Scientific Papers. Series D. Animal Science. Vol. LXVII, No. 1, 2024
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

RESEARCH ON THE PHYSICO-CHEMICAL PROPERTIES OF MANGALITSA PORK DERIVED FROM PIGS RAISED IN THE NORTHEASTERN REGION OF ROMANIA

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Abstract

Mangalitsa represents a breed of pigs specialized in fat production, which was exploited in our country until the 1950sHowever, the swine population of this breed decreased significantly thereafter due to the emergence of breeds and crossbreeds with much better productive performances, the advent of modern pig farms, and changes in the population`s consumption habits. This paper presents data obtained from the analysis of the physicochemical properties of Mangalitsa pork, derived from pigs raised on a pig farm located in the northeastern region of the country, in Neamț County. The biological material required for this study consisted of Mangalitsa pigs: the red variety and the swallow-belly variety. To achieve the purpose of the study, samples were taken from 3 distinct body regions - neck, thigh, and loin - which were processed in a specialized laboratory. The pH of Mangalitsa pork measured 24 hours post-slaughter ranged between 5.74 and 5.84, with the lowest dry matter values recorded for the batch of pigs from the red Mangalitsa variety. The protein content in the meat varied between 15.47% and 20.90%, depending on the anatomical region, while the lipid content showed wide variations, with the highest values in the Mangalitsa neck. The average values obtained for pH, dry matter, protein, and fat in Mangalitsa pork meat were within the optimal range for this breed, according to specialized literature.

Key words: *loin, Mangalitsa breed, neck, physicochemical properties, thigh.*

INTRODUCTION

Mangalitsa is one of the old-type pig breeds, formed centuries ago through the crossbreeding of European and Asian primitive pigs. The Mangalitsa pig breed was introduced to Romania from Serbia in the 19th century (Ciobanu et al., 2001; Paraschivescu et al., 2010).

Mangalitsa is a breed of pigs specialized in fat production, with a fat percentage in the carcass of 65-70%, which was exploited in our country until the 1950s. After this period, the pig population of this breed greatly decreased due to the rise of other breeds and hybrids with much better productive performances, the appearance of modern pig farms and changes regarding the consumption habits of the population. (Hoha et al., 2018; Egerszegi et al., 2003; Hollo et al., 2003).

This breed is among the ancient pig breeds formed in antiquity from the crossing of primitive European pigs with primitive Asian pigs brought by the Romans to the territory of today's Europe (Nagy, 2013).

In Romania, the Mangalitsa pig breed has been documented since 1830, with its distant origins tracing back to the domestication of the wild boar "*Sus vittatus*". As domestication progressed and human intervention in breeding intensified, several varieties with approximately the same morphological characteristics were developed: baris, blonde, red, black, and a "swallow" belly (Ciornei, 2015).

The ruggedness of the Mangalitsa breed has led to the development of a pig population with high resistance to diseases, harsh macroclimate and microclimate conditions, and grazing, especially on wet terrain. It is also noteworthy that in semi-intensive farming conditions, feeding does not require the administration of animal protein, as fruits such as acorns and beech mast are very well utilized (Ciornei, 2015).

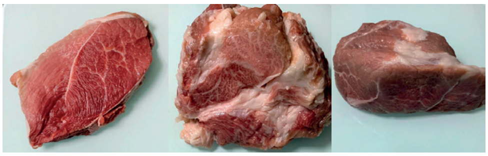
After being neglected for several decades, the Mangalitsa pig breed, thanks to its exceptional

meat qualities, has become fashionable again. In recent years, numerous studies on this breed have been conducted abroad, especially in Hungary. The population dynamics of the Mangalitsa pig breed have been sinuous, significantly influenced by market demands.
Although not originally created in our country, the Mangalitsa is considered a local breed because it has been raised on Romanian territory since ancient times, during which it adapted perfectly to our natural conditions and rearing practices. Within the breed, several varieties have emerged (blonde, red, black, 'swallow belly,' and 'baris'), each differing primarily in color, but with nearly common morpho-productive characteristics. Among these, the blonde variety has been the most widespread and represents the breed's prototype.
Pigs of the Mangalitsa breed, regardless of the color variety, have a carcass meat percentage of less than 40% (Szabó, 2006; Zăhan et al., 2009).
The meat from Mangalitsa pigs has superior taste qualities, is juicy, marbled, lending itself very well to the preparation of winter salamis (Habeanu et al., 2011).
Pork meat represents a very important source of energy and essential nutrients for humans. Due to its balanced chemical composition in nutrients with high biological value (proteins, lipids, minerals and vitamins) and its increased digestibility, meat is a food that cannot be absent from the human diet.
The chemical composition of pork is crucial for the composition of the products obtained after processing. Pork meat has a relatively constant chemical composition, very close to that of muscular tissue, but the chemical composition of fatty pork meat can vary widely (Ionescu et al., 2009).

