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QUALITY OF PORK WITH A DIFFERENT INTRAMUSCULAR FAT (IMF) CONTENT

Tomasz Daszkiewicz, Tomasz Bąk, Jerzy Denaburski

Department of Science of Commodities of Animal Raw Materials, University of Warmia and Mazury in Olsztyn, Olsztyn

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The aim of the study was to compare the quality of pig meat with a different IMF content, *i.e.*: ≤1.0%, 1.01–2.0%, 2.01–3.0%, >3.0%. The experiment was performed on samples of the dorsal muscle (*m. longissimus dorsi*) taken from 74 half-carcasses of fatteners, selected randomly at the Meat Plant in Dąbrówno. The carcass weight was 70 to 85 kg. PSE carcasses (pH_{45}≤5.8) were detected and eliminated. The basic chemical composition of pork, its physicochemical and sensory properties were determined *ca.* 48 h after slaughter. It was found that 83.8% of the samples were characterized by a fat content ≤2.0%, and that pork with a lower fat content was obtained from carcasses with lower weight and higher meatiness. An increase in the fat content of meat was accompanied by an increase in its dry matter content and marbling, and a decrease in the concentrations of crude protein and ash. A significantly lower soluble protein content was noted in the samples with the highest fat content (>3.0%). Its concentration in the other groups was at a similar level. An increase in the fat content was correlated with a tendency to lower water-holding capacity. It was confirmed by higher meat weight losses during heat treatment. The results of an organoleptic evaluation show that the IMF content above 3.0% had a positive effect on the palatability, juiciness and tenderness of pork.

INTRODUCTION

The implementation of various animal improvement programmes enables increasing the meatiness of pig carcasses and reducing their fat content [Borzuta, 2002; De Vries *et al.*, 1994; Rosner *et al.*, 2003]. However, it is more and more difficult to maintain good quality of pork obtained from pigs characterized by high meatiness. This is confirmed by a more frequent occurrence of PSE meat [Koćwin-Podsiadła *et al.*, 2001; Grześkowiak *et al.*, 1999] and the fact that consumers are not satisfied with the sensory quality of meat products with a too low fat content [Brandt, 1997; Fernandez *et al.*, 1999; Walstra *et al.*, 2001]. The results of ample studies [Bejerholm & Barton-Gade, 1986; Eikelenboom *et al.*, 1996; Park *et al.*, 2001; Wichłacz *et al.*, 1998; Wood *et al.*, 1996] show that a higher intramuscular fat (IMF) content has a positive effect on the juiciness, palatability and tenderness of meat.

Due to the fact that pork is very popular in many countries, its quality should meet the requirements of consumers. Therefore, optimum IMF content in pork and chemical composition of IMF should be determined. This could contribute to obtaining meat characterized by desirable technological quality, and meat products showing a high nutritive value as well as good sensory and wholesome properties.

The aim of the present study was to compare the quality of pork with a different IMF content.

MATERIALS AND METHODS

The experiment was performed on samples of the dorsal muscle (*m. longissimus dorsi*) taken from 74 half-carcasses of fatteners slaughtered at the Meat Plant in Dąbrówno. The body conformation of the fatteners resembled the body conformation of Polish Large White and Polish Landrace pigs. Slaughter and post-slaughter processing was carried out in accordance with the regulations binding in the meat industry. About *ca.* 45 min after stunning, the following parameters were determined: carcass weight (exact to 0.1 kg); carcass class in the EUROP system, on the basis of the percentage of meat in a carcass, measured with the apparatus Ultra-Fom 100; pH_1 of the dorsal muscle (*m. longissimus dorsi*), measured between the last thoracic vertebra and the first lumbar one, with a MASTER pH-meter (Dramiński). The weights of the carcasses varied from 70 to 85 kg. They belonged to the following classes: E (29), U (26) and R (19). Another criterion of carcass selection for further analysis was the value of meat pH_1, which could not be ≤5.8. The criteria of carcass weight and meat pH_1>5.8 were adopted to detect and eliminate PSE carcasses and reduce the effect of different weight on the parameters examined.

After 24 h of chilling at 2 to 4°C, the carcasses were divided into elements. Samples of the dorsal muscle (*m. longissimus dorsi*) were taken from the right sides, from the area of the 1st and 2nd lumbar vertebra, for further physicochemical and organoleptic analyses.

Author's address for correspondence: Tomasz Daszkiewicz, Department of Science of Commodities of Animal Raw Materials, University of Warmia and Mazury, ul. Oczapowskiego 5, 10-719 Olsztyn, Poland; tel.: (48 89) 523 34 64; fax: (48 89) 523 38 33; e-mail: fox@uwm.edu.pl

The basic chemical composition of pork, its physicochemical and sensory properties were determined *ca.* 48 h after slaughter.

