Chicory in boar feed: effect on boar taint and meat quality

Aluwé M., Millet S., Langendries K.C.M, Bekaert K.M., Tuyttens F.A.M, De Brabander D.L.

Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences Unit, Merelbeke, Belgium

Abstract— **In this experiment, we have investigated whether supplementing boar feed with chicory pulp and dried chicory root affects both the prevalence of boar taint and the meat quality.**

A group of 100 boars (hybrid sow x Pietrain boar) was divided between 2 treatments. During the last ten days before slaughter, half of the pens received a standard diet (CONTROL, n = 53) and the other half of the pens received a mixture of 90% standard diet and 5% chicory pulp (±7% inulin) + 5% dried chicory root ('Fibrofos 60', min. 60% inulin) (TEST, n = 47). At slaughter, a neck fat sample was collected from each animal to determine skatole, indole and androstenone concentration. Boar taint was also assessed using the hot iron method. On the day after slaughter, loin samples were collected from each boar to evaluate ultimate pH, meat colour, drip loss and cooking loss.

Chicory supplementation lowered the skatole concentration in the fat (12±11 vs 36±78 ppb, P < 0.001), and increased the indole concentration (58±69 vs 36±61 ppb, P = 0.001). Androstenone concentration was not affected (965±988 vs 856±786 ppb, P = 0.803). Boar taint assessment using the hot iron method revealed no differences between both groups. Ultimate pH was higher in the boars receiving chicory (5.6±0.1 vs 5.4±0.1, P = < 0.001). The CIELAB colour determinants and cooking loss did not differ between treatments (P > 0.1). Drip loss was significantly higher for the boars receiving chicory compared to the CONTROL boars (P < 0.001).

In the present study, the addition of 5% dried chicory pulp and 5% dried chicory roots decreased the neck fat skatole concentration, without greatly influencing meat quality.

Keywords— **Entire male pigs, boar taint, chicory**

I. INTRODUCTION

Boar taint, an unpleasant odour released by heating the meat of intact boars, is caused by skatole and androstenone and somewhat by indole. Various management strategies are currently being investigated to reduce boar taint in entire male pigs. Efforts to reduce skatole focus mainly on feeding strategies. Several feed components, e.g., raw potato starch, sugar beet pulp and lupines, have been tested in varying concentrations from one to several weeks before slaughter. Literature also indicates reduced incidence of boar taint when boars are fed either crude/dried chicory roots or pure inulin from chicory. Byrne [1] suggests that sesquiterpene lactones (bitter compounds) also reduce skatole but to a lesser extent than inulin. In a previous study we found that supplementing feed with 5% feed grade inulin (or 3.3% pure inulin) did not significantly reduce skatole concentrations [2]. Hansen et al. [3] found that including 14% inulin or 25% crude/dried chicory reduced boar taint. Nielsen et al [4] found that 10% dried chicory root reduced boar taint. Kjos et al. [5] compared the effect of including 3, 6 and 9% of chicory inulin on skatole reduction. Their results show that optimal skatole reduction resulted from adding 6% chicory inulin (or 4.2% pure inulin) during the last 4 weeks before slaughter. Zammerini et al. [6] evaluated the effect of 0, 3, 6 and 9% inclusion of dried chicory roots during 1 or 2 weeks on skatole reduction. Only the addition of 9% (±5,4% inulin) during 2 weeks before slaughter was effective to reduce boar taint below 200 ppb. Price competitiveness calls for the lowest effective supplementation levels. Dried chicory roots are also less costly than pure inulin.

Rosenvold et al. [7] fed gilts a diet with high inulin content and rapeseed meal and animal fat for 4 weeks before slaughter. This resulted in lower drip loss and darker but less tender meat as compared with gilts on a control diet. pH_{24} and cooking loss were not affected. The researchers assumed that the reduced tenderness was probably due to the reduced muscle glycogen stores arising from feed containing a low level of digestible carbohydrate and high level of fermentable carbohydrate. In general, boars have darker, less

tender and less juicy meat than barrows [8]. We therefore investigated whether chicory supplementation also affects boar meat in these ways.

The aim of this experiment was to investigate the effect on boar taint of supplementing feed with 5% dried chicory pulp (±7% inulin) and 5% dried chicory roots (min. 60% inulin) and to evaluate whether 10 days of chicory-supplemented feed affects the resulting meat pH_{48}, colour, drip loss, and cooking loss.

II. MATERIALS & METHODS

On a commercial farm, a group of 100 boars (hybrid sow x Pietrain boar) was divided between 2 treatment groups at an age of 10 weeks. Pigs were group housed, with 13 animals per pen. All pigs began on the same diet. Starting at 10 days before slaughter, 53 boars received a standard diet and 47 boars received a mixture of 90% standard diet (CONTROL) and 5% dried chicory pulp (1 mm) + 5% 'Fibrofos 60' (TEST).

