THESIS OF DOCTORAL (Ph.D.) DISSERTATION

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OPPORTUNITIES FOR PORK PRODUCTION WITH BOARS

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1. PRELIMINARIES AND OBJECTIVES OF THE STUDY

By the 1980'ies, the genetic potential of intensive European breeds, types and hybrids has reached to a level, from where only small improvement of fattening and cutting performance can be expected from generation to generation. The difference between certain, widely spread breeds/species has decreased, thus gender differences are greater than that between species.

Earlier, according to the general practice, male hogs were fattened as castrates, because of the long fattening period. Along with the spread of intensive hog production and the improvement of the genetic potential of different types, the fattening period significantly shortened, and before the full sexual maturity, a live weight of 100 kilograms can be achieved with fattening pigs.

In the end of the 70'ies and the beginning of the 80'ies, multilateral research works started in countries with intensive hog production and in Hungary as well, in order to work out the potential methods of pork production with boars. I joined to this current field from international aspect as well, the main findings of this research are summarised in the current dissertation.

The answers on the following questions were searched in the study:

- What are the fattening and cutting performances of boars, castrates and sows within the average national industrial keeping conditions?
- Which organoleptic investigation is suitable to measure the extent of unfavourable sexual odour (boar taint)?
- How does the serum concentration of androstenone and testosterone change in boars immunised with androstenone (the most responsible steroid in producing boar taint) conjugate during the fattening period?

- How does the concentration of serum and fat tissue androstenone and testosterone change in boars immunised with non-body androstenone conjugate during the fattening period?
- Does the immunisation affect the fattening and cutting performance of boars?
- Does the immunisation influence the organoleptic parameters of boar pork?

2. MATERIAL AND METHODS

2.1. Large farm fattening experiment

The fattening experiments were carried out with two different KA-HYB genotypes, altogether 140 fattening pigs on Hungarian average large farm. The pigs in Genotype I group were Landrace bacon type male pigs; while in Genotype II group, the progeny of Large White boar line were fattened. The fattening period lasted from the 90th day of life to 104 kilograms of live weight. The pigs were kept in small groups with a place of 0.75 squaremeter per animal, in the fattening stable with artificial light and ventilation. Besides the fattening parameters, the cutting quality and quantity performances were measured. The organoleptic evaluation (taste, odour, tenderness) was based on cooked, grilled and braised pork. In order to measure the serum and fat tissue concentration of androstenone (the most responsible steroid in producing boar taint), R.I.A method was used.

2.2. Active immunisation of boars with androstenone conjugate

The second part of the research dealt with the evaluation of the extent of boar taint and the method how to decrease it by immunisation. This task was

carried out by a team of three organisations: the Endocrine Laboratory of SOTE, Department of Organic Chemistry JATE and the co-workers of department of Pig production, PATE.

Based on the literature (J. Vaitukaitis et al, 1971 and L. Williamson et al, 1982), immunisation of boars with androstenone conjugate was expected to be an effective method at young age and in the fattening period, in order to decrease the biosynthesis of androstenone in the testicles and the boar taint muscle and other tissues without castrating. As steroids as well as androstenone have relatively low molecule weight, on their own they are not immunogenic. Therefore, we needed to join the molecule of androstenone with protein (BSA, tireoglobuline) with covalent joint in vitro.

The steroid laboratory of the department of Organic chemistry (JATE), created 5-alpha-androstenone; the antigen is the compound of androstenon-3-carboxy-methyloxime-BSA. The first immunisation experiments used this antigen.

The treated boar piglets were immunised firstly at their age of 70 days (0.5 mg of androstenon-3-carboxy-methyloxime-BSA) with the suspension of 2 ml physiologic saline and Freund's complete adjuvant in 1 to 1 ratio. The injection was given in the neck muscle. Further injections of the same dose were given at age of 107 and 147 days. Blood samples were taken on the day before the first immunisation and 14 days after the injections and at the end of the fattening period; blood serum was stored on minus 18 degrees of Celsius till the analysis.

The experiments were carried out with KA-HYB boar piglets in two repetitions on the facility of the Faculty of Animal Sciences, Kaposvár. The treated and control groups were litter mates in similar state of development.

In order to reliably identify the animals, both ear tags and tattooing were used.
In each experiment, 35 treated and 16 control fatteners were kept in the same stable with natural lightening, without bedding, in small groups. The space provided for each animal was 0.75 square meter.

