaccinated Entire Male	Improvac Vaccinated Entire Male	Un-vaccinated Entire Male	Improvac Vaccinated Entire Male	Un-vaccinated Entire Male	Improvac Vaccinated Entire Male
Dunster <i>et al.</i> (2001) Light slaughter weight	72.9	74.4	75.8	75.7	11.1	11.9
Dunster <i>et al.</i> (2001) Heavy slaughter weight	89.6	92.7	78.1	78.8 ^{***}	12.6	15.1 ^{***}
Pfizer G105 (4 weeks) Data on file	70.8	88.4	75.8	74.8	10.9	12.0
Pfizer G105 (6 weeks) Data on file	73.6	79.5	76.8	78.7	11.3	11.5
Pfizer G106 (Site 1) Data on file	70.6	73.1	69.2	68.2 ^{**}	10.9	12.6 ^{**}
Pfizer G106 (Site 2) Data on file	72.2	71.2	78.3	77.8	13.0	13.9

*, **, *** Significantly different from surgically castrated male pigs, P<0.05, P<0.01 and P<0.001 respectively.

The authors conclude that the back-fat thickness of male pigs immunocastated with Improvac™ will typically lie between that of un-vaccinated males and castrated males and sows. Figure 1 shows differences in the back-fat thickness between an entire male, a male immunocastated with Improvac™ and a surgically castrated male pig.



Fig. 1 - Thickness of fat over the loin of an entire male (left), an entire male vaccinated with Improvac™ (Pfizer Animal Health) (centre) and a surgically castrated male (right). (Photo courtesy Pfizer Animal Health).

ANTI-GnRF TITRES AND TIMING OF VACCINATION

A primary indicator of vaccination efficacy is demonstration of antibodies against the target antigen. Difficulties encountered with vaccination against endogenous GnRF, such as the need for repeated high doses (Molten *et al.*, 1994), have been overcome with the development of Improvac™. Relatively high titres of antibodies against GnRF (anti-GnRF) in response to immunocastation with Improvac™, measured using non-competitive radioimmunoassay, have been demonstrated in studies conducted by Pfizer Animal Health. Median anti-GnRF titres measured two and four weeks after the second dose of Improvac™ are shown in Table 5. In all groups tested, titres declined by approximately 50-60 per cent in this two-week period. There were no anti-GnRF titres recorded in un-vaccinated controls.

Table 5 – Median titres of antibody against GnRF in 12 groups of entire male pigs two and four weeks after a second booster dose of Improvac™

Study Number	No. of pigs	Median anti-GnRH titres	
		2 Weeks After 2nd Improvac Dose	4 Weeks After 2nd Improvac Dose
Dunshiea <i>et al.</i> (2007). Light slaughter weight.	50	1,208	813
Dunshiea <i>et al.</i> (2007). Heavy slaughter weight.	50	1,126	487
Pfizer G104	50	789	412
Pfizer G108 (Site 1). Data on file.	50	1,029	478
Pfizer G108 (Site 2). Data on file.	50	1,018	495
Pfizer G108 (Site 3). Data on file.	50	1,048	459

In Pfizer study G105 (Pfizer Animal Health), anti-GnRH titres and testosterone were measured one, two, four, six and eight weeks after the administration of the second dose of Improvac™ and, at each interval, twenty pigs were slaughtered. The width of the testes was measured prior to slaughter using engineering callipers. After slaughter, the testes were removed and weighed; the bulbo-urethral glands were dissected out, weighed and measured; and androstosterone and skatole concentrations in sub-cutaneous fat samples determined. The results are shown in Table 6. As the interval between second vaccination and slaughter increased, the median anti-GnRH titre fell. Four weeks after the second dose of Improvac™ and beyond, the number of pigs with testosterone >2nM increased, and there was a concomitant increase in the weight and dimensions of the testes and bulbo-urethral glands. Nevertheless, compared with un-vaccinated controls, the weight and dimensions of the testes and bulbo-urethral glands remained lighter and smaller throughout. Four weeks after the second dose of Improvac™ and beyond, no vaccinated pigs had levels of androstosterone >1,000 ng/g or skatole >200 ng/g in sub-cutaneous fat. These limited data suggest that the optimum timing of the second dose of Improvac™ is likely to be around 4–6 weeks before slaughter. Although androstosterone and skatole levels were still low 8 weeks after the second dose of Improvac™, there was evidence of rising testosterone, suggesting that boar taint more than eight weeks after the second dose of Improvac™ could not be predicted with certainty.

Table 6 – Effect of time interval between a second dose of Improvac™ and slaughter on titre of antibody against GnRF and the weight and dimensions of testes and bulbo-urethral glands (Study C105; Pfizer Animal Health).

Median anti-GnRF titre	1 week		2 weeks		4 weeks		8 weeks		8 weeks	
	Unvaccinated	Improvac	Unvaccinated	Improvac	Unvaccinated	Improvac	Unvaccinated	Improvac	Unvaccinated	Improvac
1135	n.a.	865	n.a.	252–405	n.a.	117–122	n.a.	68	n.a.	n.a.
Percent pigs with serum testosterone concentration > 2nM	20	90	8	71	17	91	34	79	38	89
Mean testes weight (g)	218.8	275	206.9	274.3	157.2	361.1	210.4	449.1	220.9	531.9
Mean testes width (mm)	100.8	108.4	92.6	101.9	85.3	116.6	82.6	120.8	94.1	128.9
Mean bulbo-urethral gland weight (g)	66.1	72.8	49.6	79.1	48.2	117	66.1	120	66.5	176.3
Mean bulbo-urethral gland length (mm)	90.7	92.3	82.4	95.4	81.6	106.8	90.8	114.6	80.2	128.1
Percent pigs with fat androstosterone concentration > 1,000 ng/g	5	15	0	5	0	29	0	20	0	42
Percent pigs fat skatole concentration > 200 ng/g	0	0	26	15	0	12	0	10	0	11

n.a. Not applicable.
Significantly different from surgically castrated male pigs, P<0.05, P<0.01 and P<0.001 respectively.

It has been suggested that vaccination against GnRF should be delayed because early blocking of GnRF does not decrease boar taint in maturity (Zecik *et al.*, 1989), and the advantages conferred by anabolic effects on early male growth should be exercised before suppression of GnRF to control boar taint (Boonnau *et al.*, 1994). The authors conclude from the data reviewed that the impact of ImprovacTM administration would be optimised by giving the second dose 4-6 weeks before slaughter and the first dose at least 4 weeks earlier (Dunstons *et al.*, 2001; Jara *et al.*, 2005).

EFFECT ON BEHAVIOUR AND MEAT QUALITY

Behaviour

The growth potential of entire boars may be compromised by aggressive behaviour or excessive sexual activity expressed in the form of mounting and riding of other pigs which can lead to injury, especially if post-pubertal gilts are present in the same pen. In addition, aggressive behaviour of males prior to slaughter can affect meat quality (Suther *et al.*, 1995; D'Souza *et al.*, 1999). The administration of dietary noreclopics (bromide and tyriophane) has been shown to improve average daily gain and daily feed intake without affecting food conversion ratio in heavy, group-housed boars (McCauley *et al.*, 2004). Immunocastration gave greater control of sexual behaviour and better growth performance than noreclopics, supporting the view that sexually related or aggressive behaviour can limit growth potential. Comparisons of behaviour between entire males immunocastrated with ImprovacTM at age 14 and 18 weeks, un-vaccinated entire males and surgically castrated males suggest that castration reduces undesirable behaviour and increases feeding behaviour and, by 21 weeks of age, the behaviour of immunocastrated pigs is similar to surgical castrates (Cronin *et al.*, 2003).

Fighting induced physical activity in response to aggressive interactions in pigs depletes muscle glycogen which, in turn, can affect muscle pH (D'Souza *et al.*, 1999). Dunstons *et al.* (2001) found that of 30 pigs exhibiting fight lesions prior to slaughter, 26 were un-vaccinated entire males and four were vaccinated with ImprovacTM. Although there were no lesions recorded amongst surgically castrated pigs, there were no statistically significant differences between the immunocastrates and the surgical castrates.

Meat quality

D'Souza *et al.* (2000) and Hennessy and Walker (2004) reported reduced drip loss from carcasses of entire males vaccinated with ImprovacTM compared with female carcasses. Muscle pH at end after slaughter influences the colour and texture of pig meat: dark, firm and dry meat (DFDM) may result when the muscle pH stays above 5.8 after 24 hours, and pale, soft, exudative meat (PSEM) may develop if pH does not fall below 6.0 within 45 minutes of slaughter (Aton,

2004). Although D'Souza *et al.* (2000) found that meat from entire males and females had lower pH than meat from immunocastrated males - possibly due to behavioural differences - all samples tested were below pH 5.8 by 48 hours after slaughter, regardless of sex or immunocastration. Therefore, the use of ImprovacTM does not adversely affect meat quality.

SAFETY AND USE OF IMPROVACTM ON THE FARM

Occasional injection site reactions were detected at slaughter in some of the sows described (Data on file, Pfizer Animal Health). This highlights the need for standard advice to be given on the need to maintain hygienic conditions and proper injection technique. In the field studies reviewed, approximately 90 per cent of pigs had no detectable injection site reactions following either of the two ImprovacTM doses; the remaining 10 per cent had small but visible reactions that resolved within 7-10 days. Only two of 400 carcasses required liming. Clinically, all pigs tolerated vaccination well. The correct method of administering ImprovacTM is shown in Figure 2.



Fig. 2 – ImprovacTM should be administered sub-cutaneously in the neck just behind the ear. The vaccinator should be held perpendicular to the skin on the opposite side of the pig to the operator. (Photo courtesy of Pfizer Animal Health).

Because GnRF is common to all mammalian species, including humans, accidental injection of both male and female operators is to be avoided. A single injection is unlikely to have any untoward effect, but a subsequent injection could cause suppression of sex hormones and regression of sex organs in both males and females. Therefore, precautions should always be taken when using Improvac™. A specifically designed safety vaccinator should be used such as that shown in Figure 2, which is manufactured by N. J. Phillips Pty Ltd, Australia. This example has a spring-loaded retractable safety shield that covers the needle and a dose guard that prevents product injection except when the shield is fully retracted and the needle is fully inserted into the pig. All operators should be fully trained in administering Improvac™.

When used correctly, Improvac™ is highly effective at eliminating boar taint, but it is important that all males receive two doses at least four weeks apart and that the second dose is given at least 4 weeks before slaughter. Careful planning and selection of pigs for vaccination is necessary. Cryptorchid and overtly hermaphrodite pigs should also be vaccinated, since retained testicles will produce androstenedione.

Experience in the commercial use of Improvac™ gained over the last seven years in Australia suggests that the process of vaccination should not be rushed and each pig should be clearly marked as it is injected. Post-vaccination inspections should be conducted 2-3 weeks after the second dose has been given to identify any pigs that may not have received two doses. Continuing sexual behaviour and large, retained testicles are signs that one dose may have been missed. Since inadvertent double doses do not have adverse effects (Data on file, Pfizer Animal Health), it is better to re-vaccinate if it is suspected that either the first or second dose has not been given.

IMPLICATIONS OF IMPROVAC™ USE FOR THE PIG INDUSTRY

Immunocastration offers substantial potential benefits for the pig industry, by improving pig welfare, increasing production efficiency, and guaranteeing high quality meat.

Animal Welfare

Use of Improvac™ obviates the need for painful and stressful surgical castration and eliminates the risk of post-surgical infection, hernias and other complications. It therefore reduces the amount of time that piglets must be handled. In finishing pigs, the suppression of aggressive and sexual male behaviour reduces the incidence of injuries such as skin abrasions and lacerations which result from fighting and mounting.

