THE INFLUENCE OF THE TYPE OF MAINTENANCE OF MANGALIȚA PIGS ON THE CHEMICAL COMPOSITION OF THE MEAT, THE FATTY ACID PROFILE AND THE CHOLESTEROL CONTENT OF THE MEAT

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Abstract

For quite some time, the Balkan breed of Mangalita pigs has started again to come to the attention and concerns of breeders in Romania, as well as local consumers of pork, a fact due to the publication of the results of specialized research that highlighted certain particular aspects, of an organoleptic and physico-chemical nature, possessed by the meat and fat of this breed.

Through this research protocol, the aim was to investigate the possible influences of the rearing system (in the open - on pasture and in the shelter) and feeding of Mangalița pigs on the chemical composition of the meat, on the profile of fatty acids and its cholesterol content, analyzes carried out at the level of the Longissimus dorsi lumborum muscle.

Following the research and observations undertaken, it can be stated that in the meat of pigs raised in the open air, a higher content of protein, crude ash and water and a lower content of total fat were determined, at the level of the analyzed muscle group. From the obtained data it can be deduced that the growing system did not significantly influence the cholesterol content of the meat.

Regarding fat composition, a higher proportion of n-3 and n-6 polyunsaturated fatty acids (PUFA) was identified in pasture-raised pigs, while the ratio between them was significantly lower, compared to pigs raised in shelter. The ratio of polyunsaturated fatty acids to saturated fatty acids (PUFA/SFA) was not significantly different between groups, while the ratio of monounsaturated fatty acids to saturated fatty acids (MUFA/SFA) was significantly lower in group of pigs raised on pasture.

In conclusion, we can affirm the fact that the breeding systems and the different way of feeding Mangalița pigs determine certain chemical characteristics of the meat, especially by improving the composition of fatty acids and the ratio between them.

Key words: *maintenance systems, Mangalița, meat quality, cholesterol*

1. INTRODUCTION

A new generation of consumers is distinguished by the fact that they no longer only choose meat products according to the sensory quality of perception, associated with affordable prices, but also taking into account the nutritional value of the meat, consistent with the ethical quality of its production, with direct reference to the welfare conditions of farm animals and the degree of impact of obtaining productions on the environment. Another motivation for choosing meat produced in the most traditional systems is the belief that the taste and nutritional-health valuesof this type of meat are superior to those of industrially produced meat

This is also the reason why, for a long time, the Mangalița Balkan breed of pigs has started to re-enter the attention and concerns of breeders in Romania, as well as local pork consumers, a fact also due to the publication of the results of specialized research which highlighted certain

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particular aspects, of an organoleptic and physico-chemical nature, possessed by the meat and fat of this breed.

Through this research protocol, the aim was to investigate the possible influences of the rearing system (in the open - on pasture and in the shelter) and feeding of Mangalița pigs, the red-brick variety, on the chemical composition of the meat, on the profile of fatty acids, on the content of meat in cholesterol and of the sanological properties of meat and fat, analyzes carried out at the level of the Longissimus dorsi lumborum muscle.

2. MATERIAL AND METHOD

2.1. Biological material and experimental samples

In order to establish the possible changes in the properties of pork, which appeared due to the application of different technological factors of maintenance and feeding, work was carried out on a number of 16 carcasses, obtained from castrated males and females belonging to the Mangaliţa breed, the red-brick variety, with weights bodies at slaughter relatively identical, around 120 kg.

At the beginning of the experiments, all individuals were reared in a semi-intensive (conventional) system, in the shelter, up to a body weight of approx. 75 kg, subsequently forming two working groups, one of the groups (L1-8 individuals, castrated males and females, with an average weight of 75.14±3.82 kg) being further maintained in the shelter and fed with the same type of feed ration, namely 70% maize, 5% wheat bran, 4% sunflower meal, 2% calcium carbonate and a 0.5% PVM mix supplement, plus lysine, methionine and threonine.

The other group (L2-8 individuals, castrated males and females, with an average weight of 74.20±2.15 kg) was transferred to a grassy and parceled field, with the allocated feed consisting of grass and unground grain corn, at discretion.

The average body weight at slaughter was 125.34±3.12 kg in individuals belonging to group L1, respectively 123.08±4.65 kg in individuals from group L2, the control sample and the experimental meat and fat samples being taken from the back muscles, respectively from the Longissimus dorsi muscle, the lumbar region.

2.2. Analytical determinations

After slaughter, the meat and fat samples were vacuum packed and kept frozen at approximately -20°C for further analysis. The following measurements of the chemical composition of L. dorsi muscle were performed: pH, water content, protein content, total fat, ash, total fatty acid and cholesterol concentrations.

The chemical composition was determined by the methods defined by the Association of Official Analytical Chemists [1].