Fibrofos 60 (SOCODE, Warcoing, BE) is a chicory root dried at a low temperature and reduced to a powder (±1 mm) with an anti-caking agent added. Minimum inulin level is 60% of dry matter. Chicory pulp is obtained after extraction of inulin by diffusing the chicory root shreds. The chicory pulp is dehydrated at low temperature (max. 70°C). The average inulin level of the dried chicory pulp is 7%. Nutrient levels of the CONTROL diet, the TEST diet, 'Fibrofos 60' and the chicory pulp are given in Table 1.

The pigs had free access to water at all time. Pigs were fasted for 24 hours before slaughter (exsanguination after electric stunning). Carcass weight and meat percentage (PG600) was determined at the slaughter line.

A neck fat sample was collected from each animal to determine skatole, indole (GC-MS) and androstenone (HPLC-UV) concentration (Labo CCL-ter Veghel). Boar taint was assessed using the hot iron method (upon heating neck fat with a hot iron, an expert evaluates the odour on a scale from 0 to 4).

Longissimus thoracis et lumborum samples with backfat layer were taken at the slaughterhouse 24 hours after slaughter, vacuum packed and stored under refrigeration until performing the meat quality analysis. The samples were trimmed of visible fat and cut into slices of 2.5 cm. pH_{48} was measured on two freshly cut meat samples per animal at least 48 hours after slaughter. CIELAB colour determinants (L^*, a^*, b^*) were measured using a HunterLab miniscan (45/0 geometry) on two meat samples per animal after 15 minutes of blooming. Average pH_{48} and CIELAB colour determinants were used for further statistical analysis. Drip loss was determined on meat samples of about 150 g. Samples were hung by a nylon cord in a plastic bag for 24h. The percentage of drip loss is calculated as follows. After wiping the sample dry, the difference in weight of the meat sample before cooking and cooling and again afterward was divided by the sample weight x 100. To measure cooking loss, meat cuts (2.5 cm) were boiled in a closed plastic bag in a hot water bath of 75°C during 50 minutes then cooled by placing the bagged sample in a cold tap water bath for 40 minutes. Cooking loss (%) is defined as the difference in weight of the meat sample (after wiping dry) before cooking and cooling and again afterward, divided by the sample weight x 100.

Statistical analysis was performed with STATISTICA 9 (Statsoft, Tulsa, USA). Treatment effect was tested with an independent t-test (significance level $p < 0.05$. Boar taint compounds were log transformed to ensure a normal distribution.

Table 1 Nutrient levels of the control diet, the test diet, Fibrofos and chicory pulp

	CONTROL	TEST	FIBROFOS 60	Chicory pulp
Nutrients (g/kg)				
Dry matter	879.6	886.3	931.1	887.2
ADF	57.7	59.4	53.4	245.6
ADLignine	9.0	5.8	0.0	11.7
NDF	164.8	155.7	58.6	267.9
Crude protein	145.7	142.8	50.2	65.9
Crude fat	51.2	50.1	5.0	14.3
Crude ash	43.9	46.3	47.9	54.0
Crude fibre	51.7	47.6	39.3	186.3
Sugars	49.7	83.0	574.0	156.0
Starch	400.6	330.3	86.3	36.1

III. RESULTS AND DISCUSSION

Mean carcass weight was 89.9±9.1 kg for the CONTROL group and 93.0±11.2 kg for the TEST group ($P > 0.1$). Meat percentage was not influenced by the feed treatment, with 60.3±1.8% for the CONTROL group and 60.8±2.7% for the TEST group ($P > 0.1$).

The addition of 5% chicory pulp and 5% 'Fibrofos 60' decreased the level of skatole from 36±78 ppb to 12±11 ppb ($P < 0.001$). However, the indole level increased from 36±61 ppb to 58±69 ppb ($P = 0.001$). As expected, no effects were found on the level of androstenone ($P = 0.803$), with a mean level of 856±786 ppb for the CONTROL group and 965±988 ppb for the TEST group (Fig. 1). The sensory boar taint assessment using the hot iron method did not indicate differences between the two groups (1.3±1.5, $P > 0.10$). In this study, skatole levels were rather low. Also in our previous experiments, we found more boars that deviated for androstenone compared to skatole [9].

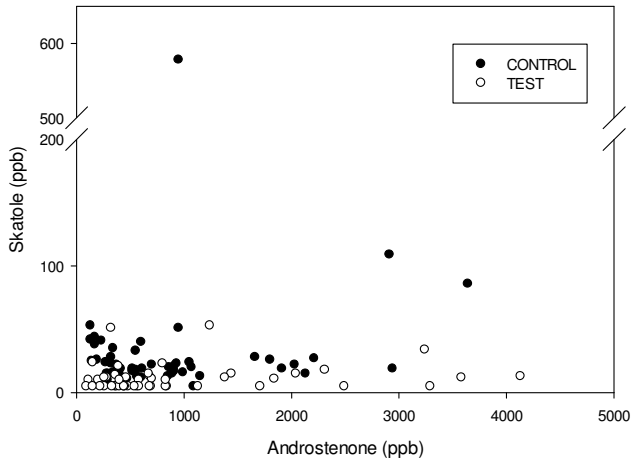

Fig. 1 Skatole and androstenone levels (ppb) of CONTROL and TEST boars

Xu et al. [10] found that adding fructooligosaccharides to the diet stimulates the bacterial conversion of tryptophan to indole at the expense of skatole. Similar effects were found with fermented liquid feed. However, Hansen et al. [3] found different results when feeding chicory: the plasma indole level was reduced within a few days after chicory was included in the diet. After a feeding period of 6 weeks this reduction was no longer observed.

