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FATTY TISSUE OF MANGALITSA IN THE FUNCTION OF HUMAN HEALTH

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ABSTRACT

The study included 24 fatteners of Swallow-Belly Mangalitsa reared in different rearing and feeding/nutrition conditions. In the samples of the two groups (G1 and G2) of pigs, subcutaneous backfat tissue (SFT) was examined for the chemical composition and fatty acid concentrations. The obtained results of the analyses of solid fatty tissue show that the average share of protein and fat in samples of solid fatty tissue was 1.62 ± 0.36% and 87.57 ± 6.50% for G1 and 1.31 ± 0.10% and 91.07 ± 1.43% for G2. The determined difference in the share of protein and fat was highly statistically significant (P < 0.0001). The same level of significance was determined for the proportion of linoleic (LA, 18:2 n-6) MUFA, PUFA and n-6 fatty acids (P < 0.0001). The determined proportion of water was higher in the G1 group (4.94%) compared to G2 (4.44%), while the proportion of palmitoleic acid (PA, 16:1) was lower in the G1 group compared to G2 (3.01: 4.07%). The determined differences for both traits were statistically significant (P < 0.05). No statistically significant difference was found for the share of ash and the share of other fatty acids, SFA, n-3 and n-6/n-3 (P>0.05). In the research, it was determined that the animals from the G2 group had a higher share of n-3 fatty acids (2.48%) compared to the animals from the G1 group (1.87%) and that the determined n-6/n-3 ratio was better in the G2 group compared to the G1 group (4.97:7.83). The best omega-6: omega-3 ratio should be 2:1. Humans get too much omega-6 in the diet and it's usually 5:1 to 10:1 in the human diet. Studies show that lowering the ratio of omega-6 (from vegetable oils) to omega-3 (from fatty fish, meat, fats and some vegetable oils) fatty acids is important for the reduction of the risk of developing malignant and cardiovascular diseases, inflammatory conditions and some forms of depression.

INTRODUCTION

Animal genetic resources, as a part of nature's biological diversity, have been developed through the domestication of wild species by mankind for mankind. Today's species of domestic animals have been shaped through selection, random genetic changes (genetic drift), and mutations, and they carry different phenotypes and genotypes. Their adaptive and productive potential varies from region to region due to changes in the set of genes they carry. These genetic variations accumulated over years of domestication in different places represent a resource for developing new strategies to combat environmental stress and face new production challenges. Agricultural biodiversity is the product of thousands of years of human activity in which people try to meet needs in a wide range of social, climatic and ecological conditions. Well-adapted and developed livestock production is an essential element of the agricultural production system and is of key importance for the food security of the population. The preservation and improvement of animal husbandry, animal genetic diversity, the preservation of locally adapted (autochthonous) and the development of new breeds, as well as the preservation of genetically diverse populations, provide society with a greater range of options to meet future challenges and the development of agriculture (Radović et al., 2019a). In addition to the genotype, the diet and pig-rearing method are the most important factors affecting the quality of meat and fat tissue. The diet must be, first of all, balanced in a way to maximize the genetic potential of the animal during fattening.

The Mangalitsa, a fatty type of pig, is an autochthonous swine breed in Serbia, where it has been present for more than 100 years. Today, breeding Mangalitsa pigs are commercialized by processing high-quality meat into products to attract growing interest in food production and consumer markets. The Mangalitsa pig's future is heavily dependent on whether products derived from it can be used effectively, and whether long-term markets can be secured. Today, consumers not only select meat products according to perceived eating quality and accessible pricing, but they also consider the nutritional value and the ethical meat quality, as well as animal welfare issues and the level of impact on the environment caused by the production system (Parunović et al., 2020). Pigs have the highest level of accumulation of fat tissue in the carcass, of all the species of domestic animals. In the case of newborn piglets, the content of fat tissue in the carcass is only about 2% and its share in the carcass increases with the age of the animal. During the lifetime of pigs, until the end of the fattening period, mainly the subcutaneous fat tissue is accumulated, which on average accounts for 60 to 70% of the total fat tissue in the body; the fat tissue of the body cavities makes up 10 to 15%, and intermuscular fat 20 to 35% (Radović et al., 2019b). Pork fat is healthy and necessary in the human diet. Numerous studies have shown that pork fat has 33% less saturated "bad" fats than butter, twice as many "good" monounsaturated fats and three times the proportion of omega-3 fatty acids. Pork fat is an excellent source of vitamin B and minerals. Research by Staniewski et al. (2021) shows that butter made in summer has less myristic acid (C14:0) compared to butter made in winter (10.56%:12.74%; for both periods the average of 11.65%) was determined, which is ten times more than the proportion of the mentioned fatty acid (1.17%) determined in subcutaneous adipose tissue (backfat) in Krškopolje pigs (Furman et. al., 2010). Oleic acid has multiple positive effects on human life and health (Arsić et al., 2019).