Acceptability of Pig Meat to Consumers

By consistent elimination of both androstenedione and skatole from pigs vaccinated with Improvac™, meat from entire male pigs can be made entirely acceptable to consumers. It should be noted that surgical castration is not completely effective at controlling boar taint because cryptorchids and inter-sex pigs may not have one or both testes removed. Elimination of taint should remove some of the conditioned resistance to pig meat following unpleasant experience of boar taint. The potential for improved meat quality from vaccinated pigs by reduction of drip loss and DFD meat can further improve the acceptability of pig meat in general.

Acceptability of Carcasses to Meat Processors

Effective vaccination with Improvac™ should produce meat at least as free of boar taint as either surgical castration or slaughter of intact boars at a lower weight. However, it will still be advisable to identify hermaphrodite or cryptorchid pigs on the slaughter line because if, inadvertently, they are not vaccinated they may have androstenedione and skatole in their carcasses. True inter-sex pigs can possess a single testicle in place of an ovary but have female genitalia of normal appearance externally. Such pigs are rare, but they may present a problem in the slaughterhouse.

Less fat will need to be trimmed from carcasses derived from immunocastrated males than from surgically castrated males in markets where surgical castration is routine.

Immunocastration is likely to reduce the incidence of skin damage arising from truck wounds inflicted during fighting. This will, in turn, reduce carcass trimming at slaughter and losses arising from such trimming.

BENEFITS FOR PIG PRODUCERS

Pig producers who currently do not surgically castrate will benefit from being able to take entire male pigs to much heavier slaughter weights than currently practised in many places. This is particularly relevant for the rearing and fattening of heavy pigs destined for the production of processed meat products such as bacon, ham and sausages.

Unlike surgical castration, immunocastration will allow producers to capitalise on the natural anabolic potential of entire males. Increased financial rewards should be obtained in markets where incentives are paid for reduction in carcass fat content when vaccinated entire males are reared instead of surgically castrated males. These benefits can be achieved without making changes to dietary protein. A recent study conducted in the USA (Study 3322E-60-04-305, Pfizer Animal Health) compared the growth performance

and carcass characteristics of surgically castrated pigs with pigs vaccinated with Improvac[™] slaughtered at around 135 kg bodyweight. Both groups of pigs were fed either a low lysine diet (0.95-0.65 per cent) or a high lysine diet (1.15-0.78 per cent) *ad libitum*. There were no significant differences between treatment groups related to diet. This implies that the growth potential of males immunocastrated with Improvac[™] can be realized - and not compromised - without increasing the specification of the diet.

In systems where finishing pigs are not separated by sex, suppression of characteristic male aggression and sexual behaviour will make management of pigs easier and may result in lower numbers of casualty pigs that fall reach the slaughterhouse. It is not uncommon for heavy pigs to sustain limb fractures during bouts of excessive riding and mounting amongst entire males. Suppression of aggressive sexual behaviour has been observed consistently in studies with Improvac[™] and these observations are born out by stockmen who have managed pigs immunocastrated with Improvac[™] (S. Davies, personal communication, 2006). The improved growth performance seen in immunocastrated males after administration of the second dose of Improvac[™] can probably be explained, at least in part, by the suppression of aggressive and sexual behaviour. Stressful interactions during loading and in lairage can lead to further skin damage and trauma and additionally have adverse effects on meat quality. Finally, the chances of pregnancy occurring in post-pubertal gilts penned with entire males should be virtually eliminated.

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— *Høringsvar vedrørende Dyreværnsrådets "Udtalelse om kastration af pattegrise og den dermed forbundne smertefølelse"*

Udtalelsen omhandler de dyrevelfærds-mæssige problemstillinger vedr. kastration med vurdering af, hvorvidt kastration af pattegrise i praksis fortsat er den eneste egnede metode til at undgå ornelugt i svinekød, om indgrebet i så fald bør ledsages af bedøvelse eller smertelindring samt om tidspunktet for indgrebet bør ændres.

Det Jordbrugsvidenskabelige Fakultet (DJF) ved Aarhus Universitet finder, at udtalelsen som helhed giver en god beskrivelse af problemstillingen omkring kastration. Vi kan tilslutte os den langsigtede målsætning om, at kastration bør undgås, så snart en alternativ metode kan sikre, at forbrugerne kan købe svinekød uden risiko for ornelugt. Ligeledes ville det være ønskværdigt at kunne iværksætte midlertidige foranstaltninger for at lindre grisenes smerter, indtil kastration helt kan ophøre.

Vi er dog tvivlende over for, om usikkerhederne omkring dosering, virkningsgrad og bivirkninger af smertelindrende produkter vil kunne være afklaret i tide til at kunne godkende produktet til brug i svinebesætninger pr. 1/1/2010, som er det starttidspunkt, der foreslås i udtalelsen. Vi skal bemærke, at afhængig af indgiftsform kan smertelindringen i sig selv være forbundet med ubehag. Endelig bør et sådant tiltag ledsages af initiativer, der modvirker, at fokus på det langsigtede mål - at undgå kastration - slækkes. Sådanne initiativer kan eksempelvis bestå af opfølgende status og iværksættelse af forskning og udvikling, der sigter mod at undgå kastration

Set i lyset af, at der i de senere år er sket betydelige landvindinger bl.a. i forståelsen af, hvordan man fodringsmæssigt kan påvirke skatol-induceret ornelugt hos hangrise, bør der i denne forbindelse fokuseres på udvikling af teknikker til måling af ornelugtskomponenter på slagtegangen. Sådant udstyr kombineret med videreudvikling af fodringsbaserede og/eller andre metoder til nedsættelse af ornelugtsproblemet burde give mulighed for efterfølgende afbalanceret og differentieret forarbejdning af kødet, hvor kød med ornelugt kan anvendes i produkter, hvor lugten almindeligvis

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ikke kan detekteres. Ud fra en velfærdsmæssig synsvinkel vil denne løsning være at foretrække frem for smertelindring. Som nævnt i udtalelsen kan der dog opstå problemer ved undladelse af kastration på grund af ornegrisesenes øgede tilbøjelighed til aggressiv adfærd. Der bør derfor sideløbende etableres et dansk erfaringsgrundlag vedrørende sådanne produktionsformer.

Vores kommentarer er uddybet nedenfor.

Smertelindring

På det foreliggende grundlag er det vanskeligt at vurdere den konkrete effekt af forslaget om intervention i form af smertebehandling, idet en behandlingsstrategi – det vil sige hvilke midler, der tænkes anvendt, indgiftsform, behandlingshyppighed og deres dosering – ikke fremgår af udtalelsen.

I udtalelsen skriver rådet: 'Det skal endvidere sikres, at indgivelsen af det smertelindrende middel ikke fører til at grisene håndteres flere gange end det i dag er tilfældet'. I de undersøgelser, vi er bekendt med, er behandling med smertestillende middel sket ved injektion 15-20 minutter før selve kastrationen for at sikre, at smertereaktionen i det beskadige væv på langt sigt reduceres, idet det aktive middel skal være fordelt i kropsvævet inden operationen påbegyndes. Andre, mindre lidelsesvoldende indgiftsformer, er ikke umiddelbart realistiske til smågrise, der er yngre end en uge, idet grise i denne alder ikke viser interesse for oral indtagelse af andet end somælk. Indgift gennem somælk kan måske være en mulighed, men indebærer, at soen udsættes for behandling. Metoden vil derfor sandsynligvis indebære forøget håndtering i forhold til det, der er tilfældet i dag. En anden strategi for smertebehandling er at lindre smerten gennem hele perioden, indtil såret er lægt. Hvis dette skal kunne ske uden hyppige håndteringer, vil også dette formodentlig forudsætte, at indgiften kan ske gennem soen og somælk, hvilket måske har bivirkninger for andre velfærdsproblemer i svineproduktionen, f.eks. udvikling af skuldarsår, da indgiften formodentlig også vil nedsætte soens smertefølsomhed. Smertelindring vil således sandsynligvis indebære hyppigere håndtering. Derfor mener vi, at udviklingsarbejdet omkring smertelindring bør vurderes i forhold til lokalbedøvelse.

De smertestillende midler, der forskes i til svin, anvendes også til smertebehandling hos mennesker. Os bekendt er der imidlertid betydelig usikkerhed om dosering og effekter af smertestillede medicin til svin, specielt i den meget unge alder. For visse af de mulige midler har svin en markant højere udskillelsesrate (6-10 gange højere halveringstid i plasma end for eksempel mennesker og kvæg), hvilket gør det svært at overføre erfaringer fra andre dyrearter. På humanside er der for flere produkter veldokumenteret risiko for bivirkninger, hvorfor man ved anvendelse til nyfødte er specielt forsigtig. Midlerne kan forventes at medføre tilsvarende



bivirkninger ved brug til nyfødte grise. Os bekendt er der ingen undersøgelser på svin, der specifikt har fulgt risikoen for disse bivirkninger. Da behandlingen blandt andet sker på et tidspunkt, hvor der er stor risiko for, at grisen skades af soen, såfremt dens vitalitet forringes, er det væsentligt både ud fra et økonomisk og et velfærdsmæssigt synspunkt at undgå disse bivirkninger, hvorfor en væsentlig forskningsindsats må være nødvendig.

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Rent forsøgsteknisk ser vi også problemer, når fastlæggelse af dosis og tidspunkt for indgift skal fastlægges. For eksempel er der kun begrænset viden om svins smertereaktioner, og det er derfor ikke oplagt, hvad der er tilstrækkelig smertelindring, og hvordan det konstateres, om den er opnået. Her er behov for yderligere forskning i svins smertereaktioner.

Et andet forhold, der ikke berøres i udtalelsen, er i hvilken udstrækning, det er muligt at sikre, at besætningerne anvender smertelindring ved kastration. Idet flere sygdomskomplekser i svineproduktionen vurderes at være forbundet med større, og især længerevarende, smerte end kastration, kan den ansvarsbevidste landmand fristes til at anvende den til kastration beregnede smertestillende medicin til dyr med større behov. Et yderligere problem ved dette er, at der her ofte vil være tale om ældre dyr, hvorfor der kan opstå problemer med tilbageholdelsestid i forhold til slagtning. Denne problemstilling bør overvejes og taler desuden for, at problemer omkring smertelindring og behov herfor i svineproduktionen behandles samlet, såvel lovmæssigt som forskningsmæssigt.

Endelig vil der med omkring 15 millioner doser om året ske en betydelig øgning af udledning af midlerne og deres nedbrydningsprodukter. Hvis midlerne tages i anvendelse i svineproduktionen, bør der foretages en vurdering af eventuelle miljømæssige risici.

Frasortering

I afsnit 1 i udtalelsen gennemgås en række tiltag med henblik på at reducere hyppigheden af forekomsten af ornelugt blandt de slagtede grise. Disse tiltag omfatter fodring med brug af cikorie, inddragelse af ornelugt i avlsmålet og nedsættelse af alder ved slagtning. Selvom disse tiltag ikke kan fjerne problemet med ornelugt fuldstændigt, vil de kunne reducere forekomsten til et niveau, hvor kød med ornelugt kan anvendes til forarbejdede kødprodukter, hvor ornelugten ikke generer. Brugen af tiltagene er dog betinget af, at der kan foretages en frasortering af ornelugtsgrise på slagtelinjen.

