

University doctoral (Ph.D.) thesis

**THE EFFECT OF CONFINED KEEPING ON THE BODY COMPOSITION OF THE
WILD BOAR**

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BACKGROUND AND OBJECTIVES

The wild boar is one of the main big game species in Hungary. Intensive plant farming provides abundant and easily available food for them. This environmental resource, which seems to be available without any limits, had a positive impact on population size. Due to the increase in the number of wild boars the damage they caused in the plough land cultures have considerably increased as well. In order to reduce the harm caused by the wild animals game-managers established several confined wild boar parks for hunting purposes.

Today, however, there are many accusations against farmers breeding and utilizing wild species under confined conditions in private game parks. Many explain the degradation of the soil surface and vegetation with confined animal keeping, while others question the ethics of the hunting in these areas as well as the "wild nature" of the meat from such farms. In Hungary approximately an annual amount of 7500 tons of venison is sold, only a several percents of which get to Hungarian consumers. The venison consumption per capita is very low, 0.2 to 0.3 kg/year, one reason for which is the lack of consumer knowledge.

One of the aims of our work was to contribute and to broaden the data published on the anatomical size of the animals in the Hungarian wild boar population as well as to gain deeper information about those main ingredients of wild boar meat which is important from the nutritional point of view. In addition, the results of the tests showing the further processing of venison in food industry are presented.

During the research the following issues were investigated:

- Is there any difference in the body size parameters of wild boars with regard to the food available for them?
- Is there any difference between the nutrition values of the meat of wild boars living in territories of significantly different habitat characteristics and different feeding possibilities, with special regard to the protein, fat, fatty acid and mineral content of the meat?
- How do the nutrition-value-parameters of the wild boar meat mentioned above differ from that of domestic pigs?
- Out of the meat produced in different nutrition intensity wild boar parks which is conforms best the processing criteria of meat industry?

When comparing our data, we tried to find correlation between the sex, age, habitat natural food sources of the animals, supplementary feeding, body size and chemical composition of meat, as well as techno-functional properties.

METHOD

The examinations were carried out in three confined wild boar parks of Hungary (in Sárkeszi, Ásotthalom, Csibrák), the location of which was significantly different from geographic, climatic and edaphic point of view. In addition to the population of the parks we involved the data of wild boars shot in open areas of Csongrád County into our examinations as a control group. We determined the nutrition conditions of the wild boars; the most part of the food in the park of Sárkeszi was composed of reed stems and roots, fish and snails, while in the park in Ásotthalom the food of the animals was seasonal, the by-products of the horticultural and plough land production, supplemented with corncobs. In the intensive system park in Csibrák a feed mix made especially for wild boar nutrition was consumed by the animals. In the last two parks the animals were feeding *ad libitum*.

In order to determine the element content of the soils the samples were taken from the parts of the parks where the animals often stayed according to the observations. Six samples were taken from each park, when we took the upper 30 cm layer of the soil.

The anatomical size sampling of the animals was conducted (n=248) during the winter hunting season between November 2006 and March 2009, immediately after the end of the hunt. A digital spring scale was used to weigh the eviscerated weight of the animals (kg), a measuring tape to take the body length (cm), head length (cm), ear length (cm) and withers height (cm). A vernier caliper was used to measure the heart length (cm) and width (cm). To describe the body structure of the stock the data were used for counting robustness, which is the quotient of the body length (cm) and withers height (cm), as well as the proportion of the body length –head length and head length-ear length.

After evisceration a sample of 500 g was taken from the *m. serratus anterior* and it was stored cooled for 24 hours at 4°C than frozen. The samples were stored in a freezer until they were used in the laboratory. The techno-functional examinations were carried out using the samples (n=66) from confined parks collected during the first year of the research. They showed the suitability of the wild boar meat for industrial processing.

Applied meat examination methods:

- dry matter determination as specified in the Hungarian standard MSZ 5874-4:1980
- crude protein determination with Kjeldahl-method as specified in the Hungarian standard MSZ ISO 937:2002

- fat content determination with Soxhlet-extraction method as specified in the Hungarian standard MSZ ISO 1443:2002
- fatty acid composition determination as specified in AOAC Official Method 996.06
- element content determination with ICP-OES (inductively coupled plasma optical emission spectroscopy) and ICP-MS (inductively coupled plasma mass spectroscopy) techniques according to the method of KOVÁCS et al. (1998; 2000)
- the water keeping ability was determined with cooking test
- the water binding ability was determined with Grau and Hamm method.

The data obtained during the examinations were analysed with the method of variance analysis. Homogeneity was examined with Levene-test. When comparing the group-pairs Tamhane-test was used in case of homogeneity, while LSD –test in case of heterogeneity. The correlation examination of the variants was carried out with correlation analysis (Pearson's-correlation coefficient) as well as linear regression.