Cholesterol content was determined using HPLC/PDA on a Waters 2695 Separation module HPLC with a Waters 2996 photodiode array detector as defined by the method of Maraschielloet et al.. Fatty acids in the form of methyl esters were detected by capillary gas chromatography with a flame ionization detector. A predetermined amount of lipid extracts, obtained by the rapid extraction method, was dissolved in tert-butyl methyl ether. Fatty acids were converted to fatty acid methyl esters (FAME) with trimethylsulfonium hydroxide according to the SRPS EN ISO 5509:2007 method. FAMEs were analyzed with Shimadzu 2010 GC-FID (Kyoto, Japan) on cyanopropyl-aryl HP-88 column (column length 100, internal diameter 0.25 mm, film thickness 0.20 μm).

2.3. Statistical analyses

Experimental data were processed and statistically analyzed by ANOVA (Origin 8.5 software, USA) and the least squares method (LSM) by applying the GLM procedure of the SAS 9.1.3 software package [2].

Maintenance and feeding type were entered into the model as independent variables, and when the means were significantly different, Tukey's test was applied to compare the mean values of the samples.

3. RESULTS

3.1. Elements of the physico-chemical structure of meat

According to specialized literature, open-air pig farming has certain effects on the quality of pork, effects that are manifested in accordance with climatic factors [3, 4], the quantity and quality of feed [5, 6]., as well as with the intensity of physical effort made by pigs in order to secure food [7, 8, 9].

Comparisons of the results regarding the chemical composition of the samples from Mangalița pigs raised in shelter (conventional) and on pasture (free system) are presented in tab. 1.

Table 1 Comparative data regarding Mangalița pork quality according to the applied exploitation system

Parameter	Growth system		Statistical significance
	Conventional (n=8)	Outdoor (n=8)	
Humidity (%)	65.20 ± 1.36	70.12 ± 1.49	**
Protein (%)	18.40 ± 0.23	21.34 ± 0.15	**
Total fat (%)	37.21 ± 1.16	34.08 ± 0.10	**
Mineral content (%)	0.84 ± 0.23	0.93 ± 0.04	*
pH (warm)	5.98 ± 0.51	5.42 ± 0.23	*
pH (cold)	5.81 ± 0.40	5.11 ± 0.36	*

Note: n – number of individuals/samples; Hot pH – pH value approx. 45 min after slaughter; Cold pH – pH value 24 hours after slaughter; ns – not significant P > 0.05; * P <0.05 ** P < 0.01 *** P < 0.001.

The data presented in tab. 1 demonstrates the fact that the extensive pig rearing system has the impact of creating a lower glycogen deposit, the final pH being lower in the muscle of individuals belonging to the L2 group, the differences between the groups, regardless of the moment of determining the pH value, being significant ($p <0.05$). The recorded data are consistent with other profile research, according to which the lower final pH can also induce a decrease in the technological yield in ham, while the technological properties of the muscle usually remain unaffected [10, 11].

Comparisons of the values for the chemical composition of L. dorsi muscle, from Mangalita pigs reared in a free (L2) and conventional (L1) system, show that there are distinctly significant differences regarding the content in water ($p < 0.01$), depending on growth system (65.20 ± 1.36% at L1 versus 70.12 ± 1.49% at L2), as also recorded in terms of protein content (18.40 ± 0.23% at L1 versus 21.34 ± 0.15% at L2, known the relationship between the percentage of water and protein. Smaller differences were found in the content of mineral substances, the data ranging between 0.84 ± 0.23% in L1 and 0.93 ± 0.04% in L2, which ensured statistically significant differences ($p < 0.05$).

3.2. Cholesterol content

The meat and fat of pigs from the Mangalița breed do not contain lower cholesterol levels, compared to other breeds of pigs, but the ratio between unsaturated and saturated fatty acids is positive. In particular, we certify that the fat content of the breed contains 8-12 % less saturated fatty acids and 6-10% more unsaturated fatty acids, compared to the values reported by other authors especially for modern pig breeds.

As is known, cholesterol is the natural component of every cell, representing the basis of the synthesis of vitamin D and steroid hormones, and the cholesterol content of pork meat is relatively low (50-85 mg/100 g) compared to other types of animal products and by-products such as liver (200-900 mg/100 g), egg yolk (1190 mg/100 g) or brain (3000 mg/100 g), [3, 12, 13].

In our research, the type of maintenance and feeding of the pigs had an insignificant effect on the amount of cholesterol in the individuals in the experiments (L1- 64.3 ± 1.14 mg/100g, against 63.5 ± 3.41 mg/100g - L2) (tab. 2).

3.3. Fat composition

The fatty acid composition as well as the cholesterol content of the L.dorsi muscle from the examined pigs are shown in tab. 2.