Ornelugtsproblemet er knyttet til forskellige lugtkomponenter og er ikke 100 procent specifikt for ukastrerede hangrise. Også blandt sogrise og kastrerede hangrise forekommer der afvigende lugt, omend i væsentlig mindre udstrækning end blandt ikke kastrerede hangrise. Oprindeligt blev ornelugten tilskrevet indhold af androstenon, mens det nu er alment



accepteret, at også skatol har mindst ligeså stor betydning for problemets opståen. Populært sagt skyldes ornelugtproblemet, at androstenon og skatol ikke udskilles hurtigt nok fra kroppen. De to stoffer trækker på samme nedbrydningsmekanisme, og når nedbrydningen er begrænset, vil der ske en stigning, både i skatol og androstenon. Skatol produceres væsentligst af bakterier i tarmen, mens produktion af androstenon er tæt knyttet til kønshormonet testosteron.

Problemstillingen kompliceres af, at der er markante forskelle på, hvordan forbrugere reagerer på de forskellige komponenter af ornelugt. For eksempel menes der at være genetiske forskelle hos forbrugere, der giver forskellig reaktion på lugtkomponenterne. Disse markante forskelle menes primært at være knyttet til reaktionen på androstenon. Det er også væsentligt, at kød med ornelugt kan anvendes i visse forarbejdede produkter uden at give anledning til reaktion hos mennesker. Som det nævnes i udtalelsen, er der tidligere udviklet udstyr til sortering ud fra ornelugtsmålinger på slagtelinjen med henblik på at kunne sortere kødet til forskellig anvendelse i den senere forarbejdning. Det nævnes i udtalelsen, at udstyret kun er i stand til at udpege nogle af de grise, der har ornelugt. Dette er korrekt, men er imidlertid et spørgsmål om design af det specifikke udstyr, snarere end et spørgsmål om teknologiske muligheder. I forbindelse med udviklingen af udstyret blev det påvist, at både skatol og androstenon var væsentlige for opfattelsen af ornelugt, men at indholdet af skatol havde den største sammenhæng med ornelugt. Man formodede derfor, at man ved at frasortere grise med højt skatol indhold samtidig undgik forhøjet androstenon. Derfor er det eksisterende udstyr kun baseret på skatol målinger. Det har siden vist sig, at denne sortering ikke var tilstrækkelig til skabe accept blandt aftagerne af kødet.

Der er dog intet, der tyder på, at det ikke skulle være muligt at udvikle tilsvarende udstyr, der kombinerer skatol og androstenon målinger. Teknologien er til stede, og udviklingen i sensorteknologier har væsentligt forbedret mulighederne. Der er også udenlandske udviklingsprojekter i gang med henblik på at udvikle et sådant udstyr.

Der skal dog bemærkes, at der stadig kan være usikkerhed om, hvorvidt yderligere 'ornelugts'-komponenter skal identificeres og benyttes. Derfor kan en nøjere kortlægning af forbrugerreaktioner på lugt-komponenter være påkrævet.

Udviklingen af et sorteringsudstyr, der omfatter flere væsentlige ornelugtskomponenter, vil kunne sikre, at tilstrækkeligt effektive, forebyggende metoder til begrænsning af forekomsten vil kunne anvendes rentabelt, hvis de i tilstrækkeligt omfang nedsætter risikoen for ornelugt og derved overflødiggør kastration ved en mere hensigtsmæssig og differentieret efterbehandling af kødet.

A A R H U S U N I V E R S I T E T



På vegne af Det Jordbrugsvidenskabelige Fakultet

Med venlig hilsen
Susanne Elmholt
Seniorforsker, koordinator for DJF's myndighedsbetjening

**DET
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22.08.08

Hørings svar om kastration uden bedøvelse

Det er forbudt at kastrere dyr uden bedøvelse, men grise er som det eneste dyr undtaget fra reglen og kan kastreres uden forudgående bedøvelse, hvis det sker inden for dyrets 2. til 7. levedøgn. Reglen gælder både for konventionelle og økologiske pattegrise.

Dyreværnslovens § 1 foreskriver: "*Dyr skal behandles forsvarligt og beskyttes bedst muligt mod smerte, lidelse, angst, varigt men og væsentlig ulempe*".

Ca. 13 millioner grise kastreres hvert år for at forhindre, at nogle af dyrene udvikler ornelugt. Lugten findes i kødet fra 5-10 procent af ukastrerede grise, når de bliver kønsmodne i en alder af ca. 6 måneder, det vil sige omkring slagtetidspunktet. Lugten skyldes især lugtstofferne androstenon og skatol. Danske slagterier har udviklet apparatur til at spore ornelugt i grisekød, men har forsømt at videreudvikle metoden.

Flere eksperter og dyrlæger mener, at de omtalte kastrationer er smertevoldende, fordi der skæres i dyr, som er ved fuld bevidsthed, fordi der ved indgrebet trækkes i testiklerne og især fordi der trækkes i sædstrengen, som sidder fast i bughulen. Ifølge Det Jordbrugsvidenskabelige Fakultet (DJF) ses der desuden smerter efter operationen og det ser ud til, at grise er påvirket i op til fem dage efter indgrebet.

Dyreværnsrådet om kastrationerne

Dyreværnsrådet udtalte i juli 2008 om kastration af grise uden bedøvelse:

- Kastration af pattegrise er forbundet med smerte og stress uanset på hvilken måde kastrationen foretages. Rådet mener, at det fremtidige mål bør være at undgå kastration.
- Pt er der ikke alternativer til kastration, skriver Rådet og anbefaler yderligere forskning, så der inden for en kortere årrække kan findes alternativer til kastration.
- Forudgående bedøvelse (lokalbedøvelse eller fuld bedøvelse) er ikke egnet til at forhindre smerte hos grise under kastration, mener Rådet.
- Rådet antager, at efterfølgende smertebehandling kan indføres inden for en kortere periode, og anbefaler, at dette krav indføres fra den 1. januar 2010.
- De personer, der foretager kastration, skal altid gøre det korrekt og så skånsomt som muligt, skriver Rådet.

Rådet mener, at der ikke på nuværende tidspunkt bør foretages andre ændringer i loven end indførelsen af efterfølgende smertebehandling og at spørgsmålet tages op igen om senest 5 år.

Ifølge Rådet kan følgende reducere ornelugt: 1) tidligere slagting (før dyrene bliver kønsmodne), 2) bedre hygiejne i staldene, 3) fodring med planten cikorie, 4) kønssortering af sæd, så der ikke avles hangrise, 5) at grise, som arveligt betinget udvikler ornelugt, ikke

bruges til avl og 6) at standse hangrisenes kønsmodning ved at vaccinere dyrene (er ikke lovligt i EU).

Det Jordbrugsvidenskabelige Fakultet om kastrationerne

DJF skrev om kastration af grise i rapporten "Smerter og lindring heraf under og efter kastration af pattegrise", som blev offentliggjort i juni 2008:

"Kastration af grise gør ondt. Det gør ondt på grisen at blive kastreret og bedøvelse kan kun løse noget af problemet. Det er smertefuldt for grisen at blive kastreret, selvom den kun er få dage gammel.", fastslog seniorforsker Mette S. Herskin, DJF.

DJF skrev blandt andet: *"En meget iørefaldende reaktion på kastration er grisens skrig. Analyser af skrigets frekvenser viser, at der er forskel afhængig af, om grisen bliver skåret i huden eller om sædstrengen bliver hevet ud og skåret over.*

Det kan gøre ondt på grisen, når man hiver i sædstrengen, selvom grisen er lokalbedøvet i testiklerne, fordi sædstrengen sidder fast helt op i bughulen. Det gør i øvrigt også ondt at blive stukket i testiklerne for at blive bedøvet, og det virker ikke 100 procent på alle grise, forklarer Mette Herskin.

Der er også smerter efter operationen. Selvom der kun er få undersøgelser af smerter i perioden efter kastration, er der noget der tyder på, at grise er påvirket i op til fem dage efter. Blandt andet gnubber de med enden, slår med halen og leger mindre".

Alder ser ikke ud til at have indflydelse på smerten. Man mener dog, at der hos de helt små er øget risiko for øget smertefølsomhed efter en operation på grund af ændringer og beskadigelser af nerve-enderne, skrev DJF. Mette Herskin udtalte: *"Nogle af reaktionerne vil formodentlig kunne afhjælpes ved at give grisen et smertebedøvende middel inden operationen og et smertestillende middel efter kastrationen."*

KVL, DJF og DFVF om cikorie

Forskere ved flere forskningsinstitutioner (KVL, DJF og DFVF) oplyste i juni 2005, at rødder fra planten cikorie forbedrer smag og lugt i kød fra ukastrerede grise. Forskerne fandt, at en uges fodring med 10% cikorie af den daglige fodermængde kan reducere dannelsen af skatol. Forskerne påviste desuden, at grise, som blev smittet med svinedystenteri, ikke fik symptomer og ikke udskilte dysenteribakterier i gødningen. Dermed kan der spares på brugen af antibiotika. Forskerne fandt også, at dyrene fik færre sygdomsfremkaldende indvoldsorm, når de fik cikorie i foderet.

Senere forsøg har bekræftet forskningen. Så sent som i juni 2008 offentliggjorde DJF nye, positive resultater fra fodringsforsøg med tørret cikorierod. Rødderne har en gavnlig effekt på tilvæksten hos økologiske smågrise i tiden lige efter fravæningen, viste disse forsøg.

Aktive Dyrerettigheders konklusion og anbefaling

Dyreværnsrådet anbefaler, at grise i modsætning til andre dyr fortsat skal kunne kastreres ved fuld bevidsthed, men med efterfølgende smertebehandling.

Dyreværnslovens § 1 foreskriver, at dyr behandles forsvarligt og beskyttes bedst muligt mod smerte, lidelse, angst og væsentlig ulempe.

Aktive Dyrerettigheder ser følgende muligheder for at undgå kastration uden bedøvelse: 1) kastration ved fuld bedøvelse, 2) fodring med cikorie (cikorie styrker desuden dyrenes sundhed og reducerer medicinforbruget), 3) tidligere slagtning (før kønsmodning) og 4) sporing på slagterierne af kød med ornelugt.

Kastration uden bedøvelse er i modstrid med Dyreværnsloven. Aktive Dyrerettigheder ønsker, at grise får samme rettigheder og samme beskyttelse ifølge Dyreværnsloven som andre dyrearter. Det betyder blandt andet, at hvis grise skal kastreres, skal det ske på samme måde, som andre dyrearter kastreres.

Nogle dyr udvikler en lugt, som generer mennesker. Selvom kastration uden bedøvelse kan undgås, bøjer lovgiverne desværre Dyreværnsloven med en særlov. Aktive Dyrerettigheder henstiller, at gældende lovgivning indrettes på en måde, så særlove og bekendtgørelser ikke er i modstrid med Dyreværnsloven, men bringes i overensstemmelse med Dyreværnslovens ord. Også regler om kastration af dyr. Dyr skal have lige ret for loven.

Med baggrund i ovenstående overvejelser anbefaler Aktive Dyrerettigheder et forbud mod kastration af grise.



Justitsministeriet
Att. Dyrevelfærdskontoret
Slotsholmsgade 10
1216 København K

22. august 2008
POL
Tlf 33 39 42 81
Fax 33 39 41 50
pol@landbrug.dk

Vedr.: Høring over Dyreværnsrådets udtalelse om kastration af pattegrise

Med henvisning til høring over Dyreværnsrådets udtalelse om kastration af pattegrise, jf. henvendelse af 1. juli 2008, sagsnr. 2008-5440-0017, skal Landbrugsrådet hermed på vegne Dansk Svineproduktion, Danske Slagterier, Dansk Landbrug og Landsforeningen af Danske Svineproducenter fremsende følgende bemærkninger.