Sunlight exposure in pigs increases the vitamin D content of the loin and may provide an additional source of dietary vitamin D (Larson-Meyer et al., 2017). In addition to the importance of human nutrition, certain fatty acids of fats have an anti-infective effect, and in combination with the root of the comfrey plant, it is used for faster healing of wounds and broken bones. Mangalitsa is mostly grown extensively and/or semi-intensively. The meat and fat of these animals have a significant proportion of essential fatty acids and have an excellent taste, especially in cured products such as salami and hams. Mangalitsa is considered a delicacy, and its rearing is becoming increasingly popular due to sustainable methods and traditional production (Migdal et al. 2018).

MATERIALS AND METHODS

The study included 24 fatteners of Swallow-Belly Mangalitsa reared in a free-range system with different feeding/nutrition conditions. The first group (G1, n = 12) was reared in the open system, and nutrition consisted of pasture, many different types of fruit (apple, plum, mulberry), and roots, with the addition of small amounts of addition bread from the bakery (to 0.3 kg/animal/day). During night and poor weather conditions, animals were kept in a facility of solid material (brick and concrete). The second group (G2, n = 12) was reared in the open system, in the wood, and nutrition consisted of pasture, roots, and oak acorn, with the addition of small amounts of corn (to 0.3 kg/animal/day). During the night and in poor weather conditions, animals were kept in a wooded area. Pigs with a body weight between 90 kg and 120 kg were transported at the end of the trial, in the morning, to the slaughterhouse. On the slaughter line, samples of subcutaneous adipose tissue (the back fat, SFT) were taken at the last rib for analysis.

The following measurements were taken of the chemical composition of the SFT of the pigs: protein, water, total fat, ash and fatty acid concentrations. Chemical composition was determined by following methods defined by the AOAC (*Association of Official Analytical Chemists*, 2016). To determine the concentration of fatty acids, total lipids were extracted by a rapid extraction method, using solvents on the Dionex ASE 200. A homogenized sample, mixed with diatomaceous earth, was extracted with a mixture of hexane and isopropanol (60:40 v/v) in a 33 mL extraction cell at 100 ˚C and under nitrogen pressure of 10.3 MPa. The extract thus obtained was steamed in a nitrogen flow at 50 °C until dry fat remains were obtained (Spiric et al., 2010). Fatty acids as methyl esters were detected by capillary gas chromatography with a flame ionization detector. A predetermined quantity of lipid extracts, obtained by the rapid extraction method, was dissolved in tert-butyl methyl ether. Fatty acids were converted to fatty acids methyl esters (FAME) with trimethylsulfonium hydroxide, according to the SRPS EN ISO 5509:2007 method. FAMEs were analysed with a GC-FID Shimadzu 2010 device (Kyoto, Japan) on a cyanopropyl-aryl column HP-88 (column length 100, internal diameter 0.25 mm, film thickness 0.20 μm). The injected volume was 1 μL. The temperatures of the injector and detector were 250 ˚C and 280 ˚C, respectively. Nitrogen was used as a carrier gas, 1.33 mL min⁻1, with a split ratio of 1:50, while hydrogen and air were used as detector gases. The temperature of the column furnace was programmed to range between 120 ˚C and 230 ˚C. The total duration of the analysis was 50.5 min. Methyl esters of acids were identified according to their retention times, which were compared with those of the mixture of methyl esters of fatty acids in the standard Supelco 37 Component FAME mix (Spiric et al., 2010). Descriptive statistics were calculated using the SAS software package (SAS, Inst. Inc. 2011: The SAS System for Windows, Release 9.4.) using the MEANS procedure. To determine the differences between groups of animals, the statistical procedure TTEST was used, also within the SAS software package (SAS, Inst. Inc. 2011: The SAS System for Windows, Release 9.4.).

RESULTS AND DISCUSSION

Analysing the basic chemical composition of the subcutaneous backfat tissue (Table 1), we see that the proportion of animal fat tissue from the G2 rearing system is 91.10% which is higher than the determined proportion of fat in animals reared in the G1 rearing system, where it was 87.57%. The determined difference is statistically highly significant ($P < 0.0001$). The same level of significance is determined for the proportion of protein between animals of G1 and G2 rearing systems (1.62%:1.31%). A significantly higher ($P < 0.05$) proportion of water is found in the animals of the G1 rearing system compared to the animals of the G2 system (4.94%:4.44%).