The fatteners were fed with the same dry feed containing 15.2 percent and 13.5 percent digestible crude protein in the first phase of the fattening period and till the slaughtering of the animals, respectively.

The ready boars were slaughtered at 105 kilograms of live weight; and the valuable parameters of cutting value were analysed. The organoleptic parameters of pork samples were tested in random system after cooking, on the day of slaughter and following the cooling of the meat after salt- and spice-free roasting.

2.3. Active immunisation of boars with non-body androstenone antigen

Brooks and Pearson in 1986 raised the opportunity to decrease the androstenone content of blood with an immunisation method applying non-body androstenone. To check their statement, secondly another immunisation experiment was carried out by injecting antigen based on 16-hidroximethil-5-alpha-androst-16-en-hemisuccinile-oximethile-BSA.

As according to certain authors (**Williamson and Patterson, 1982**), it is possible that as result of active immunisation, the blood androstenone will not but the fat tissue androstenone will change, the hormone concentration of the fat tissue was also measured in this experiment.

Similarly to the previous, this experiment was carried out with KA-HYB boar piglets in the same system. During the fattening period from 30 to 105 kilograms of live weight, 29 treated and 12 control pigs were kept in small groups. The feeding and slaughtering conditions were the same as in the first experiment.

The animals were given 0.5 mg antigen in 1:1 suspension of 2.0 ml of physiologic saline and Freund's complete adjuvant firstly at their age of 60 days. The injection was given in the neck muscle. Further injections of the same dose were given at age of 74, 84 and 130 days. Blood samples were taken on the day before the first immunisation and 14 days after the injections and at the end of the fattening period at slaughtering; blood serum was stored on minus 18 degrees of Celsius till the analysis. At 160 days of age, body fat was sampled by biopsy method from the same body part as at slaughtering.
At slaughtering, the fat samples were taken from the dorsal fat tissue of the animals and were also kept on minus 18 degrees of Celsius till the analysis.

2.4. Methods of analysis

The biometrical analysis of the data was carried out with two-way analysis of variance, when also the random system of the experiment was considered.

In the evaluation of the difference between treatments, the difference reduced by the significant difference calculated at α=5% is considered.

The relationship between the results of the organoleptic analyses and the androstenone figures was defined with correlation coefficient; although previously a detailed analysis of the data was carried out. I presumed that despite of the most suitable method used and careful treatment of the

samples, due to the timing of blood and fat sampling, the errors of sampling and other factors, outstanding extreme data can also have been registered. In order to eliminate these extreme samples, the Bartlett's test was applied.

3. RESULTS

The analysis of feed conversion efficiency determining basically the fattening performance showed that the boars were superior in all experimental groups. Boars achieved higher efficiency figures by 7.9 and 6.2 percent than the castrates and 5.1 and 3.6 percent than the sows.
The figures of average weight gain showed that the castrates were superior to boars and sows, however the difference of the averages is not significant statistically.

Looking at the production of valuable cuts of boars, it was found to be greater than those of castrates, by 5.6 and 4.6 percent in the groups Genotype I and II respectively.

The difference of the fat contents of carcasses was 8.4 and 10.7 percent between boars and castrates and 2.3 and 6.0 percent between boars and sows. The difference is significant at $p<0.001$.

According to the analyses, in similar extent to the figures of the relating literature, boars achieved higher percentage of valuable cuts in both genotypes: compared to the castrates by 10.6 and 8.27 percent and to the sows by 4.0 and 3.1 percent. The difference is significant at $p<0.001$.

The chemical analysis of the pork showed that the loin of boars contains 0.8 and 0.6 percent more water compared to the castrates and 0.4 and 0.3 percent

to the sows. The difference between the water content of hams was found similar to that of loin, however the differences are not significant at p=5%.

Significant difference of the protein content of muscle was found only in case of the ham samples taken from boars and castrates of Genotype I group. Boars were superior by 1.4percent to castrates. The samples of loin however did not show any advantage of the boars. Although the fat content of hams and loins was the lowest in case of boars in all groups, the difference is not significant.

Having compared the different organoleptic tests, it was found that the most reliable test is cooking test to demonstrate boar taint. It can be seen that this odour was found not only in case of boars, but some of the castrates had medium and 20 to 25 percent of the castrates had slight odour; surprisingly, even in case of a few sows it was noticeable. Therefore, the categories “slightly noticeable” and “not noticeable” can be joined together, and practically this can be considered as sexual odour free group.