Vi skal indledningsvis bemærke, at Dyreværnsrådets udtalelse på udmærket vis beskriver problemstillingerne og de mulige løsningsmodeller i forhold til kastration af grise.

Vi er enige i, at det langsigtede mål er, at undgå kastration af grise. Dette kan imidlertid ikke lade sig gøre på kort sigt, og udtalelsen beskriver de fleste af de udfordringer der er, inden det er muligt at stoppe med rutinemæssig kastration. Ud over de i udtalelsen fremførte forhold, så er det også helt afgørende, at der internationalt er accept fra både myndigheder og forbrugere af de metoder, der skal anvendes alternativt til kastration uden forudgående bedøvelse.

Dyreværnsrådet anbefaler afslutningsvis, at der allerede fra den 1. januar 2010 bør indføres et krav om behandling af den smerte og ubehag, som kastrationsindgrebet bevirker. Det anerkendes, at mulighederne for smertebehandling med henblik på lindring af smerterne i perioden efter kastration bør undersøges nøje. I den forbindelse er udfordringen, at der inden ovennævnte skæringsdato dels skal findes en praktisk løsning og dels ske valg og godkendelse af det mest hensigtsmæssige middel hertil. Med henblik på afklaring af de praktiske forhold er Dansk Svineproduktion parat til at iværksætte initiativer med henblik på at finde løsninger inden for den givne tidshorisont. I forhold til godkendelse af middel afhænger muligheden for ikrafttræden til den foreslåede dato endvidere af lægemiddelproducenter og godkendelsesmyndigheder.

Justitsministeriet
Dyrevelfærdskontoret

2008 NR. 5440 - 0017.

Akt.nr. 10

Dyreværnsrådet har afdækket fordele og ulemper ved anvendelse af bedøvelse forud for kastration, og er nået frem til, at det ikke kan anbefales at kastration kun kan foretages med anvendelse af lokal bedøvelse eller fuld bedøvelse. Vi kan fuldt ud støtte konklusionen på baggrund af de fremførte betragtninger.

Dyreværnsrådet peger på, at der under alle omstændigheder er behov for, at kunne identificere hangrise, som udvikler ornelugt. Metoder til identifikation af ornelugt er et helt centralt område, hvor der skal videreudvikles metoder. Der skal formentlig udvikles en ny fælles metode i EU, hvis produkter fra ukastrede hangrise skal kunne afsættes, og dette kræver endvidere, at der sker en ophævelse af det tyske de facto forbud mod kød fra ukastrede hangrise.

Dyreværnsrådet peger på, at der skal fokus på potentielle velfærdsmæssige problemer i besætningerne, hvis kastration undlades. Når dette undersøges nærmere bør det ske med udgangspunkt i de erfaringer, som er i de besætninger, som i en årrække har praktiseret hangriseproduktion.

Endelig peges på, at det skal sikres, at personalet er uddannet og har rutine i kastration af grise indtil vi kommer i en situation, hvor kastration kan undlades. I den forbindelse skal vi gøre opmærksom på, at der i forbindelse med udmøntning af det politisk vedtagne krav om egenkontrol for dyrevelfærd i svinebesætninger er lagt op til, at kastration er et af fokusområderne. Dette bør kunne opfylde behovet for løbende opfølgning af, at der er ajourført erfaring hos personer, som skal kastre grise.

Med venlig hilsen



Per Olsen

Sondrup den 12.08.08

Til Justitsministeriet
Civil- og Politiafdelingen
Dyrevelfærdskontoret
Slotsholmsgade 10
1216 København K

Høringssvar på: Dyreværnsrådets udtalelse om kastration af grise.

På baggrund af den offentlige debat, har justitsministeriet anmodet Dyreværnsrådet om en udtalelse om kastration og dyrenes smerter. Dyreværnsrådet blev bedt om at gennemgå de nyeste forskningsresultater og give en vurdering af, hvorvidt lovgivningen om kastration af grise skal revideres.

Rådet anbefaler, at det fortsat skal være tilladt at kastrere grise med kniv uden bedøvelse. Rådet anbefaler, at der tages skridt til at indføre krav om smertebehandling efter indgrebet med virkning fra 2010.

- Vi er helt uenige i Dyreværnsrådets anbefaling til ministeren. Vi er uenige i Rådets vurdering, at der ikke findes alternativer til kirurgisk indgreb uden bedøvelse. Vi er af den klare opfattelse, at operativ kastration af grise kan og skal forbydes øjeblikkeligt. Vi er opmærksomme på de overgangsvanskeligheder der for branchen er forbundet med et forbud, men fordelene ved et forbud mod kirurgisk kastration overvejer langt ulemperne.

- Anima opfordrer til at lovgiverne øjeblikkeligt ophører med negativ særstilling af dyrene i landbruget. Vi finder det uetisk, at myndighederne ved udarbejdelse af tilladelser og forbud tager udgangspunkt i dyrenes brugsværdi. Vi mener, at alene hensynet til dyret skal bestemme arten og graden af tilladelser og forbud.

Bestemmelser til beskyttelse af dyr i *bekendtgørelse om halekupering og kastration af dyr* undtager grise, blot indgrebet foretages mellem den 2. og 7. levedag. Selv landbruget anerkender dyrenes smerter ved kastration. Hverken forskning eller sund fornuft støtter påstanden om, at kastration er forbundet med mindre smerte hos grise eller at smerten er aftagende med grisens alder sådan at forstå, at jo yngre jo mindre smerte. Alligevel er det tilladt at kastrere pattegrise uden forudgående bedøvelse, hvis det sker så tidligt som muligt inden for dyrets 2. til 7. levedøgn. Hvis kastration foretages efter dette tidspunkt, skal dyret bedøves og gives længerevarende efterfølgende smertebehandling.

- Anima opfordrer til øjeblikkelig forbud mod operativ kastration af grise med mindre kastrationen udføres i behandlingsøjemed, under bedøvelse og med efterfølgende smertebehandling. Den indlysende årsag er de smerter, som kastration påfører dyrene:

'Forskellige smerter

En meget iørefaldende reaktion på kastration er grisens skrig. Analyser af skrigets frekvenser viser, at der er forskel afhængig af, om grisen bliver skåret i huden eller om sædstrengen bliver hevet ud og skåret over.

- Det kan gøre ondt på grisen, når man hiver i sædstrengen, selvom grisen er lokalbedøvet i testiklerne, fordi sædstrengen sidder fast helt op i buhghulen. Det gør i øvrigt også ondt at blive stukket i testiklerne for at blive bedøvet, og det virker ikke 100 procent på alle grise, forklarer Mette Herskin.

Der er også smerter efter operationen. Selvom der kun er få undersøgelser af smerter i perioden efter kastration, er der noget der tyder på, at grise er påvirket i op til fem dage efter. Blandt andet gnubber de med enden, slår med halen og leger mindre.

Ungdom hjælper ikke

Man har tidligere ment, at det er bedst at kastrere grise i en tidlig alder, blandt andet fordi der er en bedre sårheling. Der er dog ikke noget der tyder på, at alder har indflydelse på smerten. Tværtimod mener man, at der hos babyer er øget risiko for øget smertefølsomhed efter en operation på grund af ændringer og beskadigelser af nerve-enderne.

- Nogle af reaktionerne vil formodentlig kunne afhjælpes ved at give grisen et smertebedøvende middel inden operationen og et smertestillende middel efter kastrationen, siger Mette Herskin.

Rapporten "Smertes og lindring heraf under og efter kastration af pattedrise", Intern rapport, DJF Husdyrbrug nr. 9, juni 2008'

Cikorie kan erstatte kirurgisk kastration:

'Både i praksis og i forsøg er det påvist, at tilsætning af cikorie til svinefoder har flere gavnlige egenskaber, eksempelvis færre problemer med farefeber og mavesår hos søer, mindre ornelugt fra slagtesvin, mindre udledning af ammoniak og endda gavnlige effekt over for alvorlige sygdomme som lawsonia og dysenteri.

Cikorierødder indeholder sukkerstoffet inulin. Inulin ændrer tarmfloraen så de bakterier, der danner skatol, holdes ned. Resultaterne fra forsøgene viser, at kun få dages fodring med cikorierødder i tiden umiddelbart inden slagtning kan fjerne ornelugten.

Den ændrede tarmflora bevirker også, at grisene får færre indvoldsorm. Samtidig forebygger cikorierødder forekomsten af dysenteri.'

Lavere slagtevægt

- altså slagtning før grisene begynder at blive kønsmodne med forekomst af androsteron og skatol til følge - kan enten alene eller i kombination med mere hensigtsmæssigt foder og med foder iblandet cikorie erstatte den smertefulde operative kastration.

'For ikke så længe siden afhornede vi (landmænd) kalve uden bedøvelse. Den metode blev der heldigvis sat spørgsmålstegn ved, og i dag forstår vi ikke længere, at vi engang synes, det var helt naturligt. Med smågrisene kan det gå ligesådan. Om nogle år er det måske sat i system, at hangrisene slagtes ved en lavere vægt for at undgå ornelugten.'

Bedre staldmiljø

Nyere forskning har desuden vist, at bedre hygiejne i stalden har en gavnlige virkning på ornelugten. Ved tæt kontakt med fæces øges ornelugten/-smagen i kødet.

Vaccination (kemisk kastration) kan inden længe repræsentere endnu et alternativ til kniven. Med den viden vi har samlet om metoden – i litteraturen og hos producenten – ser vi med forhåbning frem til en EU godkendelse af endnu en mulig vej væk fra de smertefulde kirurgiske indgreb.

EU

Danske landmænd er ikke alene om at blive mødt med krav om at stoppe mishandlingen af grise. I EU er der heldigvis kommet fokus på de smertefulde indgreb og en række lande: Schweiz, Norge, Belgien og Holland har besluttet at stoppe kastration uden bedøvelse.

Anima opfordrer ministeren til at udforme dansk lovgivning om dyrebeskyttelse sådan, at dyrenes velfærd altid prioriteres højere end økonomiske argumenter.

Med venlig hilsen.
Bente Tolley

Ministeriet for Fødevarer, Landbrug og Fiskeri

Fødevarestyrelsen



Justitsministeriet
Dyrevelfærdskontoret
Slotsholmsgade 10
1216 København K.

KONTOR FOR
KEMISK FØDEVARESIKKERHED,
DYREVELFÆRD
OG VETERINÆRE LÆGEMIDLER

Att.: Eddie Khawaja

J.nr.: 2008-20-24-05256/PFJO
15.08.2008

Høringssvar til Dyreværnsrådets udtalelse om kastration af pattegrise

Fødevarestyrelsen har følgende bemærkninger til Dyreværnsrådets udtalelse om kastration af pattegrise:

Helt overordnet er Fødevarestyrelsen enig i, at det bør være målet helt at undgå kastration af pattegrise, da det, uanset hvordan indgrebet gennemføres, ikke kan undgås, at kastration af pattegrise vil være forbundet med smerte og stress for grisen. Der er senest redegjort for dette i en intern rapport fra juni 2008 "Smerte og lindring heraf under og efter kastration af pattegrise" fra Det Jordbrugsvidenskabelige Fakultet, Århus universitet.

Fødevarestyrelsen er enig i, at der ikke på nuværende tidspunkt findes en brugbar metode til at kastre pattegrise uden smerte og stress, som umiddelbart kan implementeres i praksis. Det er behov for yderligere forskning og udvikling på området, og den baggrund støtter Styrelsen at der fra 2010 indføres krav om smertebehandling i forbindelse med kastration af pattegrise.

