

Comparison of Mangalica and Hungarian Large White pigs at identical bodyweight: 1. Backfat histology (Short Communication)

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Abstract

At 130 kg bodyweight Mangalica and Hungarian Large White pig adipose tissue was compared, by means of histology. Adipose cell diameter (117.2 ± 24.1 vs. 55.3 ± 17 μm , Mangalica vs. Hungarian Large White), size (118.9 ± 44.3 vs. 31.9 ± 0.63 $\mu\text{m}^2 \cdot 100$) and volume (8.01 ± 0.67 vs. 2.18 ± 0.18 $\mu\text{m}^3 \cdot 1000$) was significantly higher in Mangalica, while the hydroxyproline content (0.04 ± 0.005 vs. 0.23 ± 0.014 weight% of wet tissue) and the connective tissue area in the microscopic images (%) were ca. 5-fold higher in Hungarian Large White. The present quantitative results underscore the experience that at identical bodyweight the fat (89.9 ± 1.19 vs. $78.9 \pm 0.39\%$) and dry matter content (97.8 ± 1.72 vs. $87.7 \pm 0.38\%$, Mangalica vs. Hungarian Large White), as well as the cellularity of Mangalica largely differs from that of Hungarian Large White.

Keywords: pig, Mangalica, Hungarian Large White, adipose tissue, connective tissue, histology

Zusammenfassung

Vergleich zwischen Mangalitza und Ungarischem Large White bei gleichem Lebendgewicht: 1. Histologie des Rückenfettes (Kurzmitteilung)

Verglichen wurden die histologischen Merkmale des Rückenfettes von Mangalitza und Ungarischen Large White bei einem Lebendgewicht von 130 kg. Für die beiden Rassen Mangalitza und Ungarisches Large White betragen die durchschnittlichen Fettzell Durchmesser 117.2 ± 24.1 bzw. 55.3 ± 17 μm , die Zellgrößen 118.9 ± 44.3 bzw. 31.9 ± 0.63 $\mu\text{m}^2 \cdot 100$ und das Zellvolumen 8.01 ± 0.67 bzw. 2.18 ± 0.18 $\mu\text{m}^3 \cdot 1000$. Sie unterschieden sich zwischen den Rassen signifikant. Bei den Ungarischen Large White wurden signifikant höhere Hydroxyprolinwerte und fünffach größere Bindegewebeoberflächen (%) nachgewiesen. Die quantitativen Ergebnisse unterstreichen die praktische Erfahrung, dass bei gleichem Lebendgewicht der Rohfettgehalt (89.9 ± 1.19 bzw. $78.9 \pm 0.39\%$) und der Trockensubstanzanteil (97.8 ± 1.72 bzw. $87.7 \pm 0.38\%$) des Rückenfettes, sowie die Zellularität beider Rassen erheblich unterscheiden.

Schlüsselwörter: Schwein, Mangalitza, Ungarisches Large White, Rückenfett, Bindegewebe, Histologie

Introduction

At present, divergently selected pig genotypes (from lean to fat) produce bacon products, Mangalica representing a special position over the meat-producing genotypes due to its superior bacon quality traits (ENDER *et al.* 2002). The preference of Mangalica is primarily bound to its fat production (EGERSZEGI *et al.* 2003). In this regard SZABÓ and FARKAS (2001) published detailed results on the fatty acid composition of adipose tissue with lower saturated (stearic acid) (CSAPÓ *et al.* 1999), and higher monounsaturated (oleic acid) proportions, as compared to meat-type genotypes, with fully identical feeding (VOLK *et al.* 2004). Thus, adipose tissue fatty acid profile may also play a role in shaping the consistency of Mangalica bacon.

In pigs, nutritional manipulation does not affect the number of extramuscular adipose cells (LEE *et al.* 1973b). Porcine adipocyte proliferation is limited to a short postnatal period (DESNOYERS *et al.* 1980), thus adipose tissue volume is primarily depending on the fat-filling (hypertrophy) of the existing preadipocytes or small adipose cells. To assess genotype-associated differences, comparison at identical bodyweight in the adulthood is the most widely applied strategy (LEE *et al.* 1973a,1973b, CORINO *et al.* 2005, FISCHER *et al.* 2006, VACLAVKOVA and BECKOVA 2007), when hyperplasia is not active.