MAJOR OBSERVATIONS

Body-size examination in wild boars

When examining the body size data of the shot wild boars **by territories** it was found that the ones in Sárkeszi had the heaviest eviscerated weight, while the ones from open areas had the smallest. The weight of the animals from Csibrák, which were fed with feed mixture, only slightly fell behind the eviscerated weight of the animals living in Sárkeszi, which consumed rhizome, fish, snails and worms. At the same time the body length of the wild boars from open areas significantly exceeded that of the boars shot in confined parks. No significant difference was found between the animals from different territories considering withers height, head length and heart width. The characteristic „torpedo” body structure typical of the wild boar could be observed on the animals from Sárkeszi and Ásotthalom, but the body structure of the animals from Csibrák and also from the open areas. The body-head ratio was the same in case of the animals from Sárkeszi and Ásotthalom, and from Csibrák and the open areas. The head-ear ratio was the same in case of the animals from Ásotthalom and the open areas, while the longest ear was measured in wild boars shot in Csibrák.

When examining the parameters **by sexes** the statistical probe showed significant difference between the eviscerated weight, the withers height, the head length, the ear length, the heart width and the heart length. However, no statistical difference was found in the results of body length, which was 119.7 cm in case of male while 116.05 cm in case of female animals. The phenotypic difference between sexes was well expressed with the figures indicating robustness. In case of males the result (1.54) indicated a powerful withers part, while in females the value of robustness (1.69) showed a longer, less robust body shape. The correlation analysis confirmed a close positive relationship between the eviscerated weight and the withers height ($r=0.84$), as well as between the body length and head length ($r=0.71$). The relationship between the eviscerated weight and the body length was moderate ($r=0.61$). There was moderate positive relationship between the examined parameters of the female animals, in their case the value of the correlation coefficient between the eviscerated weight and withers height was 0.67.

When examining the body parameters of the animals **by sexes within a certain territory** it was found that the eviscerated weight of the male wild boars from the Sárkeszi wild boar

park was the highest (89.67 kg), while the lowest values were weighed in case of males shot in open areas (62.85 kg), the difference, however, did not prove to be significant on $P < 5\%$ level. The same values of eviscerated weight were observed in case of the animals shot in the parks of Ásotthalom and Csibrák, despite the fact that the nutrition of the animals was based on by-products in Ásotthalom, while on feed mixtures in Csibrák. No significant difference was found between the average body lengths of the male animals from different territories, however the value of the body length of the animals from open areas were the highest. Similarly, no difference was found between the withers height, head length, heart length and heart width parameters of the males from different parks.

The values of the eviscerated weight of the females were smaller than that of the males by 22.4% in the wild boar park of Sárkeszi, by 34.1% in Ásotthalom and by 36% in case of the animals from open territories. The eviscerated weight of the females shot in Csibrák was smaller by only 8.8% than that of the males of the same territory. The average eviscerated weight of the females from Sárkeszi and Csibrák was almost the same, despite the fact that the foodstuff available for them was rather varied. Also during the analysis of the body length data the statistical probe confirmed significant difference between the female animals of the different territories. The shortest length was measured among the females from Ásotthalom (98.1 cm), well surpassed by the body lengths of the females from Csibrák and the open areas (129 cm). There was no significant difference observed between the withers height of the females shot in the different territories. Not only was the body length of the females from Ásotthalom smaller than that of the other females from the two other parks and the open territories, but also their withers height. Based on the analysis of the robustness we can state that lower values were characteristic of both the females from Sárkeszi and from Ásotthalom (1.45 and 1.52 respectively), which suggests a robust anterior body part.

When processing the data of all the animals **by age groups** it was found that the body length of the 1-3-year-old reached the 94%-of the body length of the 3-year-old, and then only a slight length increase was observed. On analysing the withers height data it can be stated that during the first year of age the animals reached 69.6% and by their third year of age 91% of the total withers height. When processing the data of head length a result of 36.56 cm was obtained in case of animals younger than a year, which was 69.2% of the head length of the three-year-old; by the age of 1-3-years this ratio was 90.9%. The results of the correlation examinations showed that the relationship between the parameters of the animals younger

than a year was moderately positive. The body length and withers height were the exceptions, where the 0.81 value of the correlation coefficient showed a close relationship.

Between the body sizes of the wild boars aged 1-3 years the tightness of the relationships weaken, showed loose correlation, except for the correlation between the eviscerated weight and heart length and heart width, which was moderate. The correlation examinations showed moderate correlation between the body length and head length, eviscerated weight and heart width in the animals aged over three years, while between the other body size parameters loose correlation was observed.

According to the results of the variance analysis when comparing **the animals of the same age group by territories** significant differences was found between most of the parameters taken in animals younger than one year. The exceptions were the heart length and, out of the counted data, the head-ear ratio. When analysing the data of this age group it was found that the smallest average eviscerated weight belonged to the wild boars from Csibrák (24.21 kg) despite the fact that intensive nutrition technology was applied. The largest average eviscerated weight was found in the animals shot in the Sárkeszi wild boar park (54.0 kg), where there was available food necessary for the initial intensive growth. The eviscerated weights of the wild boars from open areas and that of the animals from Ásotthalom, where their nutrition was based on by-products and maize, did not differ from each other. There was no statistically proved difference between the average body lengths of the animals younger than one year and shot in confined parks; the largest values were seen in case of the body lengths of the animals shot in open areas. Similarly, the animals shot in open areas had the highest values of head length and withers height.