Med venlig hilsen

Pernille Fraas Johnsen

Modtaget i 15/8-08.
Dyrevelfærdskontoret

Justitsministeriet
Dyrevelfærdskontoret 2008 NR. 5440-0017.

Akt.nr. 13

Eddie Omar Rosenberg Khawaja

Fra: Wieke Huizing Edinger (FVST) [WIHE@fvst.dk]
Sendt: 20. august 2008 09:24
Til: Eddie Omar Rosenberg Khawaja
Cc: Asger Lundorff Jensen (E-mail); 'Carl Kortbæk Svendsen' (E-mail); 'Eiliv Svalastoga (E-mail)' (E-mail); 'Susanne Nautrup Olsen (E-mail)' (E-mail); 'Svend Kargo Jensen (E-mail)' (E-mail); Malene Sthyr (FVST); Lissi Vestergaard Karlsen (FVST); Gunnar Mylius Pedersen (FVST)
Emne: Høring om Dyreværnsrådets udtalelse om kastration af pattegrise

Kære Eddie Khawaja

Det Veterinære Sundhedsråd kan underskrive Dyreværnsrådets udtalelse om kastration af pattegrise.

Rådet er enig med Dyreværnsrådet i, at kastration af grise ER forbundet med smerte og derfor bør afløses af noget andet og bedre. Rådet er også enig i, at de kendte metoder til lokal- eller fuld bedøvelse inden kastration ikke er egnede til at forhindre smerte ved kastration, og at det bedste alternativ ville være helt at undlade kastration. Da sidstnævnte løsning ikke er brugbar i dag, støttes, at der bliver foretaget yderligere forskning på flere alternativer til kastration (kønssortering af sæd, "vaccination" af hangrisene, som det allerede sker i Australien, fodring med fodermidler, der fjerner ornelugten fra kødet, o.a.), hvorefter spørgsmålet skal gendrages senest om 5 år.

Det Veterinære Sundhedsråd er også enig med Dyreværnsrådet i, at der for nuværende ikke er grund til at ændre på kravene til uddannelse af de grisepassere, der står for kastrationerne. Rådet er tryk ved det håndslag og den måde kastrationerne rent teknisk udføres i stort set alle sobesætninger.

Med venlig hilsen

Wieke Huizing Edinger / Juridisk sekretær

-----Oprindelig meddelelse-----

Fra: Wieke Huizing Edinger (FVST) [mailto:WIHE@fvst.dk]
Sendt: 7. juli 2008 09:28
Til: Asger Lundorff Jensen (E-mail); 'Carl Kortbæk Svendsen' (E-mail); 'Eiliv Svalastoga (E-mail)' (E-mail); 'Susanne Nautrup Olsen (E-mail)' (E-mail); 'Svend Kargo Jensen (E-mail)' (E-mail)
Cc: Lissi Vestergaard Karlsen (FVST); Malene Sthyr (FVST); Gunnar Mylius Pedersen (FVST)
Emne: 2008-20-08-00132 Høring over Dyreværnsrådets udtalelse om kastration af pattegrise. FRIST den 15. august

<<DVR-udtalelse om kastration 010708_pdf.PDF>> <<Høringsbrev_pdf.pdf>>

Kære alle

Hermed sendes i høring i Rådet Dyreværnsrådets udtalelse om kastration af pattegrise.

Jeg skal anmode om at modtage Jeres bemærkninger senest den 15. august. Jeg vil derefter - afhængig af længden af Jeres evt. bidrag - udarbejde et fælles høringssvar, som jeg vil sende rundt inden fremsendelse til JM.

Mvh. Wieke

Internal Virus Database is out of date.

Checked by AVG.

Version: 8.0.136 / Virus Database: 270.4.3/1527 - Release Date: 30-06-2008
18:07

Justitsministeriet
Dyreveifærdskontoret

Akt.nr. 15

2008NR. 5440-0017



Justitsministeriet
Att.: Christina A. Gulisano
Slotsholmsgade 10
1216 København K

DOSO
RØRHOLMSVEJ 5
HØSTERKØB
2070 HØRSHOLM
Tlf. 4970 7371
E-mail: doso@doso.dk

18. august 2008

Vedr.: Dyreværnsrådets udtalelse om kastration af pattegrise

DOSO har modtaget henvendelse fra Justitsministeriet af 1. juli 2008 (sagsnr. 2008-5440-0017), hvori man opfordres til at kommentere Dyreværnsrådets udtalelse om kastration af pattegrise. I den forbindelse skal DOSO komme med følgende bemærkninger:

DOSO kan tilslutte sig Dyreværnsrådets synspunkt om, at det fremtidige mål må være, at kastration af pattegrise helt undgås. Vi er også enige i, at det vil tage nogen tid, før alternative løsninger er udviklet. På den anden side mener vi, at man på dette område er så langt fremme, at spørgsmålet skal tages op igen om 3 år - og ikke om 5 år, som Rådet foreslår. I den forbindelse skal det nævnes, at medicinalfirmaet Pfizer er meget langt fremme med en godkendelse af vaccinen Improvac, således at kemisk "kastration" bliver muligt, og dermed forhindrer grisene i at udvikle de frygtede lugt- og smagsdannende stoffer.

DOSO kan ikke acceptere, at det fortsat skal være tilladt at påføre grise smerte gennem et operativt indgreb. Så længe kastration er nødvendigt, skal denne udføres, uden at grisen mærker smerte. Det gælder både under selve indgrebet og i tiden efter. Vi er bekendt med, at dette vil give nogle praktiske problemer, men vi mener, at disse kan reduceres, hvis bedøvelse, smertebehandling og operativt indgreb tilrettelægges optimalt. Således kan lokalbedøvelse (som sker direkte i testiklerne, og som ikke fuldt ud forhindrer smerte ved træk i sædstrengen) helt undgås, hvis man smertebehandler i god tid, inden grisen skal kastreres. Selv om dette betyder, at grisen skal håndteres to gange, er fordelene, at grisen under hele processen slet ikke udsættes for smerte, og at injektionen kan gives i et mindre følsomt område.

DOSO erkender, at der i dag ikke er tilstrækkelig veterinærfaglig viden om optimal smertebehandling og kan derfor tilslutte sig Rådets forslag om, at krav om smertebehandling først indføres 1. januar 2010.

Modtaget i 18/8

Dyrevelfærdskontoret

Justitsministeriet
Dyrevelfærdskontoret

2008 NR. 5440-0017.

Akt.nr. 14



DOSO

RØRHOLMSVEJ 5

HØSTERKØB

2970 HØRSBOLM

TEL: 461970 7371

E-mail: doso@doso.dk

DOSO mener endvidere, at kastration af pattedyr fortsat kun må foretages inden for griseopdræt, og at personen som udfører indgrebet ikke kun skal være uddannet til opgaven, men også har pligt til fortsat at vedligeholde denne kompetence i forbindelse med udvikling af nye og bedre metoder.

Til sidst skal det bemærkes, at WSPA-Danmark støtter denne udtalelse, og at dyreværnsforeningen ANIMA sender sit eget høringssvar.

Med venlig hilsen

DOSO

Peter Møllerup

Formand

22. august 2008

Att.: Cristina A. Gulisano
Justitsministeriet
Dyrevelfærdskontoret
Slotsholmsgade 10
1216 København K

Vedr. høring over Dyreværnsrådets udtalelse om kastration af pattegrise.

Det Dyreetiske Råd har modtaget en henvendelse fra Justitsministeriet af 1. juli 2008 (Sagsnr.: 2008-5440-0017) vedr. høring over Dyreværnsrådets udtalelse om kastration af pattegrise. Rådet anmodes om at komme med bemærkninger til udtalelsen.

Afsnit 1

Det Dyreetiske Råd kan tilslutte sig Dyreværnsrådets indledende betragtning om, at endemålet bør være, at kastration af pattegrise undgås. Det Dyreetiske Råd kan ligeledes tilslutte sig Dyreværnsrådets vurdering af, at det er for tidligt helt at forbyde kastration, men at forskningen i relation til alternative løsninger skal intensiveres, og at spørgsmålet skal tages op igen senest om 5 år.

Afsnit 2.1-2.2

I relation til spørgsmålet om brug af bedøvelse/smertebehandling er Det Dyreetiske Råd enig i, at de skitserede muligheder rummer visse problemer, både i relation til optimal smertedækning og i relation til en række praktiske forhold. Det Dyreetiske Råd finder det dog påvist med rimelig sikkerhed, at brug af fuld narkose eller lokalbedøvelse forud for kastrationen reducerer smertereaktionerne ved indgrebet. Det Dyreetiske Råd er samtidig enig med Dyreværnsrådet i, at det er relevant at behandle grisene for de smerter, der opstår efter indgrebet.

Set alene fra en dyrevelfærdsmæssig synsvinkel finder Det Dyreetiske Råd, at det optimale vil være, at grisene er smertedækket både under og efter kastrationen. Alene ud fra denne betragtning vil Det Dyreetiske Råd foretrække, at der stilles krav om både bedøvelse og smertedækning.

Det Dyreetiske Råd har dog forståelse for, at der kan være store praktiske problemer forbundet med både at skulle smertedække og bedøve grisene; og vil derfor kunne se det som et fornuftig kompromis, at der alene blev stillet krav om en effektiv smertedækning, som muligvis kan tage toppen af de akutte smerter, og som kan beskytte grisene mod smerter efter indgrebet.

Det Dyreetiske Råd stiller dog spørgsmålstegn ved Dyreværnsrådets forestilling om, at "at indgivelsen af det smertelindrende middel ikke fører til, at grisene håndteres flere gange end det i dag er tilfældet". Efter Det Dyreetiske Råds opfattelse, er det nemlig tvivlsomt, om der kan sikres en effektiv smertedækning, med mindre smertebehandlingen foretages *inden* kastrationen.

Så vidt Det Dyreetiske Råd er orienteret, tilsiger principper for god smertedækning, at smertebehandlingen skal iværksættes *inden* smertepåvirkningen for at have den optimale effekt. Det Dyreetiske Råd finder det derfor afgørende, at smertebehandlingen gives, inden kastrationen

foretages, og at den gives tilstrækkelig tid til at virke. Smertebehandlingen vil dermed betyde, at grisene skal håndteres 2 gange, men i modsætning til ved anvendelse af lokalbedøvelse kan midlet til smertebehandling indgives mere skånsomt (enten som blot en enkelt injektion og i et mindre følsomt område, eller via en mundsprøjte). Såfremt smertebehandlingen gives forud for kastrationen, er det endvidere muligt, at denne metode samlet set kunne give en bedre smertedækning, end der kan opnås ved anvendelse af lokalbedøvelse alene, da der formodentlig vil være en smertestillende effekt både under og efter kastrationen.

Det Dyreetiske Råd medgiver Dyreværnsrådet, at der udestår en del veterinærfaglig forskning og udredningsarbejde for at nå frem til en sikker viden om, hvordan grisene smertedækkes optimalt. På baggrund af den eksisterende veterinærfaglige viden er der dog efter Det Dyreetiske Råds opfattelse ingen grund til at udsætte et krav om anvendelse af smertedækning, idet der allerede findes smertestillende midler, der er godkendt til anvendelse på svin (Flunixin og Meloxicam). Ét af disse (Meloxicam) er det tilladt at give oralt (dvs. via munden) hos heste, hunde og katte – en mulighed, der også kan tænkes anvendt på svin. Det Dyreetiske Råd finder derfor, at krav om smertedækning bør stilles, så snart det er muligt i forhold til at få etableret nogle praktisk anvendelige procedurer, og anser 1. januar 2010, som foreslået af Dyreværnsrådet, for at være en rigeligt lang frist.

