The Comparison Analysis of the Main Chemical Composition Parameters of Wild Boar Meat and Pork

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Abstract
The chemical composition of wild boar meat from wild boar parks with various habitats and different feeding facilities was analysed. Samples were collected from *m. serratus anterior* – during the winter hunting period. The protein, the total fat, the saturated and unsaturated fatty acid content were measured and also and those elements which have great importance on human alimentation. The results were compared with other author's data of the same parameters of pork. The aim of the study was to compare the effect of different feeding systems on the ingredients of wild boar meat, and the accidental analogy with the ingredients of pork. There was no difference in protein content. The value of miristic acid (C14:0) in the samples of extensively and intensively fed group was more favourable than that of pork. Pork contains more MUFA (palmitoleic acid – C16:1). The semi-intensively fed wild boar's meat and pork contained linoleic acid (C18:3 n3) almost on the same level. The greatest difference was detected in the level of arachidonic acid (C20:4 n6). The samples from all wild boar groups contained more of this fatty acid than it was published about domestic pigs. Out of the microelements, the iodine and zinc had higher value in wild boar meat than in pork.

Keywords: chemical composition, meat, pork, wild boar

1. Introduction

In our country, the annual, per capita meat consumption significantly decreased in the last decade. According to the data of the FAO [1], the meat consumption of Hungarian people was 74.7 kg per capita, per year, of which only 0.6 kg was venison. A notable domination was reported by POLGÁR's essay published in 2007 [2]. At that time, the per capita meat consumption was 63 kg, the other types of meat (sheep, goat, fish, rabbit, venison) were only 1.1 kg. A survey on the eating habits of Hungarian households showed, that venison is served only on special occasions [3].

The nutrients of meat are indispensable for our vital functions, they are very important protein, fat, vitamin and mineral sources, thereby they are rich in flavouring materials [4]. The composition and the quality of meat are greatly influenced by breeding conditions [5]. The meat quality of domestic animals, which were bred in natural conditions, is higher, and it means greater food safety for the consumer. The fat content of the meat changes on a wide scale (1-45 g/100 g), it depends on the species, the breed, the age, the sex and the condition of the animal. The smell and taste of venison is species-specific, their colour is dark red, or brownish. The consumer behaviour is greatly influenced by these attributions. The fat content of the wild animal's meat is lower (1-4%), while the protein content is higher (21-25%).

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The iron, the zinc, the copper, the manganese and the selenium are important minerals of the assorted flesh [6].
It is an important trait of the iron in the meat, that greater amount of it (15-35%) is utilized during the absorption, while only 1-5% of the iron content of the foods is made up of plants [4].
The mezo- and microelements play a significant role in the metabolism processes of the body.
The consumers of the developed countries pay more attention to the preservation of their health, gather more information about the healthy lifestyle, and they are consciously search for the foods, they presume healthy [7; 8]. Looking at its significance, the wild boar meat is on the second place in the national venison trade. It is a pity that it does not get on Hungarian consumers' table but it is sold into foreign countries. The wild boar is an omnivorous animal. In its natural habitat, 90-95% of its food is originated from plants, and 5-10% is originated from animals. It eats the parts of herbaceous plants beneath and above ground, the fruit of woody plants, the eggs and offspring of ground-nesting birds, snails, frogs, larva and chrysalises [9; 10]. The possibility of diversified ingestion of the wild animals is ensured by the favourable facilities of the Hungarian habitats, therefore there is not element-shortage amongst them. However, in captivity the consumption of non-natural foods dominates, the man-provided foods will be the primary.
During our work, we compared data from essays about the chemical composition of commercial pork, with our own results of the wild boar meat samples. We tried to find out how the different, available foods influence the nutritional parameters of the wild boar meat, and how these data compare to the data of the commercial pork.

2. Material and method

Our examinations were done on three Hungarian wild boar parks, with very different soil conditions and flora. During our examination, we made the botanical investigation of the area at first, with the help of the National Habitat-classification System.
In the area of the wild boar park in Csongrád county (Ásotthalom) forestry acacia plantation (NHS=S1), forestry poplar plantation (NHS=S2), , forestry pine plantation (NHS=S4), featureless very weedy, turf with tall dry stalk (NHS=O1-O6), slightly weedy, mosaic dry and fresh turf (NHS=O5-6) are situated.
In the wild boar park in Tolna county (Csibrák), the typical plant community is sessile oak (NHS=R3), forestry acacia plantation (NHS=S1), weed community with tall dry stalk (NHS=R), and glade of installed forestry acacia plantation (NHS=S1).
In the wild boar park in Fejér county (Sárkeszi), featureless secondary marsh, reeds, tall dry stalks (NHS=B1b), degraded ash planted forest (NHS=R3) and featureless ash-elm planted forest (NHS=R3) are located.