The results of the cooking test show that 25.9 percent of the boars in group I had strong, 51.8 percent of them had medium odour and only 22.3 percent of them was odour-free. In Genotype II group, the respective figures were: 10.7, 39.3 and 50 percent.

Results of active immunisation with androstenone antigen

The immunisation of boars with androstenone conjugate to decrease the sexual odour has not influenced the blood androstenone content. Also in the comparing analysis of blood androstenone and testosterone, significant difference was not seen before and after immunisation.

It was also found that following the last immunisation, the blood testosterone content increased, although its androstenone content did not change. As the change of the testosterone level was similar in both groups, active immunisation did not influence the level of this hormone. These were proven by the calculations of testosterone/androstenone ratio, as the average figures increased only in the last experimental period, due to the changes in the testosterone level.

The treatment with the new type androstenone conjugant has not influenced the concentration of blood androstenone. Blood androstenone was relatively low in the beginning of the fattening period in both the control and the treated groups. Following the first immunisation, the hormone level started to increase. As the degree of the hormone level change was similar in both groups, we think that immunisation had not got any effect, and the change in the hormone level was determined primarily by the age and growth of the animals.

The average weight gain of boars in the treated groups was somewhat lower than that of the control pigs, although the difference was not significant. All the treated boars were sold at lowered price in authority butchery with veterinary permit. The consumers knew that they bought pork of boars. In their answers, the asked more than 30 consumers said that the pork bought was easy to prepare and the meal made of it was tasty and tender. Although during cooking, some of them noticed slight sexual odour, it did not influence them to buy again.

4. CONCLUSIONS

Based on the results of the analyses the following conclusions can be drawn:

1. Having compared the performances of boars, castrates and sows, it was found that the boars were superior than sows and castrates achieved the lowest figures in feed consumption, feed efficiency ratio and the production of valuable cuts. The different fattening performance of different genders makes reasonable to fatten different genders separately.
2. The two most important parameters of the carcasses: fat percent and ratio of valuable cuts were significantly the highest in case of boars independently of genotype. The difference between boars and castrates was much higher than the average difference between the two genotypes.
3. Although in some cases significant difference was seen, only small differences were found in the chemical composition of pork samples and tissues and the pH and Gö-fo values. From practical aspect, the found difference is not considerable.
4. Based on the organoleptic results, the difference between the different genotypes is only tendency, and is not significant due to the small size of the samples.
5. In boars, the immunisation with androstenone based antigen did not influence the blood androstenone. In the comparing analysis of the androstenone and testosterone content of blood, significant difference was not found before and after the immunisation. At the same time, the blood testosterone of boars increased greatly from age 22 weeks to slaughtering.
6. Neither the immunisation of boars with a new type androstenone conjugant influenced the concentration of blood and fat tissue androstenone.

7. The failures experienced in the active immunisation experiments can be explained by the low androstenone concentration of blood and fat tissue of boars and the high individual difference seen in the sensitivity for antigens.
8. Besides the positive judgement of pork tested with organoleptic methods, neither the consumers gave negative comments on the pork of boars involved in the immunisation experiments and slaughtered at 104 kilograms of live weight.

5. NEW SCIENTIFIC RESULTS AND FINDINGS

1. High individual sensitivity can be seen for the antigen used in selective immunisation against androstenone, the most responsible substrate for boar taint.
2. Immunisation with androstenone based antigen (5α-androst-16en-3-amino-oxy-acetacidoxime-BSA) did not affect the blood androstenone significantly.
3. The treatment with the new type androstenone conjugant (16-hidroxymethyl-5α-androst-16en-16-hemisuccinile oxy-methyl-BSA) has not influenced the concentration of blood androstenone. However, blood androstenone was relatively low in the beginning of the fattening period in both the control and the treated groups.
4. Following the immunisations till slaughtering, the blood testosterone significantly increased, although that of androstenone did not. The conclusion can be that the immunisation has not got influence on the testosterone level.

6. PUBLICATIONS IN THE FIELD OF THE DISSERTATION

Scientific publications

1. Fehér T. – Bodrogi L. – **Házas Z.**(1985): Érzékeny radioimmunilógiai módszer az ivari szagért felelős szteroid feromon, az androsztenon meghatározására a sertés vérében és zsírszöveteiben. Magyar Állatorvosok Lapja. 5. 271-274. p.

2. **Házas Z.**- Horn P. - Fehér T. - Sándor E. (1991): Az ivari szagért felelôs androsztenon elleni aktív immunizáció kansertésekben. I. Immunizáció androsztenon alapú antigénekkel. Magyar Állatorvosok Lapja. 46. 521-528.