Det Dyreetiske Råd påpeger videre, at reguleringen af området løbende bør justeres i forhold til udvikling af viden om forebyggelse og lindring af smerter hos grise og i forhold til udviklingen af smertestillende midler og metoder til indgivelse af disse.

Afsnit 2.3

Såfremt kastration foretages, er Det Dyreetiske Råd enig i, at det – af de anførte grunde – er formålstjenligt, at grise i almindelighed kastreres inden for deres 2.-7. levedøgn.

Afsnit 2.4

Det Dyreetiske Råd er endvidere enig i, at det er vigtigt at sikre, at kastrationen udføres så korrekt og skånsomt som muligt, men at det, set i lyset af at disse indgreb må formodes at ophøre inden for en overskuelig årrække, er unødvendigt at skærpe kravene til den relevante uddannelse.

Det Dyreetiske Råd tilslutter sig dog samtidig opfordringen til på anden måde at sikre, at de personer, der udfører kastrationerne, gør det på den mest hensigtsmæssige måde. Det Dyreetiske Råd finder i den forbindelse ikke, at det er tilstrækkeligt at vedligeholde den kompetence, der oprindeligt er opnået, men også at disse personers viden skal opdateres. Såfremt praktiserende dyrlæger, som foreslået af Dyreværnsrådet, skal involveres i dette initiativ, påhviler der dem således et stort ansvar, ikke blot for selv at holde sig ajour med relevant viden, men også for at formidle denne viden videre til de personer, som kommer til at håndtere dyrene i forbindelse med kastrationen.

Endelig vil Det Dyreetiske Råd gerne opfordre til, at der i de videre overvejelser skelnes mellem, hvad der er veterinærfagligt muligt, hvad der samlet set er dyrevelfærdsmæssigt mest hensigtsmæssigt, og hvad der er håndterbart ud fra praktiske og økonomiske synsvinkler. Efter Rådets opfattelse vil en sådan skelnen bidrage til at synliggøre, hvilke muligheder og begrænsninger der er i forhold til at reducere grisenes smerteoplevelse ved kastration eller i forhold til helt at undgå indgrebet.

Med venlig hilsen

Stine B. Christiansen
Faglig sekretær

Justitsministeriet
Civil - og Politiafdelingen
Dyrevelfærdskontoret
Slotholmsgade 10
1216 Kbh. K

22. august 2008

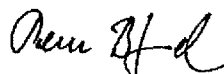
Høring over Dyreværnsrådets udtalelse om kastration

Økologisk Landsforening skal hermed fremsætte sine kommentarer til Dyreværnsrådets udtalelse om kastration af pattegrise, som er modtaget i høring den 1. juli 2008.

Økologisk Landsforening bakker op om Dyreværnsrådets opfattelse, at det fremtidige mål bør være, at kastration af smågrise undgås. Foreningen er samtidig enig i Dyreværnsrådets sammenfatning, at der ikke på nuværende tidspunkt findes alternativer til kastration og at lokalbedøvelse eller fuld bedøvelse på nuværende tidspunkt ikke er egnet med henblik på at forhindre smerte.

Vi opfordrer ligeledes til at forskningen på området intensiveres, således at det overordnede mål om kastration af smågrise kan undgås så hurtigt som muligt.

Venlig hilsen



Peder Bligaard

Konsulent

LEDELSESSEKRETARIATET

ØKOLOGISK LANDSFORENING

Modtaget i 22/8-08.
Dyrevelfærdskontoret

Justitsministeriet
Dyrevelfærdskontoret

20 NR.

Akt.nr. 17

Fra: Johanne Østerbye [mailto:JO@emdrupvej28a.dk]

Sendt: 23. august 2008 16:37

Til: Eddie Omar Rosenberg Khawaja

Cc: Marianne Jensen

Emne: Høring over Dyreværnsrådets udtalelse om kastration af pattegrise - 2008-5440-0017

Emne: Høring over Dyreværnsrådets udtalelse om kastration af pattegrise - 2008-5440-0017

Til:

Justitsministeriet

Att. Eddie Omar Rosenberg Khawaja

Sagsnr. 2008-5440-007

Justitsministeriet har d.1. juli 2008 sendt ovenstående udtalelse til høring.

Den Danske Dyrlægeforening har følgende bemærkninger til det fremsendte materiale:

Det er med stor tilfredshed, at DDD kan konstatere, at der er sammenfald mellem Dyreværnsrådet og foreningens anbefalinger på området.

Med venlig hilsen

Johanne Østerbye/sagsnr. 0801939

cand.med.vet & fagkonsulent

jo@ddd.dk

Mobil: 2943 4084

Den Danske Dyrlægeforening

Emdrupvej 28A, DK-2100 København Ø.

Tlf. 3871 0888 - Fax 3871 0322.

www.ddd.dk - ddd@ddd.dk

Åbningstid: Mandag-torsdag kl. 8:30-16.00, fredag kl. 8.30-15.30

Justitsministeriet
Dyrevelfærdskontoret

Akt.nr. 18

2008 NR. 5440-0017.

Eddie Omar Rosenberg Khawaja

Fra: lillian.christensen@3f.dk på vegne af jll@3f.dk

Sendt: 5. august 2008 08:37

Til: Eddie Omar Rosenberg Khawaja; jll@3f.dk

Emne: VS: Høring over Dyreværnsrådets udtalelse om kastration af pattegrise - 2008-5440-0017

3f har modtaget ovennævnte udtalelse om kastration af pattegrise.

Rådet udtaler at det bør overvejes, om der skal stille skærpede krav til personalet, der skal foretage kastrationen.

I den forbindelse finder 3F det vigtigt at personalet løbende efteruddannes, således at det sikres at kastrationen foretages på den mest skånsomme måde. Ligeledes finder vi, at det skal sikres, at der i den eksisterende landbrugs- og dyrlægeuddannelse indgår, at dyrene skal lide mindst muligt ved kastration.

Venlig hilsen
Jesper Lund-Larsen
Miljø- og Arbejdsmiljøkonsulent



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Justitsministeriet
Dyrevelfærdskontoret

2008 NR. 5440-0017,

Akt.nr. 11

Justitministeriet
Slotsholmsgade 10
1216 København K

15. september 2008
9.2.2.8

Eddie Omar Rosenberg Khawaja

Vedr.: Dyrenes Beskyttelses kommentarer til Dyreværnsrådets udtalelse om kastration af svin

Dyrenes Beskyttelse skal hermed fremkomme med sine kommentarer til Dyreværnsrådets udtalelse om kastration af svin:

Ornelugt og en meget ubehagelig afsmag i kødet er et problem, som forekommer hos 5-10 % af alle ukastrerede hangrise. Ornelugten skyldes først og fremmest duftstoffet skatol, men også androstenon har betydning - især i samspil med skatols lugtforstærkende egenskaber. I starten af 90'erne forsøgte svinebranchen sig med at undlade kastration i det såkaldte "Hangriseprojekt". I stedet sorterede man grise med ornelugt fra på slagteriet ved at måle mængden af skatol i spækket. Et forbud i Tyskland (det største marked for dansk svinekød) mod import af kød sorteret på denne måde betød dog, at produktionsformen blev opgivet. Kødet blev nemlig ikke testet for androstenon, som ifølge tyskerne er vigtigere mht. udvikling af ornelugt. Problemet med ornelugt betyder, at alle danske hangrise i dag rutinemæssigt udsættes for kirurgisk kastration. Det gælder også grise produceret under Dyrenes Beskyttelses mærkekrav.

Kirurgisk kastration foregår traditionelt ved, at grisen fikseres, hvorefter pungen skæres op med en skarp skalpel. Herefter trækkes testiklen ud af pungen, og sædstrengen skæres over. I nogle tilfælde pudres kastrationssåret til slut med et antiseptisk pulver. Sammenlagt varer proceduren under ét minut. Fordelene ved indgrebet er, at kastrerede hangrise ikke udvikler ornelugt, at der udvises mindre aggression og færre slagsmål i slagtesvineflokkene, og at han- og hungrise nemmere kan blandes sammen i grupper. Men der er væsentlige ulemper forbundet med indgrebet.

I henhold til Bekendtgørelse om halekupering og kastration af dyr, må dyr kun kastreres, hvis de bedøves, inden kastrationen foretages. Netop pattegrise må dog kastreres uden forudgående bedøvelse, hvis det sker inden for 2.-7. levedøgn. Foretages kastrationen efter 7. levedøgn, skal grisene bedøves og gives længerevarende smertebehandling. Det er påvist, at kastration foretaget uden bedøvelse er smertefuldt (fx Hay et al., 2003; Moya et al., 2008; Weary et al., 1998). Baggrunden for, at lovgivningen tillader kastration af nyfødte pattegrise uden bedøvelse, er en forestilling om, at nyfødte dyr pga. et uudviklet nervesystem er mindre smertesensitive end ældre dyr. Data fra mennesker og gnavere har dog tydeligt demonstreret, at nyfødte kan føle stor smerte (EFSA Report, 2004), og der er absolut ingen grund til at tro, at det skulle forholde sig anderledes hos grise. Desuden viste et forsøg, hvor grise blev kastreret hhv. 3, 10 og 17 dage efter fødslen, at effekten af kastration var ens ved de tre aldre (Taylor et al., 2001).

Der er foretaget en del undersøgelser af kastration uden bedøvelse, og konklusionerne peger generelt på, at proceduren udgør en et velfærdsmæssigt problem. For eksempel fandt Moya et al. (2008), at kirurgisk kastration fremprovokede specifik smerterelateret adfærd såsom sammenkrybning, krampetrækninger og skælven. Kastrerede grise gik mindre rundt, undgik siddeposition og tilbragte mere tid alene end ikke-kastrerede grise. Der var desuden en tendens til et højere niveau af cortisol hos kastrerede grise. Kastrerede grise oplevede smerte og ubehag i helt op til 4 dage efter indgrebet. I overensstemmelse hermed fandt Hay et al. (2003), at kirurgisk kastrerede grise generelt var mindre aktive, pattede og masserede søens yver mindre, gik mere rundt og udviste mere smerterelateret adfærd end ikke-kastrerede grise. Flere af adfærdsforandringerne varede i mere end 24 timer efter kastration, og nogle var stadig til stede efter 4 dage. Desuden har undersøgelser vist, at de højfrekvente hyl, grise frembringer i forbindelse med kastration, var langt mere intense og varede længere hos grise, der blev kastreret uden bedøvelse, end hos grise, der blev "shamkastreret" (dvs. undergik samme behandling som kastrerede grise uden dog at blive udsat for selve kastrationsindgrebet) (EFSA Report, 2004).

I Norge har kastration af grise uden forudgående bedøvelse været forbudt siden 2002. Indgrebet skal nu foretages af en dyrlæge under bedøvelse. Hvis grisene er ældre end 7 dage, skal der ud over bedøvelse anvendes langtidsvirkende smertebehandling. Ifølge § 10 i den norske forskrift for svinehold skulle et decideret forbud mod kastration af grise være trådt i kraft den 1. januar 2009. Denne er dog ifølge det norske Landbrugs- og Matdepartement for nylig blevet udsat på ubestemt tid (Altinget, 2008). I Sverige gælder der samme regler for kastration af grise som i Danmark (Altinget, 2008). I Schweiz vil kastration af grise uden bedøvelse blive forbudt per 1. januar 2009. I Australien, Storbritannien og Irland benytter man generelt ikke kastration (EFSA Report, 2004). I Holland finder de gældende EU-regler anvendelse. Men alle hollandske led lige fra svineproducenterne, over slagterierne til detailhandlen har underskrevet en erklæring, hvori de meddeler, at de vil stræbe efter at ophøre med kastration af grise i 2015. Desuden må der fra 2009 kun findes kød fra grise kastreret under bedøvelse på det hollandske marked (Eurogroup, 2007). I Belgien har der været en heftig diskussion om emnet kastration. Diskussionen ender formentlig ud med en frivillig aftale i stil med den hollandske.