As a second step, we determined the keeping and feeding circumstances of the wild boars (the intensity of the parks). The wild boar park in Fejér county was made an excellent habitat for the wild boars by its features, beside the available foods (reed roots, fish and snail), it was not necessary to supplement, in respect of feeding, it can be considered as an extensive place. In the park in Csongrád county the feeding of the animals was based on horticultural and tillage secondary products (melon, potato, cucumber, cauliflower, cabbage, carrot, paprika, tomato, apple), with some corn-cobs supplement. We considered this place as semi-intensive. In the park in Tolna county, which got the intensive ranging amongst the three, the animals eat only fodder mixture, specially made for wild boars. In the semi-intensive park, just like in the intensive park, the feeding was adjusted according to the consumption.
The sampling of the meat was made in the winter hunting season, right after the hunting. 500 g sample was taken of the shot animals (n=66) after the evisceration. Because of the specialities of venison processing, the samples are from the *m. serratus anterior*. The samples were kept for 24 hours on 4 °C, and then they were frozen. The samples were stored in refrigerator until the laboratory processing. Applied experimental methods:
Determination of elemental content with ICP-OES and ICP-MS technology,
Determination of fatty acid composition with the method of Bligh and Dyer, with the help of HP

Agilent Technologies 6890N type gas chromatograph.
The data were analysed with the method of ANOVA. The homogeneity of the variances were examined with the Levene-test. In case of heterogeneity, the Tamhane-test was applied, in case of homogeneity the results of the LSD-test were considered. The analysis was made with the SPSS for Windows 11.0 software.

3. Results and discussion

On the basis of the procession of the data of the meat-examination (Table 1.), we can claim that there is no difference between the protein content of the meat of the wild boars from the extensive and intensive parks.
The fat content of the meats shows an interesting result. In the extensive and intensive parks the values are much lower (4.27%, 6.74%), than in the samples from the semi-intensive park (14.12%). The values, we got, are still lower, than the ones ZMIJEWSKI and KORZENIOWSKI (2001) published in their essay (1.95%) [11]. The data of the samples from the semi-intensive park are the same, as the research results of TÓTH et al. (2009) about the meat of Mangalitza pigs from organic production [12]. LUGASI et al. (2006) examined the fat content of the meat of the Mangalitza, and the Large white X Dutch landrace. In case of Mangalitza 10.3%, in case of the cross-bred animals 5% was the result [13]. ŠEGULA et al. (2007) examined the meat quality of the free-kept Large white, Landrace and Pietrain pigs. The animals ate only the vegetation of the pasture, and pumpkin at the end of the breeding period [14]. KLIMIENÉ et al. (2010) got similar data, who examined the meat of cross-bred offspring (Lithuanian large white X wild boar). There was no significant difference in the protein and fat content between the results of the large white and the F1 generation [15]. In respect of the protein content higher, in respect of the fat content lower values were measured in their samples, compared to our samples. Japanese researchers [16] published similar results about the examination of the meat of cross-bred animals (domestic pig X wild boar). MARSICO et al. (2004) carried out feeding experiments on domestic pigs and wild boars, in which they verified that the fed fodder does not influence the chemical features of the meat. The meat of the wild boar always contained more protein and less fat, than the meat of the domestic pig [17]. REN GUANG-ZHI et al. (2008) made the examination of the meat of five domestic pig species, of which we publish the results of the Duroc species [18]. LOPEZ-BOTE (1998) analysed the fat content of the meat of the free-kept Iberian pigs. The fodders of the animals were acorn and the grass of the pasture [19]. PEREZ SERRANO (2008) also made experiments with Iberian pigs and cross-bred animals (Iberian X Duroc) [20]. Their results are the same, as the results of our samples from the semi-intensive fed wild boars. The result of PEINADO et al. (2008) was 4.6% total fat content in the meat of Large white X Landrace pigs, and this value is fit to fat content of the meat of wild boars which consume feed only from natural resources [21]. Very low fat content (2.24%) was found by JAKIČ DIMIČ at al. (2007) who examined Large white, German landrace, Belgian landrace and New Hampshire pigs fed with silage and protein (plant and animal protein sources) [22]. NILZÉN et al. (2001) analyzed the pork of Hampshire X Yorkshire and Hampshire X (Swedish landrace X Yorkshire) kept free range and in stable also. The fat content in the meat of free range pigs was 2.1% and in stable was 2.4% [23]. The protein content of these animals corresponds with our results (Table 1.).
The fatty acid composition of our samples (Table 2.) is parallel with the results of PALEARI et al. (2003) also in wild boar meat analyses [24]. The highest saturated fatty acid (SFA) content (39.13%) was measured in the meat of the semi-intensive fed wild boars. In the extensive and intensive groups almost the same SFA result (34.72% and 32.91%) was found. Among the examined fatty acids the palmitic acid (C16:0) did not showed significant difference between the groups. The miristic acid (C14:0) and palmitic acid (C16:0) level of the extensive and intensive groups was lower than it was found by other authors in domestic pig. Among the mono unsaturated fatty acids the palmitoleic acid (C16:1) and the oleic acid (C18:1) showed difference by the different habitats of wild boars. The fatty acid composition was analysed in different feeding circumstances in different domestic pig populations: Duroc [20], Slovenian landrace and Slovenian large white [25], Landrace X Large white X Duroc crossbred [26], and in all of them the level of palmitoleic acid was higher