In the 1-3-year-old age group no difference was shown between the average eviscerated weight, withers height and heart length by territories, while significant difference was found in the body length of this age group. The largest body length was measured in the animals from open territories (151.5 cm), while the animals shot in Sárkeszi were the shortest (107.6 cm). In this age group the head lengths of the wild boars shot in confined parks were the same; that of the animals from open areas, however, differed from that. Out of the counted values it was the robust values that indicated the powerfulness of the fore part of the animals shot in Sárkeszi and in Ásotthalom, and the typically stretched body structure in case of wild boars from Csibrák and the open areas.

The body size examinations of the over 3 year-old age group showed that there were differences between the animals from different territories regarding both their eviscerated

weight and their withers height. In this age group the largest eviscerated weight and withers height was found in the wild boars feeding on by-products and maize, while the weight and withers height of the animals consuming feed-mix was far behind that. No differences were revealed in the average values of body length and head length of the animals by territories.

Analysing the data **by sexes within a certain territory** the only differences were manifested in the eviscerated weight and heart parameters in case of the wild boars from Sárkeszi. The eviscerated weight of the male animals from this park was 22.4% larger than that of the females. In the animals from Ásotthalom significant differences were shown between the sexes in each surveyed parameter. The eviscerated weight of the male animals was larger by 34% than that of the females, while their body lengths by 13%, withers height by 16.5% and head length by 16.4%. When processing the body size data of the male and female wild boars from Csibrák the statistical probe confirmed significant difference both in case of withers height and head length. The head length was higher in males than in females approximately by 8%, while the withers height by 10%. In case of females shot in this confined park the long, stretched body was typical, expressed in the 1.86 value of robustness, while the 1.56 value of males indicates the powerfulness of the short body and the withers part. Significant difference was observed in the eviscerated weight of the male and female wild boars shot in open areas. The weight of males was approximately by 36% larger than that of the females, 62.85 kg and 40.25 kg respectively. Another difference was proved in the ear length of males and females; however in case of the other parameters the statistical probe did not confirm any significant difference.

On processing the data **between the age groups within a certain territory** it was observed that the eviscerated weight of the animals of the Sárkeszi wild boar park, which were younger than one year, was approximately 50% of the weight of the ones older than three years. This high value was certainly due to the fact that in this park an unlimited amount of animal-originated as well as plant-originated food with high protein content is available for the animals. No difference was confirmed between the 1-3-year age group and over 3-year-old age group concerning their eviscerated weight, body length, withers height, and counted parameters either. In Ásotthalom, the animals younger than one year had 28% of the weight of the ones older than three years. The weight of the animals older than three years proved to be larger by 42.3 kg than that of the values weighed in 1-3-year old ones. The body length of the two older age groups did not differ from each other, while differences appeared in case of

eviscerated weight, head length, ear length, and withers height as well as heart parameters. The eviscerated weight of the under one year old animals shot in Csibrák, where intensive nutrition technology was applied, was only 24.5% of the weight of the ones older than three years. This age group was kept in small areas of the park, where the density was rather high, therefore, due to permanent stress effects and in spite of the good quality food the weight gain of the animals was not favourable. Regarding the eviscerated weight of the 1-3-year-old age group it can be observed that after the animals were transported to another large area of the park their weight became the same as was experienced in case of the wild boars shot in Sárkeszi or in Ásotthalom. In case of the age groups of the 1-3-year-old and over the 3-year-old the body length, the head length and the heart width were statistically different. Also differences were observed in the eviscerated weight, body length and ear length of the wild boars from open areas belonging to the 1-3-year-old and over 3-year-old age groups. The animals hunted this place and younger than one year had 30% of the weight of the ones older than three years. The weight of the animals shot in open spaces was smaller by 5.7-12%-than that of the ones hunted in parks considering the same age group. However, speaking of both withers height and head length and heart sizes, it was observed that by the age of 1-3 years the animals achieved 95-96% of the size of the animals aged over 3 years, which was only experienced in case of the intensively fed wild boars from Csibrák.

Dry matter, protein and fat content examination in meat samples

On processing the examination data of all the animals it was found that the average dry matter content of wild boar meat was 30.13%, the crude protein content 20.85%, while the crude fat content 8.28%. The result of the correlation examination indicated that there was a tight relationship between the dry matter and crude fat content, the dry matter and crude protein content was negative and loose, similarly to the crude fat content having also negative but moderate relationship with the crude protein content.