Ved at bedøve forud for kirurgisk kastration kan den negative effekt på grisenes velfærd reduceres. Der kan i forbindelse med kirurgisk kastration udføres enten generel eller lokal anæstesi. Generel anæstesi er associeret med en dyb søvn, der kan føre til fx manglende indtagelse af føde og ihjellægning. Desuden fører anæstesi ved injektion ikke altid til tilstrækkelig smertereduktion. Alternativt er det i praksis muligt at udføre epidural anæstesi på smågrise, men metoden er meget arbejdskrævende og derfor ikke egnet til et stort antal dyr (EFSA Report, 2004).

Lokal anæstesi er den mest benyttede metode i forsøg, der er designet til at reducere smerte i forbindelse med kastration af grise. Lokalbedøvelser kan injiceres under huden eller i sædstrengen, og man har diskuteret, hvorvidt injektionen også er smertefuld i sig selv. Måling af blodtryk og puls hos kastrerede grise har dog vist, at injektion med lidokain er mindre smertefuldt end selve kastrationsindgrebet, og at injektion reducerer smerten ved kastration (Haga and Ranheim, 2004). I Norge, hvor kastration uden bedøvelse er forbudt, lokalbedøves de nyfødte grise rutinemæssigt i testiklerne med lidokain inden kastration. I en norsk undersøgelse blev der målt en større blodtrykstigning som respons på kastration hos ikke-lokalbedøvede grise end hos grise, der blev injiceret med lidokain forud for kastration. Det indikerer, at kastration efter injektion med lidokain er mindre smertefuldt end kastration uden lokal anæstesi (Ranheim og Haga, 2006). Også Lahmann et al. (2004) har undersøgt konsekvenserne af anæstesi i forbindelse med

kastration. De fandt, at anæstesi betød blot 12 sek. ekstra arbejde per gris. Lahrman et al. (2004) har dog fundet en højere dødelighed inden for 24 timer efter kastration, en højere dødelighed i diegivningsperioden, mere inflammation i kastrationssåret, mere diarré og lavere tilvækst i diegivningsperioden hos grise, der blev bedøvet inden kastration. På trods heraf anbefaler Lahrman et al. (2004) anæstesi af hensyn til dyrevelfærden. Nyborg et al. (2000) fandt i en undersøgelse en større mængde af et specifikt protein, der dannes i bestemte neuroner i rygmarven efter smertefulde stimuli, hos ikke-lokalbedøvede grise i forbindelse med kastration end hos lokalbedøvede grise. Nyborg et al. (2000) registrerede også grisenes adfærd, og på baggrund af observationerne stiller de spørgsmålstegn ved, om det dyreetisk kan retfærdiggøres fortsat at kastrere grise uden lokalbedøvelse. Hvad angår den smerte, grisene oplever efter kastrationsindgrebet, betvivler resultaterne fra en hollandsk undersøgelse, at lidokain skulle have nogen effekt på den smertelaterede adfærd efter kastration (Kluivers-Poodt et al., 2007).

I Norge, hvor det som nævnt er forbudt at kastrere grise uden forudgående bedøvelse, foregår således indgrebet ved assistance af en dyrlæge, som lægger en bedøvelse med et stik i hver testikel. Den mest almindelige metode i Norge er injektion med lidokain, ca. 0,5 ml x 2 (10 mg/ml med adrenalin) kombineret med en intramuskulær NSAID-injektion (meloxicam, flunixin eller ketoprofen), der virker smertestillende. Det er lovkrav i Norge at give en NSAID-injektionen i forbindelse med kastration under bedøvelse -- alligevel undlades det af en del norske dyrlæger (Birgit Ranheim, pers. com.). Der er desuden kun ringe dokumentation hvad angår deres effektivitet, toksicitet og bivirkninger (EFSA Report, 2004). De norske grise gives ingen postoperativ smertebehandling. Birgit Ranheim, forsker på Norges Veterinære Højskole (pers. com.) påpeger, at der er et generelt behov for at undersøge, hvilke lægemidler der har en smertestillende effekt efter kastration, og ved hvilke doser de er effektive.

Med det formål at beskytte såvel personer, der arbejder med svineproduktion, som konsumenter af svinekød er anvendelsen af bedøvelsesmidler under skrap kontrol. I EU-lande samt i Norge må bedøvelse kun foretages af en dyrlæge. Landmanden selv må altså kun udføre selve kastrationsindgrebet. Hvert år kastreres omkring 13 mio. smågrise i Danmark. I en artikel på www.epn.dk den 8. marts 2008 anslås det, at det vil kræve omkring 100 dyrlæger på fuld tid at realisere et krav om bedøvelse og dermed dyrlægeassistance i forbindelse med kastration, og det forekommer således at være helt urealistisk at opfylde i praksis. Det skal dog siges, at den samlede svineproduktion under mærket er ganske lille i sammenligning med den konventionelle produktion. Det kan derfor ikke afvises, at et krav om bedøvelse (og dermed dyrlægeassistance) i forbindelse med kastration af frilands- og økologiske grise kan være en mulighed i praksis.

Bedøvelse af hangrise vha. inhalation af anæstesigasser såsom isofluran, halothan og kuldioxid er blevet undersøgt. Brugen af isofluran og halothan anbefales ikke uden brug af et gasevakueringssystem. Tilsvarende evakueringssystemer er ikke nødvendige ved brug af kuldioxid, hvilket gør gasarten mere egnet til praktisk brug af landmanden selv. Kuldioxid har dog vist sig at være aversivt for svin, og der er observeret ubehag (rastløshed og hyperventilering) ved bedøvelse med kuldioxid. Desuden har kuldioxid ikke megen virkning hvad angår reduktion af den stress, der er forbundet med kastration (EFSA Report, 2004). Et hollandsk studie har vist, at der ved brug af 70 % kuldioxid og 30 % ilt er en meget snæver sikkerhedsmargin både mht. koncentrationen af kuldioxid og det tidsrum, hvori grisene indånder gassen. Metoden skal nødvendigvis være sikker for både grise og mennesker. Det er naturligvis uacceptabelt, hvis metoden anvendes på bekostning af grisenes overlevelse og landmændenes helbred. Den hollandske undersøgelse konkluderer derfor, at der er behov for mere forskning, førend metoden kan anvendes i praksis.

(Kluiwers-Poodt et al., 2007). Den hollandske dyreværnsorganisation De Dierenbescherming oplyser dog, at der i Holland forskes videre på området, og at det forventes, at de første hollandske grise kan blive kastreret under kuldioxidbedøvelse i løbet af sommeren 2008.

Som alternativ til kirurgisk kastration kan man udføre såkaldt immunokastration, hvor hangrisene vaccineres med GnRH (gonadotropin releasing hormone). Vaccinationen gør, at produktionen af det hormon, som sikrer en korrekt dannelse og funktion af testiklerne og produktion af androstenon, undertrykkes. Det fører til hæmmet testikeludvikling og forhindrer dermed udviklingen af ornelugt. Vaccinationen udføres som en dobbeltvaccination med 4-6 ugers mellemrum. Den sidste injektion gives 4-6 uger før slagtning. Jaros et al. (2004) har fundet, at immunokastrerede grise har et højere indhold af androstenon i fedtvævet og en lidt højere hyppighed af ornelugt end kirurgisk kastrerede grise. Niveaueet var dog lavere end EU's grænseværdi, og Jaros et al. (2004) anbefaler derfor immunokastration frem for kirurgisk kastration. Som ekstra gevinst var kødprocenten højere hos immunokastrerede grise. Tilsvarende fandt Hennessy et al. (2006), at hverken immunokastrerede eller kirurgisk kastrerede grise havde et skatol- eller androstenonniveau over den sensoriske tærskelværdi.

Der er en række ulemper forbundet med immunokastration. For det første virker vaccinationsmetoden også på mennesker, og der er en potentiel risiko for, at en medarbejder injicerer sig selv ved det uheld. Derudover indebærer det faktum, at der er tale om en dobbeltvaccination, at grise udsættes for håndtering og stress forbundet hermed ad to omgange. Endelig er behandlingen omkostningsfuld, og godkendte vacciner er ikke pt. tilgængelige på det europæiske marked, men der er søgt om godkendelse af GnRH-vaccinen 'Improvac' i EU. Vaccination med Improvac er siden 1998 blevet benyttet i Australien og New Zealand (Falk, 2003; Eurogroup, 2007; EFSA Report, 2004). Det har vist sig, at immuniseringen ikke er effektiv hos alle grise. Det betyder, at fraværet af ornelugt hos immunokastrater ikke kan garanteres, med mindre procedurens effektivitet måles hos de enkelte individer – fx i forbindelse med slagtning. Problemet er blot, at der ikke findes nogen tilfredsstillende metode til identificering af ornelugt ved slagtning. Det udstyr, der trods alt i dag anvendes på de danske slagterier til identificering af skatol, er stærkt nedslidt. I EFSA rapporten om kastration fra 2004 pointeres det, at immunokastration ikke kan anbefales, indtil andelen af grise, der ikke er modtagelige for immuniseringen, er fastlagt hos alle de primære genotyper, der anvendes i EU. Hvad angår Dyrenes Beskyttelses mærkeordning, harmonerer immunokastration meget dårligt med et ønske om produktion af medicinfrie grise.

Næringsstoffer og fodersammensætning har vist sig at påvirke forekomsten af ornelugt, idet et højt energiindhold øger hastigheden af kønsmodningen hos intakte hangrise. Et højt energiindhold i foderet øger niveauet af både androstenon og skatol. Omvendt sænkes niveauet af skatol i blod og fedtvæv, hvis foderet indeholder mange kulhydrater med en lav fordøjelighed (fx lupiner). Der er dog en stor individvariation mht. effekten af foder på udvikling af ornelugt (EFSA Report, 2004).

Nyere danske undersøgelser tyder på, at ornelugt – og dermed kastration – helt kan undgås, hvis grisene fodres med cikorierod eller lupin. Begge indeholder sukkerstoffet inulin, der dæmper dannelsen af skatol i grisenes tarmflora. Forskere ved DJF og KVL har fundet, at 25 % rå eller tørrede cikorierødder i foderet reducerede indholdet af skatol markant i blod og spæk. Grise fodret med cikorie havde skatolværdier, der ikke afveg signifikant fra nul. Det havde ingen betydning, om grisene blev fodret med cikorie 1, 2, 3, 4, 6, 8 eller 9 uger før slagtning. Allerede efter tre dages fodring var skatolniveauet i blodet stærkt reduceret. Stigende mængder tørret cikorie i

foderet førte til en proportional reduktion i skatolniveauet. Med den rette koncentration i foderet kan skatol i blod og spæk altså tilsyneladende reduceres til det ønskede niveau. 10 % tørret cikorie i fodret i en uge synes at være nok til, at 99 % af alle hangrise, der slagtes ved 100 kg, ikke udvikler ornelugt (Hansen, 2005). Også fodring med lupin har vist sig at kunne mindske forekomsten af ornelugt. I et forsøg, hvor grise blev fodret med 25 % lupiner i 1 eller 2 uger, fandt man en reduktion i skatolniveauet i både blod og spæk (Hansen et al., 2007). Reduktionen var størst efter fodring i 2 uger. Det anbefales dog at anvende maks. 15 % lupiner i foderet, da en højere procentandel forringer produktionsresultaterne (dvs. daglig tilvækst, foderenheder per kg tilvækst og slagtevægt). Overordnet synes fodring med cikorie og lupin således at have et stort potentiale mht. at undgå ornelugt og dermed kastration af hangrise. Dog må man forvente, at der stadig vil være problemer med aggression, opspring osv., hvis intakte grise fodres med cikorie/lupin og slagtes ved en normal slagtevægt.