MATERIALS AND METHODS

The biological material under investigation consists of the Mangalitsa pig population, raised on a livestock farm located in the northeastern part of the country, categorized as type A exploitation, specialized in the breeding, rearing and commercialization of Mangalitsa pigs. This population comprises specimens of Mangalitsa pigs, including the red variety and the swallow belly variety.
The zootechnical farm began its activity in 2018. Initially, the biological material came from a sow with 4 piglets of the red variety. Later, biological material was acquired from the blonde and swallow belly varieties. Young males that are not selected for reproduction are castrated, and then they are moved to the growth and fattening areas, alongside females that are not used for breeding1. This approach ensures efficient farm management and optimal utilization of available resources.
To achieve the established goal, 2 experimental batches of Mangalitsa breed pigs were studied, raised in a zootechnical farm specialized in the breeding of this pig breed in the NE area of the country. Each of the 2 experimental batches consisted of 10 individuals, castrated males and females of the red variety and swallow belly variety. In the zootechnical farm under study, a semi-free-range breeding system is practiced, with the pigs being fed with concentrated feed mixtures, having permanent access to pasture. Individuals from the 2 experimental batches were slaughtered in a specialized slaughterhouse at about one year old and a weight of approximately 100 kg.
The determination of the average slaughter weight of the biological material (castrated males and females) was conducted at the slaughterhouse prior to slaughter. At the slaughterhouse, the pigs were housed in individual pens in preparation for slaughter, during which they were not fed, only provided with small amounts of water (waiting period of 12-24 hours).
The basic component of meat is represented by muscle tissue, which is composed of all the striated muscles. These muscles consist of morphological and structural units known as striated muscle fibers. These fibers are made up of numerous cylindrical cells containing sarcolemma and sarcoplasm, within which myofibrils of myosin and actin are found. The striated appearance of muscle results from the alternating presence of these two types of myofibrils, each with different diameters (Multon et al., 1991).
In order to determine the physico-chemical properties of Mangalitsa pork, samples were

collected from three distinct body regions: neck, leg and loin.
The pulp samples were represented by the musculature from the pelvic region, from which the bones, soft fat, ligaments, and vascular formations on the processed surfaces were removed.
The neck samples were represented by the deboned, defatted, well-trimmed neck muscle, which exhibited an intermittent layer of up to 0.5 cm of fat on the surface, with the fascia (covering membrane) still adhering to the muscle. These samples had straight and well-defined edges, without any cuts in the muscle mass, fraying, or bone remnants.
The pork chop samples were obtained by processing the muscle from the dorsal region, which was well-trimmed. On the surface, it exhibited a thin layer of fat, no more than 0.3 cm thick, with straight and well-defined edges. There were no cuts in the muscle mass, no fringes, or small bone fragments.
These samples were processed in a specialized laboratory equipped with modern equipment and advanced instrumentation, allowing for high-precision analyses using current methodologies for these determinations (Figure 1).



pork leg pork neck pork chop

Figure 1. Sampling for Physico-chemical analysis (own source)