Fresh (after *ca.* 15 min) cross-section areas of the samples were used to determine meat colour (1 point – light, pink-gray (PSE); 2 points – gray-pink; 3 points – red-pink (normal); 4 points – purple-red; 5 points – dark purple-red (DFD), and marbling (1 point – invisible; 2 points – hardly visible; 3 points – visible; 4 points – well visible; 5 points – very well visible). These parameters were estimated applying the standards established at the Institute of the Meat and Fat Industry in Poznań.

The sensory properties (the aroma, palatability, juiciness and tenderness) of cooked pork [Znaniecki, 1983] were evaluated on a 5-point scale (1 point – the worst, 5 points – the best) [PN-ISO 4121:1998].

Before and after heat treatment preceding a sensory evaluation, the samples were weighed exact to 0.001 kg to determine cooking losses.

An analysis of the proximate chemical composition and physicochemical properties of pork included the determination of: dry matter content, fat content – by the Soxhlet method, crude and soluble protein content – by the Kjeldahl method, ash content [Znaniecki, 1983]; meat reaction – determined on the basis of pH of meat water homogenates (meat to distilled water ratio was 1:1) using a pH-meter (Radiometer) and an electrode GK 2311C; colour brightness – determined on the basis of the percentage of light reflection against the surface of minced meat (a spectrocolorimeter "Specol" and remission attachment R45/0, at a wavelength of 560 nm); water-holding capacity by the Grau and Hamm method [Znaniecki, 1983].

The samples were divided into four groups, depending on their IMF content: ≤1.0%, 1.01–2.0%, 2.01–3.0% and >3.0%, to determine the effect of its percentage on meat quality (Table 1).

Statistical calculations were done applying a one-factor analysis of variance. The statistical significance of differences between the groups was determined by the Duncan test. The results were elaborated statistically using the computer program Statistica 5.5

RESULTS AND DISCUSSION

The fat content of most samples (83.78%) was ≤2% (Table 1). In the studies conducted by Grześkowiak *et al.* [2001], the IMF content of almost 50% of *m. longissimus dorsi* samples taken from carcasses of fatteners coming from mass purchase was 2 to 3%.

A systematic increase in the average meat content of pig carcasses has been observed in Poland for several years. However, a higher meatiness of carcasses is accompanied by their lower weight and a reduced IMF content [Cameron, 1990; Kortz *et al.*, 2002; Wajda *et al.*, 1998], which was confirmed in the present study (Table 2). It was found that pork with a fat content of ≤1.0% and 1.01–2.0% was obtained from carcasses with the highest average meatiness and the lowest weight.

TABLE 1. Distribution of samples with reference to intramuscular fat content.

Samples	Fat content of meat			
	≤1.0%	1.01–2.0%	2.01–3.0%	>3.0%
Number	21	41	7	5
%	28.38	55.40	9.46	6.76

TABLE 2. Meatiness and weight of hot carcass of fatteners.

Specification	Stat. measur.	Fat content of meat			
		≤1.0%	1.01–2.0%	2.01–3.0%	>3.0%
Carcass meatiness (%)	$\bar{x}$	56.20^{a}	53.33	50.83^{a}	52.28
	SD	4.67	4.38	2.70	2.40
Hot carcass weight (kg)	$\bar{x}$	77.90	78.36	78.83	80.50
	SD	4.55	4.44	4.61	3.64

Values followed by the same letters differ significantly, aa – p≤0.05

TABLE 3. Proximate chemical composition (%) and marbling (points) of meat.

Specification	Stat. measur.	Fat content of meat			
		≤1.0%	1.01–2.0%	2.01–3.0%	>3.0%
Dry matter	$\bar{x}$	24.65^{Aa}	24.73^{Bb}	25.45^{ab}	25.74^{AB}
	SD	0.57	0.74	0.66	0.59
Fat	$\bar{x}$	0.83^{A}	1.36^{A}	2.33^{A}	3.28^{A}
	SD	0.16	0.26	0.28	0.23
Marbling	$\bar{x}$	1.52^{Aa}	1.55^{Bb}	2.14^{Cab}	3.20^{ABC}
	SD	0.68	0.61	0.90	0.27
Crude protein	$\bar{x}$	22.30^{Aa}	21.92^{B}	21.37^{a}	20.74^{AB}
	SD	0.60	0.79	0.94	0.59
Soluble protein	$\bar{x}$	6.18^{A}	5.90^{B}	6.00^{C}	5.32^{ABC}
	SD	0.39	0.47	0.50	0.44
Ash	$\bar{x}$	1.18^{Aa}	1.16^{B}	1.11^{Ca}	1.05^{AB}
	SD	0.05	0.04	0.07	0.08

Values followed by the same letters differ significantly, ABC – p≤0.01, ab – p≤0.05

Table 3 presents the results of analysis of the basic chemical composition of meat and evaluation of its marbling. The average percentage of fat in the samples varied from 0.83% to 3.28%. Its content of meat from particular groups was increasing by *ca.* 1%. This increase was lower (*ca.* 0.5%) only in the groups of samples containing ≤1.0% and 1.01–2.0% of IMF. All differences between the groups were statistically significant (p≤0.01).

