

THESES OF DOCTORAL (Ph.D.) DISSERTATION

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EFFECT OF ATROPHIC RHINITIS ON CERTAIN PRODUCTION PARAMETERS OF PIGS

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Kaposvár
2005

1 ANTECEDENTS OF THE RESEARCH, OBJECTIVES

Atrophic rhinitis (AR) of swine is a long-known and widely prevalent infectious disease of pig populations, characterised mainly by twisting and shortening of the nose. Two pathogenic bacteria have been directly associated with the aetiology of AR: toxigenic *Bordetella bronchiseptica* and *Pasteurella multocida*, which cause damage after colonising the nasal passages. Under field conditions, besides the presence of the pathogens numerous other factors may influence the severity of the clinical signs of AR (e.g. large herd size, high population density, frequent regrouping of animals, poor ventilation, pig houses with a high number of animals and/or continuous operation, poor hygiene). Therefore, it is no mere chance that the global prevalence of AR has increased in parallel with the spread of pig farms characterised by higher pig numbers and higher animal density. AR can produce more severe nasal lesions under the hygienic and technological conditions typical of these establishments. AR is classified as a List B disease by the Office International des Epizooties (OIE). By their definition, List B diseases have socioeconomic and/or public health significance and have to be taken into consideration in the international trade of live animals and animal products. Although no one disputes the economic importance of AR, so far the diversity of factors influencing the disease has prevented researchers from clearly determining the magnitude of its economic impact. From the economic point of view, reduction of the body weight gain is undoubtedly the most important issue.

The objective of this work was to answer the following questions:

- How severe lesions develop as a result of using different infection models?
- What is the dynamics of development of AR-induced nasal lesions like?
- What effect does AR have on the body weight gain of pigs?
- Does AR cause any change in the behaviour of piglets?
- What damage does the disease cause in the pig herds of large-scale farms?
- What are the interactions between economic losses caused by AR and those resulting from pneumonia under field conditions?

2 MATERIALS AND METHODS

Piglets reared free of the pathogenic agents of AR under controlled animal house conditions and those infected experimentally with the pathogens of AR in different combinations were observed in small numbers. This enabled us to study the pathogenesis of the disease and its correlation with the different performance parameters.

The effect exerted by the disease on the body weight gain of pigs and the factors influencing the development and severity of the disease were studied under farm conditions in conventional pig herds on a large number of naturally infected animals.

2.1 Infection experiments

Piglets weaned from their dam at day old and reared artificially were used in the experiments. The animals were free of both *B. bronchiseptica* and *P. multocida* infection. Three different infection models were used, each including 14 control and 14 infected piglets. The method and time of the experimental infections are presented in the following table:

	First treatment		Second treatment	
	type	time (day)	type	time (day)
Experiment 1	<i>B. bronchiseptica</i>	4	–	–
Experiment 2	<i>B. bronchiseptica</i>	4	<i>P. multocida</i>	8
Experiment 3	0.5% aceitic acid	6 and 7	<i>P. multocida</i>	8

The condition of the nasal turbinates was examined at the level of the first premolar teeth by computed tomography (CT) and then at slaughter at the times indicated below.

	Experiment 1	Experiment 2	Experiment 3
Baseline examination (day) – CT	4	4	
		8	7
Control examination (week) – CT	2	3	3
		4	
	6	5	5
	10	9	9
		13	13
		19	17
			21
Slaughter (week)		25	25

The animals were weighed regularly and their feed consumption was measured individually between week 4 and week 14.

In the third experiment, on day 8 after infection 9-hour video recordings were made of both groups in parallel. The recordings were analysed by minute using the ethological method of Molnár et al. (1998).

The severity of nasal lesions was examined *post mortem* after slaughter.

2.2 Field trials

The objective of studies conducted in two pig operations naturally infected by AR was to determine the magnitude of economic losses caused by the disease and the effect of some factors thought to have an influence on AR (parity number of sows, gender, litter size) under

field conditions. To this end, the pigs were weighed individually at different ages and the severity of nasal and lung lesions was assessed after slaughter.

2.3 Statistical evaluation

In the part of the work involving infection experiments, the group means were compared by two-sample independent *t*-test. In the ethological studies the frequencies were compared by the chi-squared test. For the analyses the SPSS for Windows 10.0 (2001) programme package was used. The functions were fitted to the plotted points by the use of the Microsoft Excel for Windows (2002) programme.

In the field trials, the frequency of the measured parameters was evaluated with the help of a contingency table, by chi-squared test, using the SPSS for Windows 10.0 (2001) programme package. Weight gain was evaluated by multivariate analysis of variance (GLM model) and using the Least Square (LS) Means, with the help of the SAS 8.2 (SAS Institute Inc., 1989-2001) programme.