than in the meat of wild boars. The altered feeding of the groups did not result in differences in the level of PUFA (linolic acid (C18:2 n-6) and arachidonic acid (C20:4 n-6)). ZUMBO et al. (2007) studied the level of linolic acid in a local breed (Nero Siciliano) and found lower level (4.72%) in the group was fed with acorn than in the group which was fed with barley (7.10%) [27]. In our samples higher value was measured in all groups (extensive: 11.85%, semi-intensive: 13.53, intensive: 12.27%). The highest linolenic acid (C18:3 n-3) value (0.79%) was found in the semi-intensive group, and this result fit to the data of FURMAN et al. 2007, and GIULIOTTI et al. 2007 [25; 28]. We found significantly higher level of arachidonic acid in the wild boar meat, than it was published in pork.

The level of Mn and iodine in the wild boar groups did not differ significantly (Table 3) and corresponded to the values published about pork. The soil of the extensive park contained lower manganese than the other two habitats (143 mg/kg vs. 314 mg/kg and 484.5 mg/kg). The calcium content of the semi-intensive group was very high (189.30 mg/kg) supposedly caused by the calcariferous sandy soil. The Ca level of habitats' soil of extensive (18.38 g/kg) and intensive (27.98 g/kg) groups comparing to the meat has similar pattern. The Ca levels of pork in publications are near the results of extensive and semi-intensive groups. The P content in the extensive and intensive groups is similar (2500 mg/kg), oppositely the law level (2009 mg/kg) of the semi-intensive group. One reason of the difference is the soil quality of the habitats, and the P content of the concentrates at the extensive habitat.

Table 1. Protein and fat content of wild boar meat and commercial pork

	Wild boar			**Commercial pork**
	Extensive $\bar{x} \pm s$ (n=6)	**Semi-intensive** $\bar{x} \pm s$ (n=30)	**Intensive** $\bar{x} \pm s$ (n=30)	
Protein (%)	21.83±0.57	19.89±1.53	21.87±1.29	19.10±2.70 [12] 22.44±1.15 [22] 22.31±0.85 [18] 23.42±0.14 [15] 21.00±0.15 [23] 24.20±0.60 [14] 21.2±0.11 [21] 20.10±0.34 [20]
Fat (%)	4.27±1.78	14.12±6.79	6.74±4.63	15.07±3.47 [12] 2.24±2.73 [22] 3.16±0.36 [18] 1.75±0.07 [15] 1.77±0.05 [29] 2.10±0.13 [23] 10.00 – 13.00 [19] 1.00±0.37 [14] 4.6±0.20 [21] 10.3±3.8 [13]

Table 2. Saturated and unsaturated fatty acid content of wild boar meat and commercial pork (percentage of the total fatty acid content)

Fatty acid	Wild boar			Commercial pork
	Extensive $\bar{x} \pm s$ (n=6)	Semi-intensive $\bar{x} \pm s$ (n=30)	Intensive $\bar{x} \pm s$ (n=30)	
C14:0	0.9±0.224	1.3±0.36	0.8±0.14	1.53±0.05 [25] 1.22±0.17 [26]
C16:0	21.3±2.99	24.7±1.84	20.8±1.94	24,0±0,15 [20] 25.14±0.37 [25] 21.74±2.82 [26] 24.6±1.1 [13] 23.86±0.32 [28]
C18:0	12.3±2.54	12.9±1.60	11.1±2.19	13.00±0.29 [20] 14.01±0.57 [25] 14.73±2.52 [26] 9.20±1.0 [13] 12.30±0.41 [28]
C20:0	0.3±0.09	0.2±0.07	0.2±0.04	0.23±0.04 [26] 0.06±0.01 [28]
C16:1	0.3±0.08	0.4±0.18	0.3±0.08	2.50±0.16 [25] 0.91±0.22 [26]
C18:1	40.6±4.63	35.6±4.50	39.5±6.14	48.20±0.27 [20] 39.80±0.53 [25] 30.39±1.44 [26] 51.30±1.9 [13] 47.58±0.43 [28]
C18:2 (n-6)	11.9±1.30	13.5±3.39	12.3±4.26	8.10±0.18 [20] 12.47±0.57 [25] 25.26±5.27 [26] 6.20±2.0 [13] 4.72±0.02 [27] 10.58±0.32 [28]
C18:3 (n-3)	0.3±0.04	0.8±0.48	0.3±0.18	0.79±0.10 [25] 1.00±0.23 [26] 0.40±0.20 [13] 0.78±0.04 [28] 0.23±0.05 [27]
C20:4 (n-6)	1.5±0.43	1.3±1.50	2.0±1.49	0.58±0.03 [25] 0.60±0.2 [13] 0.26±0.05 [26] 0.05±0.008 [28] 0.87±0.02 [27]