An increase in chemically-determined fat concentration in meat resulted in a higher level of marbling, but significant differences in this parameter were noted only for a fat content above 2.0%, *i.e.* between the group with the highest fat content and the other groups (p≤0.01), as well as between the samples containing 2.01–3.0% of fat and those containing ≤2% of fat (p≤0.05).

An increase in the fat content of meat was accompanied by a higher percentage of dry matter. However, a statistically significant increase in the dry matter content was observed only in the samples containing more than 2.0% of fat.

There was a negative correlation between the fat content and crude protein content of meat. An increase in fat concentration was accompanied by a considerable decrease in the percentage of crude protein. The difference in the average crude protein concentration in the samples with the lowest and highest fat content was 1.56%. Statistically significant differences (p≤0.05 and p≤0.01) in the crude protein content were found between the samples containing ≤1.0% and 1.01–2.0% of fat, and those containing 2.01–3.0% and >3.0% of fat.

An increase in the fat content of meat was correlated with a decrease in the concentration of soluble protein. However, a significantly lower soluble protein content was noted in the samples with the fat content above 3.0% only, which was confirmed statistically ($p \leq 0.01$).

A distinct negative correlation was observed between the levels of fat and ash in meat. The differences in the mineral component content of meat with more than 3.0% of fat and meat from the other groups were statistically significant ($p \leq 0.01$). There was also a statistically significant difference ($p \leq 0.05$) between the mean ash content of samples containing ≤1.0% of fat and those containing 2.01–3.0% of fat.

The results of analysis of the chemical composition of pork are consistent with those reported by other authors, who observed the same correlations between the intramuscular fat content and concentrations of other chemical components in meat [Park *et al.*, 2001; Wichłacz *et al.*, 1998].

One of the major elements of meat quality evaluation is the determination of its pH. In the present experiment, the pH of meat was measured *ca.* 45 min (pH_{45}) and 48 h (pH_{48}) after stunning (Table 4). The pH_{45} varied from 6.17 to 6.22, whereas pH_{48} – from 5.29 to 5.44. In both cases the differences were statistically insignificant.

An evaluation of colour lightness, measured with a spectrocolorimeter and according to the standard (Table 4), showed no statistically significant differences between groups of meat with a different IMF content.

TABLE 4. Physicochemical properties of meat.

Specification	Stat. measur.	Fat content of meat			
		≤1.0%	1.01–2.0%	2.01–3.0%	>3.0%
pH_{45}	$\bar{x}$	6.17	6.18	6.22	6.22
	SD	0.20	0.21	0.21	0.33
pH_{48}	$\bar{x}$	5.44	5.40	5.29	5.32
	SD	0.16	0.17	0.13	0.08
Colour brightness	$\bar{x}$	25.43	25.39	24.43	25.00
(%)	SD	2.54	2.65	2.30	2.35
Colour	$\bar{x}$	2.24	2.23	2.36	2.20
(points)	SD	0.41	0.55	0.80	1.10
Water-holding	$\bar{x}$	9.30	9.49	9.94	10.12
capacity (cm^2)	SD	1.93	1.97	2.04	1.17
Cooking losses	$\bar{x}$	47.55^{Aa}	48.07^{B}	51.05^{a}	52.73^{AB}
(%)	SD	3.66	3.54	2.14	1.62

Values followed by the same letters differ significantly, AB – $p \leq 0.01$, aa – $p \leq 0.05$

No statistically significant differences were noted in the water-holding capacity of meat with a different IMF content determined by the Grau and Hamm method [Znaniecki, 1983] (Table 4). However, an increase in the fat content of samples was correlated with a tendency to lower water-holding capacity in the case of endogenous water.

Too low water-holding capacity causes loss of water and the compounds dissolved in it during heat treatment of meat, which was confirmed by the results obtained (Table 4). An increase in the fat content of pork resulted in higher weight losses during thermal treatment. The difference between the highest and lowest weight loss, noted for the samples containing ≤1.0% and >3.0% of fat, was 5.18%.