3 RESULTS

3.1 Infection experiments

Infection with *B. bronchiseptica* alone produced nasal turbinate changes of moderate severity in a few animals only, by the time of six weeks of age. These changes had become practically regenerated within a relatively short period of time, by the tenth week. The changes had no detectable effect on the body weight gain on group level.

As a result of combined infection with *B. bronchiseptica* and *P. multocida*, the piglets developed marked nasal lesions by the third week after infection. From the fifth week, the severity of nasal lesions decreased reaching a moderately mild or severe level. The inter-group difference in average body weight changed almost parallel with the severity of nasal lesions: more pronounced nasal lesions resulted in higher weight gain reduction. From the fourth week, the average body weight difference between the infected and the control group continuously decreased. Statistically significant differences could be detected from the second to seventh week. Between week 8 and 14 the individually measured feed consumption was significantly lower in the infected than in the control group. Infection with *P. multocida* after pretreatment with acetic acid induced the progressive form of AR. The nasal lesions were severe already in the third week and their severity progressively increased up to the slaughtering age. From the fifth week up to slaughter, the weight of infected pigs was 10-12 % lower than that of the control animals. The infection reduced the feed consumption of pigs

between weeks 8 and 14. Although the feed conversion of the affected pigs was better, it was accompanied by a markedly poorer growth performance. Piglets suffering from AR spent less time with eating and had reduced activity level, while the time they spent with resting was substantially longer.

The group means of nasal lesion scores obtained in the three experiments and the means of relative body weight gain reduction could be characterised by linear regression. With the applied mathematical model we obtained an R^2 value of 0.77, where an increase in the severity of nasal lesions by one score value resulted in a 0.57 % decrease of the liveweight.

3.2 *Field trials*

In the two AR-affected herds the proportion of pigs showing nasal lesions was 70–80%, while that of feeder pigs exhibiting severe clinical signs was about 40–50% of the affected animals. The gender did not have a detectable effect on the severity of nasal lesions. Pigs from litters of smaller size showed more severe nasal lesions than those from bigger litters. The number of animals affected with AR was significantly higher among the progeny of primiparous sows.

In one of the two herds, a correlation was found between weight at birth and the severity of nasal lesions at slaughter. The birth weight of animals showing severe AR lesions at slaughter was significantly (by 180 g) lower than that of pigs found healthy at slaughter, indicating that piglets of lower birth weight are more susceptible to AR.

During the growing period (between 28 and 90 days of age), weight gain reduction attributed to AR was as much as 16%, which rate then decreased somewhat by the end of the finishing phase, but still remained above 10%.

The weight gain reducing effect of pneumonia was found to be very similar to that of AR in terms of both its time of occurrence and degree. The two respiratory problems occurred also independently of each other. When occurring separately, AR and pneumonia caused economic losses of about the same magnitude. When occurring together, the influences of nasal changes and the lung lesions exerted on the body weight gain simply added up, and no significant interaction could be demonstrated between the two effects.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 *Model experiments (experimental infections)*

Using early weaning combined with medication, a technology that had been developed by us, we could successfully raise piglets originating from a *B. bronchiseptica* infected herd free from the pathogen and, also, rear them without their dam. This method makes it possible to carry out experimental studies demanding animals free from various pathogens.

On day 8 after *P. multocida* infection we observed that the piglets spent less time with eating and social activities than the control piglets while the time they spent with resting increased.

When comparing the weight gain reduction induced by the three infection models, it is conspicuous that the effect of *B. bronchiseptica* tends to manifest itself at a younger age (1–3 weeks) while that of *P. multocida* at a later stage of life (5–7 weeks of age). The live weight reduction was proportional to the severity of the nasal lesions in all three experiments. When evaluating the average scores of nasal lesions induced by the different infection models in relation to the percentage live weight difference found between the infected animals and the control group, we found a significant difference of medium degree. With the applied mathematical model we obtained an R^2 value of 0.77, where an increase in the severity of nasal lesions by one score value resulted in a 0.57% decrease of the live weight. This finding calls attention to the importance of slaughterhouse monitoring of AR in order to assess the economic losses caused by the disease.

4.2 *Field observations*

Pigs affected with AR were significantly more common among the progeny of primiparous sows, than among piglets born to sows with higher parity number. This phenomenon suggests that the introduction of a higher rate of gilts into the breeding may increase the AR-induced economic losses.

Contrary to our expectation, pigs from litters of smaller size showed more severe nasal lesions than those from bigger litters. However, smaller litters were characteristic more to the primiparous sows. With respect to the severity of AR lesions, parity number seems to be a more important factor than the litter size.

At slaughter, pigs having nasal lesions were more frequently affected with pneumonia than pigs not showing such lesions. Some authors attribute this to the predisposing effect of AR, but it seems to be more likely that the correlation between the two respiratory problems can be attributed to the combined effect of factors predisposing to respiratory diseases.

