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## Chicory root improves the taste and odour of organic pork

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At slaughter, there is a risk that meat from boars develops an unpleasant odour and taste (boar taint). Boar taint is caused by a complex interaction of an overproduction of the pheromone androstenone, which is produced in the testes, and a high level of skatole that acts as an odour enhancer (**see Box 1**).

The problem of boar taint can be overcome by castration of boars or by reducing the concentration of skatole. This improves the aroma and taste of the meat from the 5-10 percent of boars that would otherwise have developed boar taint. A reduction in the skatole concentration also improves the aroma and taste of meat from proportion of female pigs that also exhibit boar taint.

### Possibilities with chicory

The carbohydrate inulin is known to reduce the production of skatole in pigs. This is caused by inulin changing the intestinal flora, so that the bacteria that produce skatole (**see Box 2**) are held in check. This change in intestinal flora also reduces the number of intestinal parasites in the pigs. However the high cost of inulin makes its use in pig feed impractical.

Chicory root contains inulin and a series of other carbohydrates and secondary metabolites (**see Box 2**). Therefore we have examined whether chicory root can replace pure inulin and thereby reduce boar taint, improve the taste of pork and reduce the infection of pigs with pathogenic parasites and bacteria.

### Reducing skatoles

Experiments with chicory root have shown that minced root (25 percent of feed intake) significantly reduced the skatole concentration in the meat and fat of female and entire male pigs, compared to an organic diet without chicory root.

This result was irrespective of whether chicory root was included in the daily fodder ration for 1 week or up to 9 weeks before slaughter (2x8 replicates per

treatment). Feeding with 14 percent inulin produced the same effect, but pure inulin is not price competitive as a fodder ingredient.

Regular blood samples in a short-term experiment showed that the skatole concentration was reduced after only 3 days feeding with 25 percent chicory root. This is shown in **Figure 1** (8 replicates per treatment).

Finally, another experiment showed that feeding various amounts of dried chicory root for 1-3 weeks reduced the concentration of skatole dependent on the amount chicory root that was added (**Figure 2**). These results show that 1 week of feeding with 10 percent dried chicory root was sufficient to achieve the desired reduction in skatole concentration.

### **Improved taste**

In 3 experiments pork fillets were prepared and served to a trained sensory panel of 8-10 people. The meat from pigs fed chicory root (female and entire male) was compared with meat from similar pigs fed a common organic diet or a diet containing inulin. The expressions 'piggy taste' and 'boar taint' were exclusively used to describe meat from the pigs fed the organic diet. In general meat from the pigs fed chicory root was judged to have the highest eating quality.

### **Chicory can prevent swine dysentery**

The influence of chicory root on the incidence of swine dysentery was also examined. In one experiment pigs were accustomed to organic fodder with supplemental rapeseed cake or dried chicory root with lupins and hereafter exposed to bacterial infection. All animals fed the diet with rapeseed cake supplement developed bloody diarrhoea and dysentery bacteria were cultured from the faeces of 17 of the 18 pigs. The pigs fed the chicory and lupin supplement did not show symptoms of dysentery and no dysentery bacteria were cultured from the faeces of any of the 18 pigs.

This result is very significant, especially for organic pig farming, as it shows the possibility for controlling swine dysentery without the use of antibiotics. All farms affected by swine dysentery experience a reduction in animal health and growth rate and, in the worst case, increased mortality.

Experiments looking at the composition of the intestinal flora revealed a larger percentage of bifido-bacteria in pigs fed with dried chicory. At this time it is not known if feed containing chicory can be used to control intestinal infections of other pathogenic bacteria.

### **Chicory can reduce parasite infections**

A number of experiments have been conducted to examine the influence of chicory root on different intestinal parasites. A marked and statistically significant reduction has been seen in the excretion of eggs of the nodular worm in the faeces of pigs fed dried chicory (**Figure 3**). This effect was greater than that observed for pure inulin. Minced raw chicory root, in contrast, had only a mild effect on the nodular worm.

It was also shown that larvae of the nodular worm developed slower and less successfully in pigs fed a diet containing dried chicory. Even though there was no significant effect on the elimination of adult nodular worms the inclusion of dried chicory in the diet will reduce the infection pressure of this parasite on the farm.

Results indicate that the use of chicory root can also influence the establishment of the pig roundworm, the most common intestinal parasite in Danish swine herds. Forthcoming experiments will examine the extent of this effect. However the pig roundworm is located in the small intestine, while the

nodular worm is located in the large intestine where the physical and chemical changes are largest, so the effect is likely to be smaller.

## Perspectives for feeding with chicory

Feeding with dried chicory has been shown to have several positive effects, which are primarily the result of changes to the intestinal environment. With this in mind it is important to note that feeding with chicory has not had a negative influence on the pig's appetite or growth.

Additionally, it is important that the inulin rich chicory used in these experiments can be grown with good yields in Denmark. Due to the similarity in appearance between chicory and the rosette-stage of sugar beet the chicory root can be harvested with known implements. Generally the yield of chicory root should be similar to that of sugar beet but chicory has two advantages. The bitter compounds in the leaves of chicory are resistant to insect attack and the deep root system can access nitrogen that is unavailable to other crops.

Strategic use of chicory in the feed of fatteners enables an improvement in animal welfare by allowing the use of entire males, without the producer having to slaughter animals at an uneconomically low slaughter weight to avoid boar taint.

That this reduction in boar taint is accompanied by an improved taste experience for meat from females can potentially provide a special organic quality niche that is not used for conventional pork. Since chicory also has a significant influence on parasites and dysentery bacteria it is possible that the feeding of chicory can be used preventively or curatively, allowing a reduction in the use of veterinary medicines which is especially beneficial in organic swine herds.

## References

Some of the results discussed in this article are contained in a patent application, which is available publicly (see details below). The major results concerning taste and odour are contained in a scientific manuscript submitted to Animal Science (Hansen et al., 2005, see below). Finally more **information on the project** can be found on the Danish Research Centre for Organic Farming homepage.

Hansen, L.L., Jensen, M.T., Byrne, D., Roepstorff, A., Thamsborg, S.M. and Mejer H. (2004). Use of a chicory root product to reduce/prevent boar taint, to reduce skatole content in pigs and to reduce/prevent gastrointestinal tract parasitic infections in animals e.g. hare, pig, horse and sheep. **Patent no. WO2004084644-A1**.

Hansen, L.L., Jensen, M.T., Mejer, H., Roepstorff, A., Thamsborg, S.M., Byrne, D.V., Karlsson, A.H., Hansen-Møller, J. & Tuomola, M., 2005. Influence of chicory roots (*Cichorium intybus* L) on boar taint in entire male and female pigs. Submitted to Animal Science. Draft version uploaded to Organic e-print, but not released on site.

Mejer, H., Roepstorff, A., Thamsborg, S.M., Hansen, L.L. and Bach Knudsen, K.E. 2005. The effect of *Cichorium intybus* on helminth infections in pigs. Draft version uploaded to Organic e-print, but not released on site.