Table 1 Chemical composition of the fat tissue

Fat properties	G1	G2	*P*-value[a]
Number of observations (n)	12	12	
Share of protein, %	1.62 ± 0.36	1.31 ± 0.10	***
Share of water, %	4.94 ± 1.35	4.44 ± 0.74	*
Share of total fat, %	87.57 ± 6.50	91.10 ± 1.43	***
Share of ash, %	0.004 ± 0.002	0.005 ± 0.003	NS

[a] significance level for rearing system; NS – not significant; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$;
G1 and G2 groups differed in their environment and feed, aving mainly pasture and fruits vs parture and oak acorn

In Table 2, the 8 most important fatty acids (FAs) with the highest percentage in each identified group of FAs were presented. In addition, the following ratios and indices were calculated (n-6/n-3). The determined difference for the share of linoleic (LA, 18:2 n-6) monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and n-6 fatty acids ($P < 0.0001$). The proportion of palmitoleic acid (PA, 16:1) was lower in the G1 group compared to G2 (3.01:4.07%). The determined differences were statistically significant ($P < 0.05$). No statistically significant difference was found for the share of other fatty acids, SFA, n-3 and n-6/n-3 ($P > 0.05$).

Table 2 Fatty acid composition (%) content (mg kg‾1) of the fat tissue

Fat properties	G1	G2	*P*-value[a]
Number of observations	12	12	
C14:0	2.58 ± 0.79	3.87 ± 1.06	NS
C16:0	27.97 ± 4.12	29.77 ± 5.18	NS
C16:1	3.01 ± 2.57	4.07 ± 1.24	*
C18:0	11.57 ± 3.38	9.89 ± 2.96	NS
C18:1 n-9	39.08 ± 2.52	35.89 ± 2.62	NS
C18:2 n-6	9.61 ± 1.89	10.13 ± 5.85	***
C18:3 n-3	ND[b]	ND	NS
C20:3 n-3	0.75 ± 0.68	1.16 ± 0.85	NS
SFA	45.50 ± 3.12	50.80 ± 5.50	NS
MUFA	42.73 ± 2.66	36.57 ± 8.85	***
PUFA	11.76 ± 2.22	12.62 ± 6.25	***
n-6	9.61 ± 1.89	10.13 ± 5.85	***
n-3	1.87 ± 1.47	2.48 ± 1.24	NS
n-6/n-3	7.83 ± 570	4.97 ± 4.77	NS

[a] significance level for rearing system NS – not significant; * p < 0.05; ** p < 0.01; *** p < 0.001; [b] ND – not detected; SFA - saturated fatty acids, MUFA - monounsaturated fatty acids, PUFA – polyunsaturated fatty acids, n-6/n-3 ratio was calculated; G1 and G2 groups differed in their environment and feed, aving mainly pasture and fruits vs parture and oak acorn

In the research, it was determined that the animals from the G2 group had a higher share of n-3 fatty acids (2.48%) compared to the animals from the G1 group (1.87%), and that the determined n-6/n-3 ratio was better in the G2 group compared to the G1 group (4.97:7.83). The results of our research on the proportion of fat in the subcutaneous backfat tissue are similar to the research of Parunović et al., 2020 for Mangalitsa cattle reared in the free system with available acorns in the diet (91.10:90.75%). The afore-mentioned group of authors determined a higher proportion of water (6.96:4.44) and a higher proportion of protein in fat tissue (2.30:1.31%) compared to our research. For the mentioned traits, they determined a significant difference between free-range reared Mangalitsa pigs compared with the conventionally reared group (P < 0.001). In the same study for animals reared in the free system and had acorns in their diet, they had a lower proportion of C14:0, C16:0, C16:1, saturated fatty acids (SFA) (42.11:50.80%) and PUFA (8.27:12.62%) and a higher share was determined for C18:1n-9 (45.55:35.89%), C18:2n-6 (14.65:10.13%) and MUFA (55.66:36.57%). Furman et al., (2010) found a significantly higher proportion of oleic acid (C18:1n-9) in the intermuscular fat in the autochthonous breed of Krškopolje pigs compared to our research (43.27:39.08 and 35.89%). In the same research, they determined for commercial meaty fatteners in Slovenia the share of oleic acid of 37.74%. Also, in their research, a higher proportion of linoleic (C18:2n-6; 11.28%) was determined for Krškopolje pigs compared to our research. For the Italian local pig breed Cinta Senese reared outdoors Pugliese et al., (2005) found a lower proportion of C14:0, C16:0, C18:0 and SUFA (31.40:50.80%) in the subcutaneous fat tissue and a higher proportion of MUFA compared to our research (55.08:36.57%). Also in the samples of East Balkan pigs of the inner and outer backfat layer, taken at the last rib, Popova et al., 2015 determined a lower proportion of C14:0, C16:0, C18:0 and SUFA a higher proportion of MUFA and PUFA compared to our research. For the Prestice Black-Pied pig, fed with complete mixtures with SFA 33.69, MUFA 37.12 and PUFA 29.19 (g/100 g of total fatty acids) of diets, Nevrkla et al., 2017 established in the samples of the backfat (g/100 g of total fatty acids) of SFA 39.93, MUFA 46.55 and PUFA 13.52. In the samples of fatty tissue of the lumbar part, Catilo et al., 2021 determined for Italian Large White animals the highest proportion of oleic fatty acid of 38.71% in samples from animals with the lowest fleshiness score (class O), with less about our research for animals from the G1 group (+0.37%) and more with the animals of the G2 rearing system by (-2.82%).