Ultimate pH and drip loss were higher in the boars fed chicory ($P < 0.001$). CIELAB colour determinants and cooking loss did not differ between groups ($P > 0.1$) (Table 2). The increase in drip loss as a measure of water holding capacity does not agree with Rosenvold et al. [7]. The reason for this discrepancy is unclear. However, as juiciness is more correlated with cooking loss ($r = -0.50$) than drip loss ($r = -0.09$) [11], the effect of inclusion of chicory on juiciness may be rather limited.

Table 2 Mean ± st.dev. of pH48 and CIELAB colour determinants (*L*, a*, b**), cooking loss and drip loss for the CONTROL and the TEST group

	CONTROL	TEST	P-value
Number of animals	53	47	
pH48	5.4±0.1	5.6±0.1	***<0.001***
*L**	57.2±3.2	56.7±3.4	0.499
*a**	8.9±1.3	8.8±1.1	0.744
*b**	16.8±0.9	16.6±0.8	0.230
Drip loss (%)	3.8±1.3	4.8±1.5	***<0.001***
Cooking loss (%)	29.8±2.8	30.0±2.3	0.727

CONTROL: Control diet; TEST: control diet with 5% chicory pulp and 5% 'FIBROFOS 60'; pH48: pH at least 48 hours after slaughter; *L**: Luminosity, *a**: redness, *b**: yellowness

At an average daily feed intake of 2.6 kg per day during the last 10 days before slaughter (unpublished results), the extra cost of including 9% chicory roots would be about 0.15 €/d. When 4.5% feed-grade inulin is included, the extra cost would be 0.19 €/d. Inclusion of 5% chicory pulp + 5% chicory roots may be more cost-effective (0.09€/d).

IV. CONCLUSIONS

In the present study, inclusion of 5% dried chicory pulp (±7% inulin) and 5% dried chicory root (min. 60% inulin) decreased the neck fat skatole concentration, without major effects on meat quality parameters.

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REFERENCES

[1] Byrne D, Thamsborg S, Hansen L (2008) A sensory description of boar taint and the effects of crude and dried chicory roots (Cichorium intybus L.) and inulin feeding in male and female pork. Meat Sci 79(2):252-269

[2] Aluwé M, Millet S, Nijs G et al (2009). Absence of an effect of dietary fibre or clinoptilolite on boar taint in entire male pigs fed practical diets. Meat Sci. 82:346-352.

[3] Hansen L, Mejer H, Thamsborg S et al (2006) Influence of chicory roots (Cichorium intybus L) on boar taint in entire male and female pigs. Anim Sci 82:359-368

[4] Nielsen S, Hansen L & Byrne D (2007) Sensory emphasis on pork quality related to the diet content of fermentable fibre-rich feedstuffs (chicory and lupine) with special emphasis on the effect on boar taint. Sensory science report http://orgprints.org/12959/1/12959.pdf

[5] Kjos N, Øverland M, Fauske A et al (2010) Feeding chicory inulin to entire male pigs during the last period before slaughter reduces skatole in digesta and backfat, Livestock Science - September 2010 (Vol. 134, Issue 1, Pages 143-145

[6] Zammerini D, Whittington F, Nute G et al (2010) Effect of dietary chicory on boar taint, British Society of Animal Science Annual Conference April 12 to 14, 2010, Queen's University, Belfast, pp181.

[7] Rosenvold K, Laerke H, Jensen S et al.(2001) Strategic finishing feeding as a tool in the control of pork quality. Meat Sci. 59:397-406

[8] Bonneau M, Lebret B (2010). Production systems and influence on eating quality of pork, Meat Sci. 84:293-300.

[9] Aluwé M, Bekaert K, Tuyttens F et al (2010). (Missing) link between different boar taint detection methods. Proc 61st EAAP, Heraklion, Greece, pp. 140

[10] Xu Z, Hu C, Wang M (2002) Effects of fructooligosaccharide on conversion of L-tryptophan to skatole and indole by mixed populations of fecal bacteria, J. Gen. Appl. Microbiol. 48:83-89

[11] Van Oeckel M, Warnants N, Boucque C (1999) Pork tenderness estimation by taste panel, Warner-Bratzler shear force and on-line methods. Meat Sci 53(4):259-267