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# Associations between the dominance status and sexual development, skin lesions or feeding behaviour of intact male pigs

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ABSTRACT

In boars, social relationships could influence pubertal development and feeding behaviour. The objectives of the present study were to determine the relationships between behaviour (agonistic, mounting and feeding behaviours), plasma sex steroids (oestradiol, testosterone) and fat androstenone.

A total of 270 Pietrain x Large White boars, derived from four distinct genotypes were used. They were raised in groups of 11–12 pigs/pen. Animals were observed for about two times 10 h/day at the beginning or about 6 h at the end of fattening. Agonistic (fighting, hitting, biting, threatening, chasing) and sexual (mounting) behaviours were counted in early fattening shortly after a social mixing (for 177 of the 270 animals) and in late fattening after several weeks of social stability. Skin lesions were counted in the same periods and on carcasses. Data obtained from electronic feeders were used to determine the number and duration of meals, and the feed intake over 96-h periods in the middle and at the end of fattening. At the end of fattening, blood was sampled to measure oestradiol and testosterone. At slaughter, fat was collected to measure androstenone. Using the agonistic behaviours, a dominance index was calculated (DRrank).

As expected, numbers of skin lesions and agonistic acts were higher in early fattening ($P < 0.0001$) whereas that of mounting acts was lower in early than in late fattening ($P < 0.05$). The feeding characteristics ($r = 0.25$ to 0.39) were significantly correlated between ages, whereas numbers of mountings ($r = 0.18$), of skin lesions ($r = 0.05$) and agonistic acts ($r = -0.05$) were not. The number of agonistic acts was significantly correlated with that of mountings only in early fattening ($r = 0.38$). At both ages, no difference between dominance groups was observed for feeding characteristics. This was probably related to low competition between boars for access to feed. Dominant boars had a higher concentration of androstenone in fat than subordinates ($P < 0.05$) but no difference was observed for plasma steroids. An active role of androstenone in controlling social behaviour but not reproductive function may explain this phenomenon.



## 1. Introduction

Boar taint still remains a major constraint for the development of intact male pig production. Androstenone (or 5α-androst-16-en-3-one) is one of the two main compounds responsible for this unpleasant odour (Patterson, 1968). Three main factors involved in the regulation of boar taint – age, genetics and nutrition – have been highly studied (reviewed by Zamaratskaia and Squires, 2009). Very few studies have focused on the influence of other factors, for example the social environment, on fat androstenone although such influences can be anticipated from the existing literature. First of all, androstenone is a pheromone implicated in the communication between pigs that not only stimulates sexual behaviour in females (Perry et al., 1980), but may also reduce aggressiveness (McGlone and Morrow, 1988). Moreover, androstenone is an androgen synthetized by the testes that shares numerous common pathways with testosterone (Zamaratskaia and Squires, 2009; Robic et al., 2014) and it is well accepted that androgens, especially testosterone, stimulate aggressive behaviour (Soma et al., 2008). Therefore, a link between androstenone, aggressiveness and

*Abbreviations:* E2, plasma concentration of 17β-oestradiol; TES, plasma concentration of testosterone; AND, fat concentration of androstenone; NSL, number of skin lesions; Nago, mean number of performed agonistic acts per hour; Nsex, mean number of performed mountings per hour; Nmeals, mean number of daily feed intake; Dmeals, mean duration of daily feed intake.

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**Table 1**
Numbers of pens and pigs of the different genotypes according to the batch number.

| | Total number of pigs | | | | | Total number of pens | | | |
|---|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | All | T1 | T2/T3 | T4 | All |
| Batch 1 (October to December) | 11 | 26 | 21 | 35 | 93 | 1 | 4 | 3 | 8 |
| Batch 2 (December to March) | 47 | 0 | 0 | 35 | 82 | 4 | 0 | 3 | 7 |
| Batch 3 (March to May) | 95 | 0 | 0 | 0 | 95 | 8 | 0 | 0 | 8 |
| Total | **153** | **26** | **21** | **70** | **270** | **13** | **4** | **6** | **23** |

dominance can be envisaged. In agreement with this hypothesis, Giersing et al. (2000) have shown a positive relationship between plasma androstenone and the social rank or the aggression level.

In this paper, dominance is defined as the consequence of the relationship between all dyads of animals in the group, by considering all their agonistic interactions (Drews, 1993). Several dominance indexes exist, all of them taking into account only agonistic behaviours. In the present study, it was based on the behaviours of pigs interacting all together in their home pen without modifying their usual resources. Artificial pair contests were not used since it can result in a rank order based on their motivation for the resource to compete which can be different from that occurring in the home-pen day life (Craig, 1986). The index selected involved an analysis of the difference between agonistic acts that are performed and received in all dyads of pigs, and takes also into account the number of pen mates with whom a pig has interacted (adapted from Brouns and Edwards, 1994).