As a summary the obtained results the obtained results of the analyses of solid fatty tissue show that the average share of protein and fat in samples of solid fatty tissue was 1.62 ± 0.36% and 87.57 ± 6.50% for G1 and 1.31 ± 0.10% and 91.07 ± 1.43% for G2. The determined difference in the share of protein and fat was highly statistically significant ($P < 0.0001$). The same level of significance was determined for the proportion of linoleic (LA, 18:2 n-6) MUFA, PUFA and n-6 fatty acids ($P < 0.0001$). The determined proportion of water was higher in the G1 group (4.94%) compared to G2 (4.44%), while the proportion of palmitoleic acid (PA, 16:1) was lower in the G1 group compared to G2 (3.01:4.07%). The determined differences for both traits were statistically significant ($P < 0.05$). No statistically significant difference was found for the share of ash and the share of other fatty acids, SFA, n-3 and n-6/n-3 ($P > 0.05$). In the research, it was determined that the animals from the G2 group had a higher share of n-3 fatty acids (2.48%) compared to the animals from the G1 group (1.87%) and that the determined n-6/n-3 ratio was better in the G2 group compared to the G1 group (4.97:7.83).

The best omega-6: omega-3 ratio should be 2:1. Humans get too much omega-6 in the diet and it's usually 5:1 to 10:1 in the human diet. Studies show that lowering the ratio of omega-6 (from vegetable oils) to omega-3 (from fatty fish, meat, fats and some vegetable oils) fatty acids is important for the reduction of the risk of developing malignant and cardiovascular diseases, inflammatory conditions and some forms of depression. Saturated fats are stable at high temperatures and therefore there is less danger of ominous trans-fats with higher saturation in the fat composition. Saturated fatty acids are essential in our diet for the central nervous system and cell membranes. The most famous monounsaturated fatty acid, which is the trademark of the healthiest oil of the Mediterranean diet - olive oil, which all cardiologists zealously recommend, namely oleic acid - has been proven to reduce "bad" cholesterol-LDL, and "support" good-HDL cholesterol. The WHO (2003) recommended the consumption of 5–8% of n-6 PUFA, 1–2% of n-3 PUFA of lesser value (4% of n-6 PUFA, 0.8% n-3 PUFA) in 2001, as later stated by French Agency for Food Safety (Scientific Opinion, 2009).

In developing countries where children may be in an energy deficit, and where it is planned to increase the energy density of the diet with fats and oils, every encouragement should be given to the development of indigenous oils that are more physiologically balanced in terms of linoleic and linolenic acids rather than importing linoleic acid rich oils which dominate the Western markets.

Similarly, developing countries need to guard against importing food products that are rich in atherogenic and thrombogenic fats and do not provide a balance of essential fatty acids (FAO, 2010). In the human diet, it is necessary to have well-balanced meals and be moderate in diet even when it comes to the healthiest nutrients.

CONCLUSION AND RECOMMENDATION

Our study has confirmed that rearing conditions and feed basis could make difference in body composition and fatty acid profile of Mangalitsa. Pigs kept in wooded area and fed with parture and oak acorn mainly, exhibited a significantly higher fat content, lower protein content, and a more favorable omega-6 to omega-3 (n-6/n-3) fatty acid ratio than pigs kept in pastutre and fed fruits and roots (4.97 vs. 7.83). Additionally, wooded area kept pigs had higher levels of n-3 fatty acids, including beneficial polyunsaturated fats, which are associated with reduced risks of cardiovascular disease, cancer, inflammation, and depression. These results suggest that Mangalisa kept in wooded area, rather than fed fruits, offers a more nutritionally advantageous fatty acid profile, making it potentially more beneficial for human health.

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