Examining the nutrition values of wild boar samples **by territories** significant differences were found in case of all the three parameters. The dry matter content was the same as in the samples from Ásotthalom and also from the open areas, being definitely different from that of the samples taken from animals shot in Sárkeszi and Csibrák. The crude protein content of the meat from animals in Sárkeszi, which were fed on reed rhizome, fish and worms and also of the animals from Csibrák consuming feed mix was higher than that of

the wild boars feeding on by-products and corn in Ásotthalom. The lowest protein content was found in the meat of the animals from the open areas (18.29%) feeding on cultivated plants. The crude fat examinations showed the highest amount of fat in the meat of the animals consuming by-products and maize (11.63%), followed by that of the wild boars from open territories (8.72%). The lowest level of fat was measured in the meat of the animals from Sárkeszi (4.61%). The correlation examination showed that in case of the meat samples from Sárkeszi there was a tight positive relationship between the dry matter and crude fat content, while it was negative between dry matter and crude protein contents and positive between crude protein and crude fat, which however, did not prove to be significant.

Also a tight and positive relationship was described in case of the dry matter and crude fat content of the samples from Ásotthalom. The dry matter and crude protein content of these samples were in loose negative correlation, while the crude protein and crude fat content in moderately negative correlation. The dry matter and crude fat content of the meat samples from Csibrák confirmed a tight correlation again, while there was a loose negative relationship between crude protein and crude fat contents. No correlation was confirmed between dry matter and crude protein content. According to the results of correlation relationships between the parameters the tightest relationship was confirmed between the dry matter and crude fat content of the food samples from open areas ($r=0.92$; $R^2=85$, $P<1\%$). A loose negative correlation was observed between the crude protein and crude fat content, while the statistical probe of the correlation between the dry matter and crude protein contents did not prove any significant relationship in this case either.

The data analysis **by age groups** found that the crude fat content of the samples from animals younger than one year significantly exceeded that of the other two age groups being higher by 3.72% than that of the 1-3-year-old age group and by 3.03% than that of the over 3-year-old. No statistically proven difference was found between the fat content of the meat from the 1-3-year-old age group and that of the over 3-year-old. Based on the results of correlation relationships between the parameters the tightest relationship was observed between the dry matter and crude fat contents of all three age groups. In case of the samples from animals younger than one year and the ones between 1-3 years the relationship was tight positive, while in case of the samples of the animals over three years it was especially tight positive ($r=0.94$; $R^2=88$, $P<1\%$). The dry matter content showed a loose negative relationship with crude protein content in the samples of animals younger than one year, the value of the correlation coefficient was $r=-0.36$. The crude protein and crude fat content showed a

moderate negative tightness in the samples of the animals younger than one year and in the ones older than three years. In the intermediate age group the correlation was weaker but also negative. The value of the determination coefficient was between 10.5 and 19.4 indicating a loose relationship between the two parameters.

The examination of the meat **of the same age group by territories** showed difference in the dry matter, crude protein and crude fat content in the animals younger than one year. A higher dry matter content was typical of the meat of the wild boars from Ásotthalom and the open areas, while it was lower in case of the animals shot in Sárkeszi and Csibrák. The meat of the animals shot in Ásotthalom and in open areas contained the lowest dry matter content. It was the highest in the meat samples from Sárkeszi, and the protein content of the meat of the animals from Csibrák differed only slightly. Rather high values were observed in case of the fat content of the meat of animals from Ásotthalom and from open areas (13.75%, 9.45%), while the meat of the animals shot in Sárkeszi and Csibrák contained much less fat (3.73%, 4.4%). Considering the 1-3-year-old age group it was also the meat of the animals from Ásotthalom and the open areas where the dry matter content was the highest, although the difference did not prove to be significant. The crude protein content of the meat samples taken from all the three confined parks was approximately the same (22.91%, 21.36%, and 21.9%); the protein content of the samples from open areas (18.29%) fell behind these values. It must be mentioned that the protein content of the meat of wild boars from Sárkeszi was the highest in this age group as well. The crude fat content of the animals from Sárkeszi and Csibrák was increasing when compared to that of the previous age group; however it did not come close to that of the animals from Ásotthalom and the open areas belonging to the same age group.

No significant difference was found in the dry matter content of the meat of the animals aged over three years when examined by territories. In case of all age groups it was observed that the dry matter content of the meat of animals from Ásotthalom was higher than that of the animals from the other territories. Considering the crude protein content of the wild boars belonging to the old age group it was found that it was the same in the samples taken in Sárkeszi (24.98%) and Csibrák (22.99%), as well as those taken in Ásotthalom (20.68%) and the open areas (19.19%). The tendency of the previous age groups remained, with the highest protein content of the meat of the animals consuming reed rhizome, fish, snail and worms, while the lowest of the animals feeding on plough land plants. The crude fat content in this age group is around 5%, except for the samples from Ásotthalom, where a value of 9.47% was observed, which can be due to the maize supplement.