However, there is lack of controlled studies on the adipose tissue, and in particular, on its connective tissue moiety of the highly important Hungarian Mangalica breed. Thus, the present study aimed to describe and compare some backfat histological characteristics of Mangalica and Hungarian Large White pigs, at identical bodyweight values.

Material and methods

Animals

Mangalica and Hungarian Large White castrates were compared (n=3-3). The bodyweight of pigs was highly similar (Table 1), while the keeping was extensive for Mangalica. Both pig genotypes were bedded on straw, had *ad libitum* access to water. Mangalica pigs had an access to free-range scavenging on a fence-limited paddock, while Hungarian Large White were kept closed. Adipose tissue samples were collected at the slaughter, by dissecting them from the halved bodies at the third cervical vertebra, at 10.5 cm off the carcass midline; backfat thickness was measured at this location. All samples showed a typical two-layered structure, divided with a connective tissue barrier. In all instances the subcutaneous layer was analysed.

Diets

The nutrient composition of the two fattening diets was basically similar, as assessed from the packages, and as shown in Table 2. For both genotypes dosed feeding was applied. Since Mangalica keeping was extensive, which is the conventional and characteristic keeping mode of this breed, the composition of the additional feed components was unknown.

Table 1
Biological characteristics of the pig genotypes and their adipose tissue samples
Biologische Merkmale der Genotypen der Schweine und ihrer Fettgewebeproben

	Mangalica	Hung. Large White	P (t-test)
N	3	3	–
Bodyweight, kg	132±9	130±8	>0.05
Age at slaughter, days	310	228	–
Backfat thickness, mm	49±6	24±5	<0.05
Hydroxyproline, wet tissue wt%	0.04±0.005	0.23±0.014	<0.001
Collagen, wet tissue wt%	0.26±0.03	1.73±0.1	<0.001
Fat content, wet tissue wt%	89.90±1.19	78.90±0.39	<0.001
Dry matter, %	97.80±1.72	87.70±0.38	<0.001
Cell diameter, µm	117.20±24.1	55.30±17	<0.0001
Cell area, µm ² ·100	118.90±44.3	31.90±0.63	<0.0001
Cell volume, µm ³ ·1 000	8.01±0.67	2.18±0.18	<0.0001
Area% of connective tissue in the adipose tissue	3.57±0.65	11.38±1.62	<0.0001

Table 2
Nutrient composition of the diets
Futterzusammensetzung

	Mangalica	Hungarian Large White
Dry matter, %	88.4	88.0
Metabolizable energy, MJ/kg	13.5	13.7
Digestible energy, MJ/kg	13.6	13.9
Crude protein, %	11.8	12.0
Crude fat, %	4.2	4.0
Crude fiber, %	5.0	5.0

Histological analysis

Fresh tissue samples were fixed in 10% neutral buffered formalin. Sample preparation was performed with a tissue processor equipment (Thermo Shandon Pathcentre, Thermo Fisher Scientific Inc., Waltham, MA, USA). Sectioning was performed with a sledge microtome (3 µm, Reichert Optische Werke AG, Vienna, Austria) from the paraffin-embedded blocks, and staining was carried out with a carousel-type slide stainer (Thermo Varistain 24-4, Thermo Fisher Scientific Inc., Waltham, MA, USA), with hematoxylin and eosin, at the Kaposi Mór Hospital, Department of Pathology, Kaposvár, Hungary.

Histometrical measurements were performed on a standard PC with the ImageJ 1.41 (2002) software, on the digital images captured on a light microscope. For cell diameter calibrated line measurement was performed on 100 cells/ocular field (CORINO *et al.* 2005). Adipocyte size was measured with the polygon measurement method. Subsequently, cell volume was estimated according to HIRSCH and GALLIAN (1968), by the formula:

$$CV = \frac{\pi}{6(3\sigma + \bar{x}^2)} \quad (1)$$

where *CV* is the cell volume, σ is the variance of the cell diameter and \bar{x} is the mean cell diameter. For the image-based quantification of connective tissue (area%), the green channel of images was selected, and a threshold value of 165 was applied for all images.

Chemical analysis

Adipose tissue collagen content was determined based on its hydroxyproline content (Mersmann *et al.* 1973), as determined with a photometric method (MSZ ISO 3496:2000). Fat content was determined by the Soxhlet method, while dry matter content with drying in an oven at 103°C until constant weight.