Table 3. Element content of wild boar meat and commercial pork

Elements	Wild boar			Commercial pork
	Extensive $\bar{x} \pm s$ (n=6)	Semi-intensive $\bar{x} \pm s$ (n=30)	Intensive $\bar{x} \pm s$ (n=30)	
Ca (mg/kg)	55.77±3.78	189.30±38.35	83.16±8.53	57.80±2.45 [12] 110.0±0.31 [18] 63.30±0.52 [14]
P (mg/kg)	2501±51.19	2009±66.43	2500±81.23	1754.00±23.3 [12] 2216.70±28.8 [14]
Mg (mg/kg)	250.80±4.99	187.60±9.46	259.70±8.85	212.00±3.65 [12] 278.30±0.98 [14]
Fe (mg/kg)	44.25±5.10	39.83±3.52	55.66±3.83	12.90±0.20 [12] 50.1±0.88 [18] 12.00±0.3 [30] 30.21±10.51 [31] 54.0 [32] 13.00±0.6 [33] 64.00±7.80 [14]
I (mg/kg)	0.071±0.008	0.107±0.019	0.111±0.009	0.025 ± 0.0155 [34]
Se (mg/kg)	0.130±0.013	0.047±0.006	0.075±0.005	0.014 [35] 0.16±0.05 [33]
Mn (mg/kg)	0.220±0.038	0.569±0.119	0.517±0.052	0.504 ±0.01 [18] 0.43 [36] 0.12±0.06 [33]
Cu (mg/kg)	1.922±0.169	1.325±0.110	2.174±0.092	1.003±13.9 [12] 1.91±0.45 [18] 1.08±0.23 [31] 2.1 [37] 0.92±0.36 [33] 1.00±0.20 [14]
Zn (mg/kg)	52.17±6.99	37.87±3.23	50.28±3.62	20.30±0.15 [12] 4.94±0.91 [18] 19.49±6.02 [31] 15.3 [38] 3.30±0.30 [33] 12.30±0.70 [14]

The iron level of the meat was the lowest (39.83 mg/kg) in the semi-intensive group, and the difference between the groups was significant. The iron content was described as lower in pork [12; 30; 33]. The utilization of iron is correlated to the copper level. The copper level in the samples from the extensive (1.92 mg/kg) and intensive (2.17 mg/kg) groups was higher than in the semi-intensive group (1.32 mg/kg). The Ca has also an influence on Cu utilization, so the high Ca level of semi-intensive group reduced the copper level of the meat. The zinc content of the meat samples was very similar to the copper level. The results of the extensive and intensive groups (52.17 mg/kg; 50.28 mg/kg) significantly altered from that of the semi-intensive group (37.87 mg/kg), because the soil of the habitat of this group was very poor in zinc (15.75 mg/kg), and also the high level of Ca reduces the Zn utilization. The soil of the extensive and intensive habitat contained more (42.25 mg/kg; 58.35 mg/kg) zinc. Data about the zinc content of pork [12; 18; 14; 31; 33] show lower values than we found in the wild boar.

The selenium content of the meat in the three groups remarkably differed (extensive: 0.13 mg/kg, semi-intensive: 0.047 mg/kg, intensive: 0.075 mg/kg) and did not correlate to the Se levels of the habitats soil types (extensive: 1.86 mg/kg,

semi-intensive: 2.12 mg/kg, intensive: 2.62 mg/kg).

4. Conclusions

On the basis of the results the following can be concluded:
The wild boars fed intensively produced their meat almost with the same ingredients as those who live free and fed from natural resources.
The outstanding value of wild boar meat seems to be the mineral content, especially the phosphorus, iron, iodine and zinc can have great importance in human alimentation. By the results approx. 200 g wild boar meat covers the daily requirement of an adult man.
About 7000 t/year game meat is harvested in Hungary, but most of it is sold in foreign countries.

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