The pH determination of Mangalitsa meat was performed in accordance with the current standards (SR ISO 2917:2007; SR 2443:2008).
The acidity of meat is determined by the content of organic acids in pork meat, as well as by all substances in meat that have an acidic character. This property of meat is expressed through the pH value (the logarithm with reversed sign of the hydrogen ion concentration).
pH influences the quality of pork meat in terms of organoleptic, hygienic and technological aspects. Thus, a gradual decrease in pH to a value of approximately 5.4 results in a brighter color of the meat, while a sudden decrease in pH leads to a pale pink hue, characteristic of exudative meat, frequently encountered in the case of pigs (Păsărin et al., 2007).
The knowledge of pH evolution in pork meat during the period after slaughter is of paramount importance. This parameter directly influences the organoleptic properties of the meat, including its tenderness, consistency, aroma, and taste. Additionally, it affects the meat’s water retention capacity and its suitability for preservation.
In terms of chemical composition, pork meat consists of the following components: water, nitrogenous protein and non-protein substances, carbohydrates, lipids, enzymes, vitamins and mineral substances.
The water found in meat constitutes the largest proportion of its total weight. However, its proportion in meat can vary depending on numerous factors, including breed, age of the animal, level of fatness, physiological condition, sex, and diet.
The fatness level of pigs significantly influences the water content in their meat. Consequently, leaner pigs have a higher water content in their meat compared to fatter pigs, where the water content is lower.
The determination of moisture content in Mangalitsa meat was carried out according to the ISO 1442:2010 standard - Meat and meat products.
The water and dry matter content of pork meat can vary widely depending on the type of meat, breed, sex and age of the slaughtered pigs, the fattening condition, the rearing system, the provided diet, the anatomical region, etc.
The determination of protein content in Mangalitsa meat was conducted according to the SR ISO 937:2007 standard - Meat and meat products - Determination of nitrogen content.
The protein content of pork meat is influenced by the fattening condition of the animal, the water content of the meat, the breed, the age of the slaughtered animal, as well as the type of muscle.
The determination of lipid content in Mangalitsa meat was conducted in accordance with the SR ISO 1444:2008 standard - Meat and meat products - Determination of free fat content.

The amount of lipids in pork meat varies greatly depending on the type of muscle, the breed and age of the animal and its fattening condition. The lipid content of meat is inversely proportional to its water content.

RESULTS AND DISCUSSIONS

The physico-chemical properties of pork were determined on samples of leg, loin, and neck collected from 10 carcasses, for each of the two varieties of Mangalitsa breed pigs studied (the red variety, the swallow belly variety) (Figure 1).

The laboratory analyses performed allowed the determination of the pH, the dry matter, protein, and fat content of the pork.

Figure 1. Mangalitsa pigs, swallow belly variety (own source)

To obtain a good yield at slaughter and meat with optimal physico-chemical and organoleptic qualities, within the unit, Mangalitsa breed pigs were slaughtered at weights exceeding 100 kg live weight, thus obtaining a higher percentage of lard in Table 1.

Table 1. Medium weight at slaughter

Lot	n	Sex	Live weight MEAN ± SEM (kg)
Mangalitsa, the red variety	10	♀+♂	105.51±1.43
Mangalitsa, swallow belly variety	10	♀+♂	108.14±1.31

The pH values of the analyzed meat samples were determined in a specialized laboratory 24 hours after slaughtering the pigs according to current standards. The determinations were made on samples collected from the leg, neck and loin for the two varieties of Mangalitsa pigs, according to the laboratory protocol.

The recorded values for pH 24 hours after slaughtering ranged between 5.80±0.02 and 5.84±0.03 in the case of neck samples, between 5.74±0.01 and 5.77±0.03 in the case of leg samples, and between 5.76±0.04 and 5.78±0.02, as recorded in the case of loin samples (Table 2).

Table 2. The pH values of the pork from the Mangalitsa breed

Lot	n	Sex	pH MEAN ± SEM		
			neck	leg	loin
Mangalitsa, the red variety	10	♀+♂	5.84±0.03	5.74±0.01	5.78±0.02
Mangalits, swallow belly variety	10	♀+♂	5.80±0.02	5.77±0.03	5.76±0.04

Understanding the evolution of pH in pork meat during the post-slaughter period is of particular importance because this parameter directly influences the organoleptic properties of the meat and its water retention capacity, as well as the meat's suitability for preservation.

Regarding the dry matter content of the analyzed samples, the average values obtained are presented in Table 3.

Table 3. The dry matter of pork from the Mangalitsa breed

Lot	n	Sex	D.M. MEAN ± SEM		
			neck	leg	loin
Mangalitsa, the red variety	10	♀+♂	41.44±0.30	30.94±0.52	32.87±0.51
Mangalitsa, swallow belly variety	10	♀+♂	42.05±0.38	32.67±0.43	33.38±0.51

According to the data in Table 3, the dry matter content of the meat samples from the two experimental batches varied depending on the anatomical region. Thus, the highest values were recorded for pork neck, ranging between 41.44% and 42.05%, while the lowest were recorded for pork leg, situated in the range of 30.94% to 32.67%.