Statistical analysis

Biometric data were compared by independent samples t-test, with the SPSS 10 (1999) software.

Results

Characteristic sections of Mangalica and Hungarian Large White adipose tissue are shown in Figure 1a and b, at identical magnifications. Image analysis results obtained for cellularity and connective tissue content are shown in Table 1. Adipose cell diameter, cross-sectional area and volume, and tissue fat and dry matter content was significantly higher in Mangalica pigs, while the connective tissue content, as assessed by direct chemical and image analysis was significantly higher in the Hungarian Large White pigs. This latter property can also be recognized in the microscope images (Figure 1 a, b). In the hydroxyproline content ca. 5-fold higher values were found in the Hungarian Large White pigs.

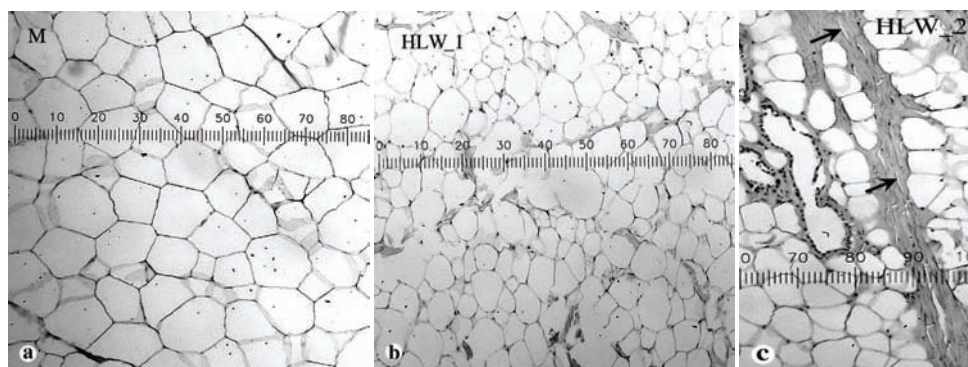


Figure 1

Mangalica (a) and Hungarian Large White (b, c) adipose tissue at 200×. 10 units on the scale bar represent 100 µm.

Mikroskopische Abbildung des Rückenfettes beim Mangalitzta und Ungarischen Large White bei 200facher Vergrößerung. 10 Einheiten auf der Skala entsprechen 100 µm.

Discussion

The propensity of pigs to fatten depends largely on genetical factors (HOOD and ALLEN 1977), as the final fat cell number is reached at a rather early age (LEE and KAUFFMAN 1974, DESNOYERS *et al.* 1980). Thus, at constant bodyweight total body adiposity is a correlate of adipose cell volume (HOOD and ALLEN 1977). More progressed cell hypertrophy and cellular fat content at identical weight refers to an excessive lipogenesis and a consequent fat accretion, as found in the Mangalica pigs in the present study, since in

swine the site of *de novo* lipid synthesis is primarily the adipose tissue (STEELE *et al.* 1974). It is widely accepted that selection had a secondary influence on the lipogenic activity of adipocytes of lean and fat swine breeds, but altered the developmental stage at which maximal lipogenic ability is manifested. This is consonant with the large age and tissue dry matter content difference between the animals of the present study, meanwhile age basically determines the extent of adipose tissue development, manifesting also in prenatal differences among pre-obese and lean foetuses (TRUSTY and HAUSMANN 1990).

A basic aspect of investigating the connective tissue moiety in adipose tissue is that collagen deposition and lipid accretion are separately controlled in swine (HAUSMAN and KAUFFMAN 1986). Connective tissue fibers were more expressed in Hungarian Large White, and were less frequently occurring in Mangalica. Merely in Hungarian Large White, at some infrequent sites adipocyte groups, surrounded by loose connective tissue fibers were also recognized in the sections. These fat cells were spindle-shaped or smaller than the majority of adipocytes (Figure 1c, marked). MERSMANN *et al.* (1975) reported similar findings in newborn piglets, with higher frequency, suggesting an earlier developmental stage of adipose tissue Hungarian Large White pigs, as compared to Mangalica, where these were absent.

In conclusion, the comparison of adipose tissue at identical bodyweight provides quantitative evidence for the more expressed lipogenesis (larger cell size) of Mangalica and an earlier developmental status of Hungarian Large White (dry matter), with overt small cells and a higher connective tissue contribution.

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