According to the results of the data processing **between the age groups within a certain territory** the dry matter content of the meat of the animals from Sárkeszi belonging to the 1-3-year-old age group was higher than that of the wild boars older than three years. In this park no statistically proven difference was observed between the age groups with regard to either the crude protein or the crude fat content. In the park in Ásotthalom no significant difference was observed in the dry matter content, however there was in the crude protein and crude fat content between the age groups. No difference was found between the 1-3-year-old or the over the three year old age groups with regard to the crude protein (21.36%, 20.68%) or the crude fat (9.71%, 9.47%) content. No differences could be seen between the age groups in the samples from Csibrák either in the dry matter or in the crude fat content. In case of the samples of wild boars shot in open areas no proven difference appeared in either nutrition value parameter between the age groups. The dry matter and fat content of animals over three years was smaller than that of the younger ones, while the protein content was 1% higher.

When studying the nutrition values of the meat of all the animals **by sexes** in the examination it was observed that the meat of the females contained more dry matter, protein and fat, however this difference was not mathematically-statistically proven. The correlation examinations of both sexes showed tight relationship between the dry matter and crude fat content of the meat samples ($r=0.86$). The relationship between dry matter and crude protein was loose, while the crude protein was in moderate correlation with crude fat content, negatively in both cases.

When examined **by sexes within a certain territory**, statistically proven difference was found only in the nutrition values of the meat from wild boars of Csibrák consuming feed mix. In this park the dry matter and crude fat content of the females was higher than that of the males.

Techno-functional examination in meat samples

Considering the results of the meat samples **by territories** it was found that the water binding ability of the ones taken from the animals in Ásotthalom showed favourable value (14.69%). According to the data obtained this type of meat is suitable for producing meat products after the usually applied cooking, smoking and pressing procedures.

When analysing the techno-functional results **by sexes** it was found that there were no differences in either the water binding or the water keeping ability of the meat samples of the two sexes.

Examining the parameters **by age groups** it was found that in case of all three parameters difference can be proven between the samples of the various age groups. Based on the results of the cooking and pressing tests it was observed that the meat of the animals younger than one and older than three years is more favourable for industrial meat processing.

The techno-functional parameters **between age groups within the same sex** showed that the cooking loss of the animals older than three years was the smallest. The highest cooking loss was found in case of the meat from the animals belonging to the 1-3-year-old age group, however the difference was not significant. Differences were proven between the water binding ability of the male age groups. In this examination also the meat of the male animals older than three years proved to be more favourable since the pressing loss of the younger age groups was rather high (20.63%, 24.6%). The results of the females were better than that of the males. The water keeping and water binding ability of the females younger than one year was the best; almost 5% lower than that of the 1-3-year-old wild boars.

Because of the low element number of the first year, only the data of the wild boars from Ásotthalom and Csibrák were presented **by sexes within a certain territory**. The cooking and pressing loss of the meat of females fed half-intensively (with by-products and maize) was more favourable than the males in the same territory. The statistical analysis, however, did not prove significant difference in either parameter of the males from any confined park.

Saturated and unsaturated fatty acid content in meat samples

On examining the fatty acid content of the meat samples **by territories** it was found that the saturated fatty acid content of the meat of the animals from Sárkeszi and Csibrák was smaller. The high miristin acid (C14:0) and palmitic acid (C16:0) content was unfavourable from nutrition biological point of view, therefore the examination results showed that the food basis of the reedy swamp habitat as well as the feed mixes provided better development. The ratio of the monounsaturated fatty acids was higher in the samples of the animals from Sárkeszi and Csibrák than that of the animals from Ásotthalom and the open areas. The ratio

of polyunsaturated fatty acids was the highest in the samples of the animals from Ásotthalom, (16.15%), the smallest in that of Sárkeszi (13.88%), which can be due to the lower linoleic (C18:2n-6) and linolenic acid (C18:3n-3) content of the samples. It is favourable for production since the oxidation and rancidity disposition of such products is smaller. The analysis of the results of polyunsaturated acids (PUFA) by territory showed a statistically proven difference in case of all fatty acids between the groups with various nutrition backgrounds. The most linoleic acid (13.58%) and linolenic acid (0.83%) was contained by the meat of the animals from Ásotthalom, while the arachidonic acid (C20:4n-6) content of the samples from Csibrák was outstanding. Significant difference was found between the arachidonic acid (C20:4 n-6) content of the wild boar meat and domestic pig meat. This fatty acid content of the wild boar meat significantly exceeded that of the domestic pigs as described in the professional literature.