According to tab. 2, in both growth systems, palmitic acid (C16:0) was the most abundant acid in the SFA category (distinctly significant differences between batches), oleic acid (C18:1) the most abundant among MUFA fatty acids (insignificant differences between batches) and linoleic acid (C18:2) the most abundant PUFA fatty acid (significant differences between batches) according to the muscle samples taken. Pigs raised in the shelter showed a higher content of PUFA fatty acids in the muscles, compared to those raised in the open air and fed naturally (5.93 ± 0.45 mg/100g versus 6.45 ± 0.50 mg/100g), but the differences between the groups were not statistically significant.

These differences were mainly produced by an approximately fourfold higher total PUFA n-3 polyunsaturated fatty acids in the muscles of free-range pigs ($p<0.001$) and also by significantly higher levels of n-3 polyunsaturated fatty acids -6 PUFA ($p >0.05$). This situation led to significantly lower n-6/n-3 ratios in the muscle of free-range pigs fed corn and pasture ($p < 0.001$).

Table 2 Dynamics of fat composition in fatty acids in frozen Mangaliţa meat

Fatty acids (%)	Rearing system		Statistical semnificance	Data comparative (M.a.)
	Conventional (n = 8)	Outdoor (n = 8)		
Lauric ac. C12:0	0.57 ± 0.21	0.54 ± 0.01	NS	-
Myristic ac. C14:0	0.95 ± 0.03	1.08 ± 0.21	*	-
Palmitic ac. C16:0	21.55 ± 0.19	23.30 ± 0.21	*	-
Margaric ac. C17:1	0.25 ± 0.07	0.23 ± 0.51	NS	-
Palmitoleic ac. C16:1	3.58 ± 0.16	4.15 ± 0.18	**	-
Stearic ac.C18:0	12.31 ± 0.31	12.51 ± 0.42	NS	-
Oleic ac. C18:1	43.67 ± 0.22	43.24 ± 0.24	NS	-
Linoleic ac. C18:2	4.86 ± 0.17	5.40± 0.32	*	-
Linolenic ac. C18:2	1.83 ± 0.41	2.12± 0.17	***	-
α linolenic ac. C18:3 n-3	0.21 ± 0.21	0.57 ± 0.13	**	-
Eicosatrienoic ac.C20:3	0.23 ± 0.02	0.27± 0.12	NS	-
Arahidonic ac. C20:4	0.15 ± 0.05	0.17 ± 0.02	NS	-
DPA ac. C22:5 n-3	traces	0.10 ± 0.02	***	-
DHA ac. C22:6 n-3	traces	traces	NS	-
SFA (total value)	38.6 ± 0.12	35.5 ± 0.37	**	43.37 ± 0.56
MUFA (total value)	55.4 ± 0.43	54.3 ± 0.28	NS	44.86 ± 1.11
PUFA (total value)	6.12 ± 0.15	6.83 ± 0.20	NS	11.47 ± 0.81
PUFA/SFA	0.16 ± 0.37	0.19 ± 0.11	NS	0.33 ± 0.02
MUFA/PUFA	9.05 ± 0.07	7.95 ± 0.23	**	-
MUFA/SFA	1.43 ± 0.61	1.52 ± 0.16	*	-
Total n-3 PUFA	0.19± 0.45	0.57 ± 0.05	**	-
Total n-6 PUFA	6.07 ± 0.08	7.63 ± 0.54	**	-
n-6/n-3 PUFA	31.9 ± 1.98	13.3 ± 2.13a	***	-
Cholesterol	64.3 ± 1.14	63.5 ± 3.41	NS	48.16 ± 0.37
h/H	2.30/2.45	2.28/2.45	NS	2.03/2.45
IA	0.42/0.36	0.37/0.36	NS	0.52/0.36
IT	1.22/1.09	1.18/1.09	NS	1.75/1.09

Notă:n – number of samples. SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids, Content of SFA, MUFA, PUFA – calculated from all recorded acids.. ns – not significant $P > 0.05$; * $P <0.05$ ** $P < 0.01$ *** $P < 0.001$.
M.a. Large White race
IA = [(C12: 0 + (4 × C14: 0) + C16: 0)] ⁄ (MUFA + n−6 PUFA + n−3 PUFA)
IT = (C14: 0 + C16: 0 + C18: 0) ⁄ [(0.5 × MUFA) + (0.5 × n−6 PUFA) + (3 × n−3 PUFA) + (n−3PUFA⁄n−6 PUFA)]
h/H =(C18: 1n−9 + C18: 2n−6 + C20: 4n−6 + C18: 3n−3 + C20: 5n−3 + C22: 5n−3 + C22: 6n−3) ⁄ (C14: 0 + C16:0)

Therefore, although the n-6/n-3 ratio (31.9 ± 1.98, in the L1 group, against 13.3 ± 2.13 in the L2 group) was higher, compared to the norms recommended by the profile forums [14], free range has shown to be a way to reduce this ratio in pork.