Undersøgelser har vist, at korrelationen mellem skatol- og androstenonkoncentrationen på den ene side og slagtevægten på den anden er ret lav. Fx viste resultaterne fra en norsk undersøgelse, hvor intakte hangrise blev slagtet ved 53-62 kg, at både skatol- og androstenonniveauet var højere end tærskelværdien (EFSA Report, 2004). Alligevel er det foreslået, at ornelugt kan undgås, hvis ikke-kastrerede hangrise slagtes ved en tidligere alder og lavere vægt - dvs. inden kønsmodning. Hangriseproduktion har, ud over at man undgår det smertefulde kastrationsindgreb, en række produktionsmæssige, kødqualitetsmæssige og miljømæssige fordele. Hangrise har en 12 % bedre foderudnyttelse, en op til 10 % højere daglig tilvækst, en lavere fedtaflejring, en bedre proteinaflejring samt ca. 14 % lavere udskillelse af gyllenitrat per kg produceret kød (Laue, 1994). Af ulemper ved hangriseproduktion kan nævnes aggression og opspring. Fx ser man i England voldsomme kampe mellem intakte hangrise i forbindelse med sammenblanding, under transport og på slagteriet. Opspring kan, især når hangrisene nærmer sig slagtevægt, medføre benskader og andre skader på de grise, der springes på. Det er særligt underlegne individer, der lider under problemer med opspring og aggressivitet.

Hvad angår udviklingen af ornelugt, så tyder undersøgelser på, at hvis ukastrede hangrise holdes i såkaldte "birth to slaughter"-systemer, hvor de opstaldes med deres egne kuldsøskende fra fødsel til slagtning, hæmmes initieringen af hangrisenes kønsmodning, hvorved niveauet af androstenon og evt. skatol reduceres (EFSA Report, 2004). Desuden er det sandsynligt, at kønsopdeling kan mindske udviklingen af ornelugt. Nogle sogrise kommer nemlig i brunst før slagtning, og kønsudviklingen stimuleres muligvis, når hangrisene opstaldes med sogrise i brunst. Kønsvis opstaldning kan derfor tænkes at forsinke hangrisenes kønsudvikling. For at metoden er effektiv, skal der dog formentlig være stor afstand mellem stier med hhv. so- og hangrise.

I relation til den eksisterende viden om hangriseproduktion skal det nævnes, at Dyrenes Beskyttelse fra 2006 til ultimo 2008 deltager i det økologiske forskningsprojekt "Svin, Nye sæsonbaserede svinefødselsprodukter" under innovationsloven. Formålet er at undersøge det kommercielle grundlag for afsætning af sæsongrise med vægt på sporbarhed inden for princippet "fra bonde til kunde". Sæsongrise vil sige, at hangrisene slagtes som små ved 40-60 kg, hvor risikoen for ornelugt er lille, at sogrisene slagtes ved en højere vægt end normalt, og endelig at førstelægssoen tænkes ind i kødproduktionen. Ved sæsongproduktion samles faringerne om foråret. I projektet opstaldes grisene i "birth to slaughter"-systemer (se ovenfor). Kødprodukter fra den lille hangris og den store sogris vil være tilgængelige hhv. sommer og vinter. Opgørelser over projektførelsen i 2007 viste, at der kun blev solgt i alt 20 grise som små hangrise (dvs. ved en vægt på 40-60 kg). Herudover blev 11 hangrise solgt ved 60-70 kg. 5 af disse 11 grise havde udviklet ornelugt, selv

om de blev slutfodret med 20 % lupin. Projektgruppen erfarede i 2007, at en beslutning om at undlade kastration af hangrise indebærer en risiko for store tab, hvis de ikke kan afsættes som ukastrerede hangrise (Tilskudsregnskab 2007).

Sæsongriseproduktion må i høj grad betragtes som en nicheproduktion, idet kødprodukterne ikke er permanent tilgængelige i butikkerne.

Kastration kan også helt undgås ved at anvende kønsorteret sæd, således at der kun produceres hungrise. Kønsorteringen af sæd hos svin og selve insemineringen er dog ikke effektiv nok på nuværende tidspunkt til, at metoden kan implementeres i praksis. Nicolai Nørgaard, direktør i DSP, udtaler i en artikel på www.epn.dk den 8. marts 2008, at DSP er ved at udvikle en ny teknologi til kønsortering af sæd, men at der går to år, inden systemet er færdigudviklet. Desuden er Dyrenes Beskyttelse holdning til kønsortering af sæd som udgangspunkt negativ ud fra en dyreetisk vinkel - både inden for svineproduktion og inden for fx kvægproduktion, hvor aflivning af Jersey-tyrekalve lige efter fødslen kunne undgås ved kønsortering af sæden.

Forskning har påvist en genetisk indvirkning på skatolniveauet hos grise – herunder variationer i fedtvævet skatolniveau hos forskellige racer og tilstedeværelsen af et specifikt gen, der påvirker udviklingen af ornelugt som respons på skatol. Skatol dannes ud fra stoffet tryptofan og er et produkt af bakterieaktiviteten i tyktarmen. Det højeste niveau af skatol i fedtvævet ses typisk hos racerne Meishan og Landrace, mens racerne Yorkshire, Hampshire og Duroc har det laveste niveau. Androstenon dannes i testiklerne ud fra pregnenolon, androgener og østrogener, når hangrisene bliver kønsmodne. Der er dog en meget stor variation mellem hangrise mht. androstenonniveauet i fedtvævet. Som tidligere nævnt har kun en mindre procentandel af intakte hangrise et øget niveau af androstenon i fedtvævet ved slagtevægt. Desuden er der store forskelle mellem forskellige racer mht. androstenonniveauet. Intakte Duroc-hangrise har typisk høje koncentrationer af androstenon. Androstenonniveauet i fedtvævet er i højere grad under genetisk kontrol end skatolniveauet. Derfor vil genetisk selektion formentlig være mere effektiv mht. at sænke androstenonindholdet, mens fodersammensætning vil være mere effektiv mht. at sænke skatolindholdet (EFSA Report, 2004). Der er dog stadig behov for forskning på området.

Problemet med ornelugt kan tænkes løst ved identificering af slagtekroppe med et uacceptabelt højt niveau af ornelugtfremkaldende stoffer. I dag kan man på danske slagterier måle mængden af skatol i spækket vha. en on-line metode (EFSA Report, 2004). På den måde kan kød med ornelugt med rimelig sikkerhed frasorteres. Begrænsningen er dog, at mængden af androstenon ikke måles, og at der kun kan testes 180 prøver per time. Desuden er det anvendte apparatur nedslidt. Hvad angår selve frasorteringen af slagtekroppe, skal man endvidere være opmærksom på, at frasorterede slagtekroppe giver en lavere afregning til landmanden. En nyere metode med en såkaldt "elektronisk næse" (et kemisk sansesystem) vil muligvis i fremtiden kunne bruges til at identificere kød med ornelugt.

Dyrenes Beskyttelse har i den seneste tid været involveret i flg. aktiviteter på kastrationsområdet:

- 1) I 2007 deltog Dyrenes Beskyttelse i en spørgeskemaundersøgelse som led i EU-projektet PIGCAS. Projektet har til formål at indsamle information om relevante interesseorganisationers attitude i forhold til kastration af grise, indsamle information om kastration i praksis, evaluere forskningsarbejde og anden information mhp. at undersøge de forskellige alternativer til kirurgisk kastration uden bedøvelse og endelig at integrere den indsamlede information og evaluering i en rapport til støtte for politiske beslutninger i EU.

- 2) Fra 2006 til ultimo 2008 deltager Dyrenes Beskyttelse i det økologiske forskningsprojekt "Svin, Nye sæsonbaserede svinekødsprodukter" (se beskrivelsen ovenfor).
- 3) Dyrenes Beskyttelse udarbejdede i 2007 en "Aktionsplan for udvikling af svineopdræt på friland". Et af formålene med aktionsplanen er at undgå kastration i frilandsproduktionen og i den økologiske produktion under mærket. I aktionsplanen fremhæves det, at det skal være muligt at producere hangrise med høj kødkvalitet uden at gå på kompromis med dyrevelfærd. Derfor skal der undersøges og afprøves metoder til begrænsning af ornelugt uden brug af kastration.

Med to indslag i DRI-nyhederne hhv. den 12. marts og den 6. april 2008 blev der for alvor sat fokus på kastration af grise i Danmark. På spørgsmålet i indslaget den 12. marts om, hvorvidt kastration uden bedøvelse nu vil stoppe, svarede ministeren ja.

Det er således tvingende nødvendigt, at der overvejes alternativer til kastration uden bedøvelse inden for produktion af svin under mærkeordningen. Det er dog vigtigt, at ophør med kastration ikke indebærer nye problemer med dyrevelfærd eller med landmandens og forbrugernes sikkerhed. Der synes at være to løsninger inden for produktion under mærkeordningen hvad angår problemet med kastration, som kan implementeres uden yderligere forskning og udvikling:

- 1) Kastration under bedøvelse samt efterfølgende smertebehandling (dvs. kastrationsindgrebet accepteres fortsat).
- 2) Slagtning af hangrise inden kønsmodning (dvs. kastrationsindgrebet accepteres ikke).

I relation til produktionen under mærket "Anbefalet af Dyrenes Beskyttelse" er det besluttet at tage følgende initiativer:

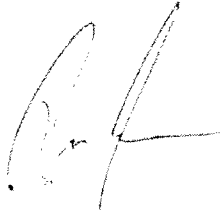
- Dyrenes Beskyttelse udfører i efteråret 2008 et pilotprojekt, som har til formål at belyse, om der udvises mere aggression i flokke af ukastrerede hangrise end i flokke af kastrerede grise.
- Dyrenes Beskyttelse har ansøgt Fonden for Økologisk Landbrug om støtte til et projekt, hvis formål er at kunne anvise produktionsmetoder, som muliggør en dyrevelfærds- og spisekvalitetsmæssig acceptabel hangriseproduktion, således at kastration kan undgås. I projektet skal slagtealderens betydning for dyrevelfærd og risikoen for ornelugt i et sæsonbaseret produktionssystem undersøges. Desuden skal det undersøges, om konsvist opstaldede hangrise har velfærdsproblemer som fx aggression.

Med udgangspunkt i resultaterne i disse initiativer vil der inden udgangen af 2009 taget beslutning om at stoppe om formentlig at stoppe for kastration af svin i produktionen under mærket "Anbefalet af Dyrenes Beskyttelse".

Dyrenes Beskyttelse finder at der senest den 1. januar 2010 skal være et krav om smertebehandling for kastrationen.

Dyrenes Beskyttelse finder, at der foreligger en så stor viden, og der er taget så mange initiativer i andre lande, at der skal indføres et lovkrav allerede nu om, at kastration af svin ophører senest i 2014.

Med venlig hilsen



Per Jensen
Præsident



Ole Münster
Direktor