The results of the examinations **by age groups** pointed out that the saturated fatty acid ratio of the samples of animals younger than one year was almost equal in the samples from Ásotthalom and the open areas (38.8% és 37.53%), while their ratio is smaller in the samples from Csibrák (35.82%) and Sárkeszi (33.42%). Concerning the stearic acid (C18:0) content of the meat samples from Sárkeszi and from open areas it was observed they were smaller (11.32%, 11.82%), than that of the wild boars from Ásotthalom and Csibrák (12.8%, 12.7%). The ratio of monounsaturated fatty acids was 44.59% in the samples from Sárkeszi, while it was 41.55% in the samples from the open territories. The polyunsaturated fatty acid content was the highest in the samples from Csibrák (19.68%) and Ásotthalom (17.43%), while the lowest in the samples from Sárkeszi (13.73%). Significant difference demonstrated in the samples of this age group with regard to linolenic acid (C18:3n-3) content. As for the samples from Ásotthalom and the open areas, they considerably surpassed the linolenic acid content of the meat samples taken from the other two parks. The arachidonic acid (C20:4n-6) content of the meat did not differ between the samples from Sárkeszi, Ásotthalom and the open areas (1.18%-1.80%), however the arachidonic acid content (3.06%) of the sample from Csibrák showed a considerable deviation. Analysing the saturated fatty acid content of the 1-3-year-old age group it was found that the lowest value (32.99%) was found in the meat samples of the animals (consuming feed mixture) from Csibrák, which can be explained by the low amount of palmitic acid (C16:0) and stearic acid (C18:0). A monounsaturated fatty acid ratio of over 40% was characteristic of the samples from the parks of Csibrák and Sárkeszi, as well as the open areas. Concerning polyunsaturated fatty acids in this age group, no significant

differences were demonstrated between the territories as for linoleic acid (C18:2n-6) and arachidonic acid (C20:4n-6) contents. Regarding the saturated fatty acid ratio of the meat from wild boars older than three years it was found that owing to the large amount of palmitic acid (C16:0) and stearic acid (C18:0) it was the highest in the samples from Sárkeszi (41.2%), and the most favourable value in the samples of the animals from Csibrák (33.21%). The monounsaturated fatty acids ratio was the least different in this age group. Considering the territorial ratios, the largest difference was 5.29%, while in the samples of animals younger than one year it was 7.58%, and that of the 1-3-year-old wild boars was 6.07%. The polyunsaturated fatty acids ratio changed between 14.16% and 15.93%, with the highest value in the meat of the wild boars from Csibrák, which can be explained with the higher arachidonic acid (C20:4n-6) ratio.

The results of the data processing **between the age groups within a certain territory** of the samples from wild boars in Sárkeszi showed, that the saturated fatty acid ratio of the 1-3-year-old age group was only by 2.2% higher than that of the animals younger than one year. The fatty acid profile of the meat of the animals older than three years typically contained more myristic (C14:0), palmitic (C16:0), stearic (C18:0) and oleic (C18:1) acids than that of the younger age groups, the differences between the average values, however, were not proved mathematical-statistically. The saturated fatty acid ratio in the meat of the Ásotthalom wild boars younger than a year was 38.78%, in the 1-3-year-old age group 39.65%, both values were higher than that of the samples taken in Sárkeszi (33.42% and 35.66%). The monounsaturated fatty acids ratio is lower, while the polyunsaturated fatty acids ratio was higher than in the samples from Sárkeszi. The saturated fatty acid ratio of the meat from animals in the young age group, due to the higher palmitic acid, heptadecanoic acid and stearic acid ratio, proved to be higher (35.82%), than that of the animals older than one year (32.99%, 33.21%). Significant differences were found by age groups concerning monounsaturated fatty acids. In the samples of the 1-3-year-old a higher ratio of fatty acid was observed (45.72%), at the same time the polyunsaturated ratio was rather low (13.26%). The average quantity of polyunsaturated fatty acids in the meat of the boars younger than one year was higher than that of the older animals. The saturated fatty acid content of the meat of boars younger than one year shot in open areas was the same, their monounsaturated fatty acid content was almost the same as that of the meat from animals belonging to 1-3-year-old age group. In the meat of the boars older than three years the lowest saturated fatty acid (34.63%) and the highest monounsaturated fatty acid ratio (43.69%) was found. The meat

samples of animals younger than a year had more favourable linolenic acid (C18:3n-3) content (0.76%) than that of the older age groups (0.54%, 0.39%), however the deviance was not proved statistically.

Based on the results of the examination **by sexes** it was observed that no differences showed in the saturated and polyunsaturated fatty acid ratio; the statistical probe indicated significant difference between the two sexes only in case of oleic acid (C18:1) and arachidonic acid (C20:4n-6).

Analysing the results By sexes within a certain territory it was found that no differences appeared in the fatty acid contents of the meat of animals shot in Ásotthalom and the open areas. In case of the samples from Sárkeszi only the eicosanoic acid (C20:2n-6) content was different between the sexes. In the samples of the females in Csibrák the higher level of miristin acid (C14:0) and palmitic acid (C16:0) was typical, while in that of the males the linoleic acid (C18:2n-6), eicosanoic acid (C20:2n-6) and arachidonic acid (C20:4n-6).