3. **Házas Z.**- Horn P. - Fehér T. - Sándor E. - Hackler L. - Schneider Gy. (1992): Az ivari szagért felelôs andorsztenon elleni aktív immunizáció kan sertésekben. II. Immunizáció testidegen androsztenonszármazékból elôállított antigénnel. Magyar Állatorvosok Lapja. 11. 590-596.

4. **Házas Z.**: (1986): Carcass Quality and Fattening Performance of Boars, Barrows and Sows kept under Industrial Conditions. World Review of Animal Production 2. 9-11. p.

5. Kiscsordás I. – **Házas Z.**(1981): Az egymást követő KA-HYB konstrukciók genotípus-környezet kölcsönhatás vizsgálata nagyüzemi tartásban. Szaktanácsok 2. 45-46. p.

6. **Házas Z.**(1983): Kanok, ártányok és kocák hízási és vágási teljesítménye iparszerű tartásban. Szaktanácsok 3. 44-49. p.

7. **Házas Z.**(1984.) Ivari szag vizsgálata kanok, ártányok és kocák vágottárujában. Szaktanácsok 3. 37-42. p.

8. Fehér T. – **Házas Z.**(1987): Kortizol és androsztenon ellenanyag előállítása és hormonszint meghatározás sertések stresszérzékenységének és kanszagának vizsgálatára. Napjaink biotechnológiája. 10. 110-114. p.

9. Horn P. – Kiscsordás I. – **Házas Z.**– Kovách G. – Mészáros Z. (1987): Eltérő genotípusú és végtömegű hízósertések hústermelésének és húsminőségének alakulása. Szaktanácsok 2. 30-39. p.

10. **Házas Z.**- Vagyon L. (1989): Hízási és vágási teljesítmény-különbségek hízósertéseknél ivartól függôen. Szaktanácsok. 1. 17-21.

Proceedings of full publications

11. Kovách G. - **Házas Z.**(1989): Wartosc tucza I rzezna tuczników zywionych mieszankami a róznei zawartosci bialka. Biuletyn Naukowy. 5. 155-158.

12. **Házas Z.**- Fehér T. (1991): Slaughter performance of offsprings of two genetically alterated KA-HYB boar lines. With special enphasise on the evaluation of boar taint. 15th Genetical days. Ceské Budejovice. 203-205.

13. Fehér T. - Bodrogi L. - **Házas Z.**(1988): Kortizol és androsztenon MkEa elôállítása és hormonszint-meghatározás sertések stresszérzékenységének és kanszagának vizsgálatára. Napjaink biotechnológiája. Állattenyésztési Biotechnológia. III. kerekasztal-konferencia. Hôgyész. 110-114.

Proceedings of abstracts

14. **Házas Z.**(1981): Kasztrálás nélküli kansüldőhízlalás jelentősége és hatása az iparszerű sertéshús termelésre. VSZNTO. NTO. Állattenyésztési Tudományos Konferencia Moszkva.

15. **Házas Z.**(1985): The effects of castration on fattening and slaughter performance of pigs. Materialy na III. Miedzynarodowa Konferencje Naukowa. PT.: "Problemy Hodowli i Chowu Trzody Chlewnej w Gospodarstwach Wielkotowarowych. Akad. Rolniczo-Techn. Olsztyn.

16. **Házas Z.**(1985) Fattening performances and carcass quality of boars, barrows and sows in industrial pigs keeping conditions. 36th Annual Meeting of the EAAP. Kallithea, Halkidiki, Greece. 312-313. p.

17. Kovách G. – **Házas Z.**(1987): Fattening and slaughtering performance of pigs fattened of feed stuffs of different protein content. IV. Science Conference "Current Problems in the Breeding and the Production." Gdansk.

18. **Házas Z.**- Horn P. - Fehér T. - Sándor E. (1993): Active immunization against the Boar TAINT Androstenone. 44th Annual Meeting of the EAAP. Arhus, Denmark.

19. Kiscsordás I. – Házas Z.(1982): A különböző genotípusú sertések növekedésének és vágási osztályba sorolásának vizsgálata iparszerű tartásban. XXIV. Georgikon Napok, Keszthely. 42-43. p.

20. **Házas Z.**- Horn P. - Fehér T. - Hackler L. - Schneider Gy. (1989): Aktív immunizáció és húsminôsítés sertésekben. MTA Szteroidkémiai Munkabizottság Tudományos ülése. Szeged. 1989. okt. 19-20.