Comparing the average values obtained for dry matter, it can be observed that the lowest values were recorded in the case of pigs from the Mangalitsa breed, red variety.

The protein content of the samples studied, collected from Mangalitsa breed pigs, varied depending on the anatomical region, so for pork neck the recorded values were the lowest, being between 15.47% in the case of the red variety and 15.69%, as recorded in the case of the swallow belly variety (Table 4).

Table 4. The protein content of pork from the Mangalitsa breed

Lot	n	Sex	Proteins MEAN ± SEM		
			neck	leg	loin
Mangalitsa, the red variety	10	♀+♂	15.69±0.28	20.90±0.31	20.31±0.37
Mangalitsa, swallow belly variety	10	♀+♂	15.47±0.22	20.33±0.24	19.74±0.31

For pork leg and loin, the average values obtained for protein content were around 20%, the highest values being determined in the case of the red variety.

In terms of protein content in Mangalitsa loin, we can observe that the highest value for this indicator was calculated for the red variety (20.31±0.37%), while the lowest was determined for the swallow belly variety (19.74±0.31%).

The lipid content of Mangalitsa pork varied within a wide range, thus the lowest average values were between 8.85±0.25% and 8.94±0.20% and were recorded for Mangalitsa leg, while the highest values were 24.55±0.35% for the neck from the red variety, respectively 25.32±0.47% for the neck from the swallow belly variety (Table 5).

Table 5. Lipid content of Mangalitsa pork

Lot	n	Sex	Lipids MEAN ± SEM		
			neck	leg	loin
Mangalitsa, the red variety	10	♀+♂	24.55±0.35	8.85±0.25	12.05±0.12
Mangalitsa, swallow belly variety	10	♀+♂	25.32±0.47	8.94±0.20	12.22±0.10

The lipid content of Mangalitsa meat varied within quite wide limits, both depending on the variety of Mangalitsa breed pigs and especially on the type of meat, with Mangalitsa neck presenting the highest lipid content.

The average values obtained from the laboratory analyses for pH and the content of dry matter, protein, and fat in Mangalitsa pork meat fell within the optimal range for this breed of pigs, being close to those reported in the specialized literature (Stănescu et al., 1987; Egerszegi et al., 2003; Hollo et al., 2003; Szabó, 2003; Szabó, 2006; Lugasi et al., 2006; Petrović et al., 2007; Zăhan et al., 2009; Petrović et al., 2010; Nistor et al., 2012; Nagy, 2013).

CONCLUSIONS

The values obtained for the pH of Mangalitsa meat determined at a 24-hour post-slaughter interval varied between 5.74, as recorded in the case of pork leg samples from pigs of the red variety, and 5.84, as recorded in the case of pork neck samples, also collected from pigs of the red variety.

The dry matter content of the meat samples from the two experimental groups ranged between 30.94% and 32.67% for pork leg, between 41.44% and 42.05% for pork neck and between 32.87% and 33.38% for pork loin.

The values recorded for pH 24 hours after slaughter were close for all 6 experimental batches, being around the value of 5.7.

Comparing the average values obtained for dry matter, it can be observed that the lowest values were recorded in the case of the batch consisting of pigs from the Mangalitsa red variety.

The protein content of the samples from the two experimental groups collected from Mangalitsa pigs ranged between 15.47%, as recorded in the case of pork neck collected from the swallow belly variety, and 20.90%, as obtained in the case of pork leg collected from pigs of the red variety. Thus, the percentage of protein in the samples taken in the study varied depending on the anatomical region, with the lowest values recorded for pork neck. Regarding the lipid content of Mangalitsa meat, it varied within quite wide limits, both depending on the variety of Mangalitsa pigs and especially on the type of meat, with Mangalitsa neck showing the highest values. Regarding the lipid content of Mangalitsa meat, it varied within quite wide limits, both depending on the variety of Mangalitsa breed pigs and especially on the type of meat, with Mangalitsa neck presenting the highest values.

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