Mineral content in meat samples

Considering the results **by territories** it was found that the Ca content in the meat of animals from Ásotthalom and from the open areas was prominent (188.3 mg/kg and 197.66 mg/kg), which can be explained by the maize available in the parks as well as in the plough land and also the soil type. However, the soil features of the parks in Sárkeszi and in Csibrák cannot be related to the low levels of Ca in meat samples (101.73 mg/kg and 77.29 mg/kg). The low level of P content in the samples from Ásotthalom well indicated that of the soils and also the lack of cereal nutrition. The highest P content was measured in the meat of the wild boars from open territories owing to the consumption of cereals grown in their habitat. Soils with higher Mg content (Sárkeszi, Csibrák) resulted in higher Mg content in the meat as well, however the water keeping ability of them was not favourable. The negative effect of Ca, P and Fe on Mn was not proved in our examination, on the contrary, the highest Mn levels were observed in the samples containing the most Ca, P and Fe. The low Mn content (0.23 mg/kg) of the meat samples from Sárkeszi was the obvious consequence of the Mn-poor vegetation of the swamp and turf soils. Considering the copper content both the soil of the park in Ásotthalom and the meat of the wild boars shot there contained the least amount. There was significant difference between the Fe content of the meat samples of the four territories. The

Fe levels of the samples from confined parks were similar as opposed to that of the open areas. The Zn content (41.19 mg/kg) of the meat samples from related to, on the one hand, the little Zn content of the soil of the (15.75 mg/kg), on the other hand the negative effect of Ca might have dominated. Out of the examined elements it was the zinc, the tendency of which was the same considering both soil and meat. When comparing our results to that of the domestic pig it can be pronounced that the wild boar meat contains much more zinc than that of the meat of the domestic pig. On analysing the iodine examination data it can be stated that significant differences were found by territories, where the iodine content of the meat samples from Csibrák, and particularly the open areas, were outstandingly high. The selenium content of the soils did not affect the selenium content of the meat.

Regarding the mineral content of the meat **by age groups** the analysis did not indicate significant difference between the iron, copper, iodine and selenium content of the three age groups. Out of the macro-elements the most calcium was measured in the samples of the animals younger than one year, while the most phosphorus and magnesium in the samples of the 1-3-year-old. Considering the micro-elements the zinc content showed the most significant difference, the meat of the animals older than three years contained approximately 8% more than that of the younger ones.

On examining the meat samples **of the same age group by territories** it was found that in the Ca and Zn content of the meat from animals younger than one year differences appeared between the territories. The P, Mn and I levels of the meat samples from the three confined parks was smaller than that was measured in the meat of the wild boars from open territories. When comparing the meat samples of the 1-3-year-old age group by territories, no difference was proved in their Zn and Se levels. Considering the samples from the three confined parks the most Mg, Fe and Cu was measured in the ones from the animals feeding on feed mixture, however the samples of the animals from the open areas contained considerably more of these elements. In case of all three age groups it was found that the P, Mn, Fe and I levels of the samples from open areas was higher than that of the animals from the confined parks.

As a result of the examination **between the age groups within a certain territory** it was found that the iodine content of the meat of 1-3-year-old animals in Sárkeszi was higher than that of the young or old animals. The Mg, Mn and Se content showed a decreasing tendency

with the growing age however it was not statistically proved. When examining the data from Ásotthalom the slight decline of the Mn and Fe content was observed. The statistical probe showed significant differences in the element levels of the meat from Csibrák in case of P, Fe and Cu on $P < 5\%$ level between the age groups. According to the results, the meat of the 1-3-year-old animals contained the most of these elements. A decrease can be observed in the Ca and I levels of the meat from open areas; an increase in the Zn and Se content of the meat of older age groups, however the variance analysis did not indicate any significant difference.

Next the element content of the meat was examined **by sexes**. Considering the results of all the animals it was found that the statistical probe did not prove significant difference in case of any elements between the group-pairs. Similarly, no difference was observed between the results of the male and female animals of the same age group, the statistical probe did not prove any deviance.

When examining the meat of the animals **of the same sex by age groups** it was observed that the Mg and Cu content of the meat of the 1-3-year-old males was higher than that of the two other age groups. In the meat of the females younger than one year higher Ca and Cu levels, while in the 1-3-year-old higher Mg and Zn levels were measured than in the other age groups, which differences were statistically proved.

When examining the element content of the meat samples by sexes within a certain territory differences between the sexes could be observed in the iodine and selenium content of the samples of the animals shot in Sárkeszi in the zinc content in the samples from Ásotthalom, while in the magnesium content in the samples from the open areas. No differences were found between the element content of the samples from Csibrák, where the animals consumed feed mix.

During the correlation examination of the certain elements based on the meat-examination results of **all animals** a moderate positive relationship was found between the Ca and the Mn ($r=0.46$), the P and the Mg ($r=0.67$), the P and the Cu ($r=0.46$), the Mg and the Zn ($r=0.48$), as well as the Fe and the Cu ($r=0.41$). A tight relationship of the Mn and the Fe was proved ($r=0.79$).