In pigs, social dominance is established 48 h after creating a new social group and is supposed to remain stable afterwards (Meese and Ewbank, 1972). Moreover, once the dominance order is established, signals of dominance between animals are very subtle and difficult to detect (McBride et al., 1964). Therefore, it is difficult to determine the dominance rank in stable groups of pigs. Other more easily measured indicators could be used to estimate a pig's social rank. For example, feeding behaviour could be used since Hoy et al. (2012) have shown a relationship between the dominance order and the characteristics of feeding behaviour. The number of skin lesions could also be used since Turner et al. (2006a) have shown, in post-weaned piglets, a relationship between this criterion and aggressive behaviours which themselves are commonly used for determining social dominance. These two indicators could be used to estimate the social rank of boars and to predict their androstenone concentration.

Results concerning the possible influence of the androstenone concentration achieved in the most odorous male pig in a group on the androstenone concentrations of its pen mates are contradictory. Data from two studies lead to the conclusion of an inhibiting effect (Andresen, 1976; Claus et al., 1994), whereas data from another study lead to the opposite conclusion (Giersing et al., 2000).

The objectives of the present study were to analyse the relationships between the dominance rank, skin lesions, feeding behaviour, agonistic and sexual behaviours, plasma sex hormones, and fat androstenone. In addition, we determined whether the concentration of fat androstenone in the male with the highest concentration showed an association with the androstenone concentration of its pen mates.

## 2. Material and methods

The experiment was conducted according to the French guidelines for animal care and use (http://ethique.ipbs.fr/sdv/charteexpeanimale.pdf; accessed 15 January 2011). Furthermore, the complete experimental procedure was approved by the local ethic committee (Comité Rennais d'Ethique en matière d'Expérimentation Animale) and received the authorization number R-2012-NM-01.

### 2.1. Animals and management

A total of 270 crossbred Pietrain x Large White boars of four genotypes, issued from three distinct Pietrain type sire lines and two distinct Large White type maternal lines (T1, n = 153; T2, n = 26; T3, n = 21; and T4, n = 70), were raised under the same conditions from 35.6 ± 5.1 days of age; 9.5 ± 2.3 kg (mean ± SD) until slaughter (163.3 ± 9.9 days of age; 110.1 ± 5.7 kg) in a testing station (Le Rheu, France). Genotypes were chosen to represent sire and maternal lines that are commonly used in France. Pigs of different genotypes were raised in separate pens, except genotypes T2 and T3. Animals were raised in three successive batches (Table 1). Groups of 5 or 6 piglets were constituted at weaning. When entering the fattening unit (68.9 ± 3.7 days of age; 29.9 ± 5.1 kg), pigs from two different post-weaning pens were grouped together in pens containing 11 or 12 pigs. Those pens measured 12 $m^2$ and had mixed flooring (half solid, half slatted). The mean room temperature was 22 °C. Natural light was available, supplemented with artificial light between 08:00 h and 16:00 h during the week, and for animal care during the weekend. Animals had free access to water and were fed ad libitum at an electronic single-space feeder (ESF), except from 15:00 h onwards on the day before slaughter. Pellets were of standard composition (NE = 9.5 MJ/kg, total nitrogenous matter = 163 g/kg, digestible lysine content = 0.94 g/MJ NE, and digestible tryptophan content = 1.7 g/kg). Boars from the same batch were slaughtered in a commercial slaughterhouse during five successive weeks. Each slaughter batch was composed, on average, of 39 boars (between 32 and 63). Boars for slaughtering were selected at a fixed liveweight of 110 kg, regardless their genotype. Animals were transferred directly from their home pen to the truck without waiting in a lairage area. However, during transport and at lairage in the slaughterhouse, boars from different pens were grouped together, which can cause aggression between boars. The total mean duration between departure from the farm and slaughter was 171 min (between 85 and 240 min), with about 20 min of transport and 150 min of lairage in the slaughterhouse.

### 2.2. Measurements

Pigs were weighed upon entering the fattening building and before departing for the slaughterhouse which enabled calculation of the average daily gain (ADG) over this period.

#### 2.2.1. Pubertal development and boar taint

A blood sample was collected in an EDTA tube from the external jugular vein, between 09:30 h and 11:00 h, 9.3 ± 4.0 days before slaughter for the analysis of sex hormones (TES: testosterone and E2: 17β-oestradiol). A piece of backfat was sampled in the neck region (between cervical and first dorsal ribs) from the carcass for the analysis of androstenone. This piece (about 7 × 5 cm in surface and 1–2.5 cm in depth including the skin) was trimmed from skin and muscle before analysis. The treatment and analysis of blood and fat samples were identical to those described in Parois et al. (2015). Measures were performed in 261, 263 and 258 boars, respectively for oestradiol, testosterone and androstenone. Concentrations of boar taint compounds were expressed per gram of liquid fat. The