As mentioned before, according to many authors, IMF has a positive influence on the sensory quality of meat, whereas others doubt whether there is a significant correlation between a high IMF content of meat and its sensory properties [Dikeman, 1987; Göransson *et al.*, 1992; Homer *et al.*, 1997]. The results of an evaluation of the aroma, palatability, juiciness and tenderness of cooked pork are presented in Table 5. They show that there were no statistically significant differences between the groups as regards the sensory properties examined. Irrespective of the fat content of meat, the intensity and desirability of its aroma were evaluated as very good. The differences concerning the palatability, juiciness and tenderness of the samples containing ≤3.0% of fat were very small. A positive influence of a higher IMF content was visible when its concentration was above 3.0%. However, it should be kept in mind that an increase in the fat content of meat is accompanied by a higher level of marbling, often considered undesirable by consumers. Therefore, according to Fernandez *et al.* [1999], positive effects of a higher IMF content on the sensory quality of meat may be observed only for its concentration not exceeding 2.5–3.5%.

TABLE 5. Organoleptic properties of meat.

Specification	Stat. measur.	Fat content of meat			
		≤1.0%	1.01–2.0%	2.01–3.0%	>3.0%
Aroma	$\bar{x}$	5.00	5.00	5.00	5.00
(intensity)	SD	0.00	0.00	0.00	0.00
Aroma	$\bar{x}$	5.00	5.00	5.00	5.00
(desirability)	SD	0.00	0.00	0.00	0.00
Taste	$\bar{x}$	4.31	4.30	4.36	4.60
(intensity)	SD	0.46	0.49	0.38	0.55
Taste	$\bar{x}$	4.31	4.30	4.36	4.60
(desirability)	SD	0.46	0.49	0.38	0.55
Juiciness	$\bar{x}$	3.24	3.43	3.29	3.60
	SD	0.44	0.60	0.49	0.55
Tenderness	$\bar{x}$	4.26	4.28	4.14	4.40
	SD	0.51	0.54	0.38	0.89

CONCLUSIONS

1. Among 74 meat samples taken from half-carcasses of fatteners selected randomly at a meat plant, 83.78% were characterized by a fat content ≤2.0%. Pork with a lower fat content was obtained from carcasses with lower weight and higher meatiness.

2. An increase in the fat content of meat was accompanied by an increase in its dry matter content and marbling, and a decrease in the concentrations of crude protein and ash. A significantly lower soluble protein content was noted in the samples with the highest fat content (>3.0%). Its concentration in the other groups was at a similar level.

3. Pork with a different intramuscular fat content did not show significant differences in physicochemical properties. However, an increase in the fat content was correlated with a tendency to lower water-holding capacity. It was confirmed by higher meat weight losses during heat treatment.

4. A higher fat content of pork had no considerable effect on its sensory properties. An improvement in its palatability, juiciness and tenderness was noted for the IMF content above 3.0%.

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JAKOŚĆ MIĘSA WIEPRZOWEGO O RÓŻNEJ ZAWARTOŚCI TŁUSZCZU ŚRÓDMIĘŚNIOWEGO

Tomasz Daszkiewicz, Tomasz Bąk, Jerzy Denaburski

Katedra Towaroznawstwa Surowców Zwierzęcych, Uniwersytet Warmińsko-Mazurski w Olsztynie

Celem pracy było porównanie jakości mięsa tuczników o zawartości tłuszczu śródmięśniowego w przedziałach: ≤1,0%, 1,01–2,0%, 2,01–3,0%, >3,0%. Badania przeprowadzono na próbach mięsa (*m. longissimus dorsi*) pobranych z losowo wybranych w zakładach mięsnych 74 półtusz tuczników. Masa objętych badaniami tusz mieściła się w przedziale 70–85 kg. Z badań eliminowano mięso PSE (pH_{45} ≤5,8). Po około 48 h od momentu uboju zwierząt przeprowadzono analizę podstawowego składu chemicznego oraz właściwości fizykochemicznych i sensorycznych mięsa. Stwierdzono, że 83,8% prób mięsa odznaczało się zawartością tłuszczu na poziomie ≤2,0% (tab. 1). Ponadto wykazano, że mięso o niższej zawartości tłuszczu pochodziło z tusz o mniejszej masie i większej mięsności (tab. 2). Wraz ze wzrostem zawartości tłuszczu w mięsie, zwiększał się w nim udział suchej masy i marmurkowatość, a zmniejszała zawartość białka ogólnego i popiołu (tab. 3). W odniesieniu do białka rozpuszczalnego jego istotnie niższą zawartość stwierdzono w mięsie o najwyższej zawartości tłuszczu (>3,0%), przy zbliżonym udziale tego składnika w mięsie z pozostałych grup (tab. 3). Stwierdzono także tendencję do gorszego wiązania wody własnej przez mięso wraz ze wzrostem w nim udziału tłuszczu, co znalazło swoje odbicie w zwiększonych ubytkach masy mięsa w czasie obróbki termicznej (tab. 4). W ocenie organoleptycznej poprawę smakowitości, soczystości i kruchości mięsa odnotowano przy udziale tłuszczu w mięsie przekraczającym 3,0% (tab. 5).