Based on the examinations **by territories** it was found that in the meat samples from Sárkeszi there was a moderate relationship the Ca and Fe content, the P and I content, as well as the I and Se content, while there was a tight relationship between their Mg and the Mn content. In case of the samples from the open areas moderate correlation was found between the P and the Cu, the Mg and the Zn, the Mn and the Fe, the Mn and the Cu, as well as the Cu and the iodine content, where the correlation coefficient changed between 0.45 and 0.54. In the samples from the open areas the tightest relationship was observed between the Mg and the P content ($r=0.70$). Based on the correlation relationships of the samples from Ásotthalom it was found that the relationship was moderate positive between the examined parameters in case of the Ca and Fe, P and Mg, P and Cu, Mg and Cu, Mg and Zn and the Mn and Fe, the correlation coefficient values changed between 0.44 and 0.66, except for the Ca and the Mn, where the values of the correlation coefficient was 0.72, showing tight relationship. The correlation examinations showed moderate correlation between the Ca and Mn, Ca and Fe, the P and Fe, the P and Cu, the Mg and Fe, the Mg and Cu, the Mn and Fe, the Fe and Cu, as well as the Cu and Zn levels, when examining the element content of the meat samples from Csibrák. The relationship between the P and the Mg content of the meat samples from this park was quite tight positive, with a correlation coefficient value of 0.93.

Analysing the tightness of the relationship between the elements **by sexes** it was found that moderate positive correlation existed between the Ca and Mn, the P and Mg, the P and Cu, the Mg and Zn, as well as the Fe and the iodine in case of both sexes. The tight Mn and Fe relationship was typical in both sexes. When analysing the samples of males a moderate positive relationship was found between the P and Fe, the Mn and Cu, as well as the Fe and Cu, while in case of females there was a typically weak relationship between these elements.

Analysing the correlations between the elements **by age groups** it was observed that the relationship between the Mn and Fe grew tighter with the increasing age. A moderate correlation was typical in case of the Mg-Zn relationship ($r=0.55$), a loose correlation in the 1-3-year-old age group ($r=0.37$), and even weaker in case of the animals older than three years ($r=0.21$). Similar tendency can be observed in the relationship of the Mn and the iodine and also in that of the Fe and the iodine, the correlation examination proved moderate then loose correlation in the younger age groups, while there was no significant correlation in the samples of the animals older than three years.

NEW SCIENTIFIC RESULTS

1. Regarding the body parameters, the relationship between the eviscerated weight and withers height was tighter than that between the eviscerated weight and body length. Therefore it can be suggested for the selection of breeding boars in the intensive system wild boar parks to consider the withers height primarily and the body length should be the secondary in this respect. According to our examinations there were no differences between either the body length or the head length of the males and that of the females therefore the secondary genital difference appearing in the body structure of the males can be traced back to the powerfulness of their withers part.
2. The eviscerated weight, body length and withers height of the males are not influenced by the nutrition and feeding conditions varied by territories, while they are affected in females.
3. There is a tight positive correlation between the dry matter and fat levels of the meat of wild boars from confined parks, while there is a moderate negative correlation between the fat and protein content.
4. There is no difference in the protein and fat content in the meat of the middle-aged (1-3-year-old) and the old (over 3 years) wild boars from confined parks.
5. The meat of the wild boars nourished with concentrates is more favourable for human consumption, because of its fatty acid composition compared with those animals' meat (with unfavourable fatty acid content and composition) which were fed with by-products of arable and horticultural production and supplemented with corn.
6. The negative effect of Ca, P and Fe concentration on Mn level was not confirmed in our examination, moreover the highest Mn levels were observed in the samples containing the most Ca, P and Fe. With the growing age of the animals, an ever growing tightness of positive correlation was typical in the Mn and Fe relationship.

PRACTICAL USABILITY OF THE RESULTS

When keeping groups of piglets and young animals in a small ground space in confined parks the adverse effect of crowdedness on weight gain cannot be compensated by nutrition with the expertly compiled feed mixes. This is the reason why special care must be taken when housing young animals and determining their population density.

The protein content of the meat samples from gardens applying natural nutrition as well as feeding in accordance with the demand of the animals was higher, the fat content lower than that of the animals feeding ad hoc with seasonal by-products and maize. To achieve better meat quality it would be advisable for the operators of the wild boar parks to apply rationally compiled food for the nutrition of the animals.

During the techno-functional examinations it can be suggested that wild meat processing units handle the meat of the various sexes and age groups separately, according to the character of the product to be made. In addition to the individual identification it is recommended to provide information on the sex and age of the wild boar both for the processing units and the consumer.

Out of the consumed feed mix, the wild boar produces meat with more favourable saturated fatty acid content than domestic pigs do. At the same time the linoleic acid content of such meat is rather low. It would be desirable to increase the concentration of n-3 from nutrition-biological point of view; however it would have a harmful effect on the conservation and shelf-life of the meat, thus lessening the oxidative stability of the meat.

In all three age groups the phosphorus, manganese, iron and iodine content of the meat samples taken from free areas was higher than that measured in the samples of the animals from private wild boar farms. This is certainly can be explained by the omnivorous feeding type of the wild boar also on the variety of food available for them on the fields. That is the reason why it is recommended to place salt licks with micro-element content in confined wild parks.

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