We remind you that at European level, the ratio considered optimal between Omega 6 and Omega 3 is 5/1, but ideally it would be 3/1. In reality, following many tests performed on both adults and children, this ratio reaches values of over 120/1 [15, 16]. The imbalance of the Omega-6/Omega-3 ratio, through a high consumption of Omega 6 fatty acids can cause inflammation in the body, immune imbalances, cardiovascular risks, impairment of memory and the ability to concentrate.

Animals fed on pasture had higher concentrations of PUFA fatty acids, respectively stearic acids (12.31 ± 0.31mg/100g versus 12.51 ± 0.42mg/100g, insignificant differences between groups), linoleic (4.86 ± 0.17mg/100g versus 5.40± 0.32mg/100g, significant differences between batches), linolenic (1.83 ± 0.41 mg/100g vs. 2.12± 0.17 mg/100g, highly significant differences between batches), arachidonic (0.15 ± 0.05mg/100g vs. 0.17 ± 0.02 mg/100 g, insignificant differences between batches), eicosapentaenoic acids-EPA (0.23 ± 0.02mg/100g versus 0.27± 0.12 mg/100 g, insignificant differences between batches) and docosapentaenoic-DPA (traces of fatty acids in batch L1 versus of average values of 0.10 ± 0.02 mg/100g in group L2, very significant differences between groups), identified in their fat compared to pigs fed with protein concentrates, in the shelter.

In our experiment, it can be considered that the existence of a higher content of PUFA fatty acids in pasture-raised pigs can be both the result of providing a different feed (grass and grain corn), but also of the existence of a higher percentage of meat lean in the case.

From a health point of view, we believe that a higher content of α-linolenic acid (C18:3) in the diet led to the accumulation of increased amounts of n-3 fatty acids, especially EPA (C20:5) and DPA (C22:5), but not DHA (C22:6), the amounts identified in the meat from the two batches being in the form of traces, and the difference between the batches being statistically insignificant ($p > 0.05$). The role of EPA and DHA in alleviating the symptoms of a number of diseases, including coronary heart disease, is well recognized and appreciated [14]. An increasing content of EPA and DHA and decreasing n-6/n-3 ratio, together with high levels of MUFA fatty acids, indicate a potentially beneficial effect of feeding pigs on pasture and support a healthier image of pork, obtained according to the ecological exploitation methods.

CONCLUSIONS

In monogastric animals, such as pigs, there is a reasonable possibility that, by changing the structure of the diet and the type of technological exploitation (intensive industrial, semi-intensive or extensive), the breeder can influence both the body composition of the animals and the composition of the food products derived from meat.

The future of the Mangalitsa, one of the Balkan indigenous breeds, depends to a great extent on whether the products derived from its meat have a competitive production price and whether the breed can be used effectively, in line with the long-term market opportunities that can be insured.

According to the research carried out, pasture-raised Mangalitsa pigs (from 75 kg to 120 kg body weight) resulted in a higher meat content of proteins, minerals and water and a decrease in the total fat content of the Longissimus muscle back The differences in the growth system did not significantly affect the cholesterol content (64.3 ± 1.14 mg-100g in group L1, compared to 63.5 ± 3.41mg/100g in group L2).

It is very important to note that current research shows that the general nutritional properties of animal fats depend on the inclusion of monounsaturated fatty acids in the ratios, along with the results of invasive transformation processes, such as heat.

Also, the ratios of PUFA/SFA and n-6/n-3 PUFA have become, in most current studies, some of the most important parameters included in the estimation of the nutritional value and health of foods. Nutritionists recommend a reduction in total fat intake, especially saturated fat (SFA) as well as trans fatty acids, which are associated with an increased risk of cardiovascular disease and some forms of cancer.

In the same way of interpretation, the IA, IT and h/H indices of the obtained fat are sufficiently suggestive, indicating the functional effects of fatty acids for human health.

As is known, high Atherogenic Index (IA) as well as increased Thrombogenicity (IT) values are responsible for the formation of atheroma and stimulate platelet aggregation in the human cardiovascular system. Therefore, the lower values of these indices are desirable, being the guarantor for the prevention of cardiovascular disorders.

The meat of the Mangalița breed, the red-brick variety, due to its nutritional properties, can be considered a functional and health food for the human diet. Even the meat/fat ratio is lower than the improved breeds, and the dorsal fat layer is higher compared to other breeds, the cholesterol levels are significantly similar to the other breeds exploited in Romania.

In full accordance with the results of the research carried out, we recommend the production and consumption of meat belonging to the Mangalița breed, in accordance with the obvious health benefits that this product brings, compared to other sources of meat.

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