The mean boneless meat percentage of animals suffering from severe AR was significantly higher than that of the healthy animals, which may have been the result of the reduced feed intake.

On one of the farms we demonstrated that the birth weight of animals showing severe AR lesions at slaughter was significantly lower than that of animals free of turbinate atrophy. This underlines the importance of the balanced birth weight of litters, also because of the appearance and increasing economic losses caused by AR.

In the pig herds studied, a significant interaction between lung and nasal lesions in terms of their effect exerted on live weight was not found in any case, indicating that the two respiratory diseases exerted their harmful effects independently of each other.

The effect exerted by AR on performance was reflected in the impairment of several performance parameters. Therefore, the control of AR in the infected pig herds is absolutely justified. The high prevalence of the disease also calls attention to the importance of this problem. The prevalence of AR can be reduced by the use of modern vaccines, repopulation of farms from herds free of the disease or by purchasing breeding animals from such herds. Through the modernisation of management systems the animal facilities may become suitable for repopulation with an AR-free stock by reducing the risk of reinfection to the minimum.

5 NEW RESEARCH RESULTS

1. *B. bronchiseptica* and *P. multocida* free piglets were obtained by modified medicated early weaning from a conventional herd for scientific purposes.
2. Dynamics of nasal lesions by experimental infection either with *B. bronchiseptica* or *P. multocida*, or *B. bronchiseptica* and *P. multocida* were shown *in vivo*.
3. In large-scale pig farms the reduction of average daily gain, the feed consumption and the changes of the feed conversion induced by the atrophic rhinitis were defined.
4. The relation between the atrophic rhinitis and the social behaviour was proven.

6 PUBLICATIONS WRITTEN BY THE AUTHOR ON THE SUBJECT OF THE DISSERTATION

6.1 Papers published in foreign-language peer-reviewed journals:

1. Magyar, T., Kovács, F., **Donkó, T.**, Bíró, H., Romvári, R., Kovács, Melinda, Repa, I.: Turbinate atrophy evaluation in pigs by computed tomography. Acta Veterinaria Hungarica, 2003. 51. 4. 485-491.

2. **Donkó, T.**, Kovács, Melinda, Magyar, T.: The effect of atrophic rhinitis (AR) on the weight gain of swine. *Agriculturae Conspectus Scientificus*, 2003. 68. 3. 161-164.
3. **Donkó, T.**, Kovács, Melinda, Magyar, T.: Association of growth performance with atrophic rhinitis and pneumonia detected at slaughter in a conventional pig herd in Hungary. *Acta Veterinaria Hungarica* (accepted for publication).

6.2 Papers published in Hungarian language in peer-reviewed journals:

4. **Donkó, T.:** Sertések torzító orrgyulladásának (atrophic rhinitis) termelésre gyakorolt hatása [Effect of atrophic rhinitis of swine on performance]. *Acta Agraria Kaposváriensis*, 2001. Vol. 5. No. 3. 65-67.
5. **Donkó, T.**, Kovács, M., Magyar, T.: A sertések torzító orrgyulladásának hatása a súlygyarapodásra I. Megfigyelések a betegséggel érintett állományokban. Irodalmi összefoglaló [Effect of atrophic rhinitis of swine on the liveweight gain I. Observations in herds affected with the disease. Review of the literature]. *Magyar Állatorvosok Lapja* (accepted for publication).
6. **Donkó, T.**, Kovács, M., Magyar, T.: A sertések torzító orrgyulladásának hatása a súlygyarapodásra. II. Kísérleti körülmények között végzett megfigyelések. Irodalmi összefoglaló [Effect of atrophic rhinitis of swine on the liveweight gain II. Observations made under experimental conditions. Review of the literature]. *Magyar Állatorvosok Lapja* (accepted for publication).

6.3 Conference proceedings published in foreign language:

7. Magyar, T., Kovács, F., **Donkó, T.**, Bíró, H., Kovács, Melinda., Repa, I.: Computed tomography – a powerful tool to track turbinate atrophy in pigs. *Proceedings of the 18th IPVS Congress, Hamburg, Germany, 2004.* 1. 198.

6.4 Conference proceedings published in Hungarian language:

8. **Donkó T.:** Környezeti tényezők szerepe a sertések torzító orrgyulladásának kialakulásában [Role of environmental factors in the pathogenesis of atrophic rhinitis of swine]. *XLIIIrd Georgikon Days, 20–21 September 2001.* Keszthely, pp. 666-670.

6.5 Conference paper:

9. **Donkó T.:** Sertések torzító orrgyulladásának termelésre gyakorolt hatása [Effect of atrophic rhinitis of swine on performance]. 1st Pig Breeding Scientific Day, 9 May 2001, Kaposvár.

6.6 Educational paper published in foreign language:

10. **Donkó, T.:** On the atrophic rhinitis, as the things are now. CEVAVET, 2003. 2. 7-8.