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RESEARCH ARTICLE

# The Effect of Different Amounts of Corn in the Diet of Pigs on Slaughter Value and Meat Quality

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## Abstract
The aim of the research was to determine the effect of different amounts of corn grain in pigs' diets on slaughter value and meat quality parameters. The experiment was performed with 100 Polish Landrace pigs. The pigs were fed with a barley and wheat mixture (control group) and with corn grain added at the level of 20%, 40% and 60% (experimental groups). It was found that the tested corn grain had a significant effect on the fatty acid profile especially on the PUFA linoleic and linolenic acids content as well as on the PUFA n-6/n-3 ratio in the LL muscle. More desirable values for these acids were observed in the control pigs fed with barley and wheat. It was found that the higher the amount of corn in feed the worse the fatty acids results were. To conclude, the pigs feeding in the grower and finisher phase with corn addition did not affect the slaughter, physical and chemical as well as sensory meat traits but caused a negative effect on the fatty acids profile especially by increasing the PUFA n-6/n-3 ratio.

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**KEYWORDS**
pigs; fattening; corn; meat quality

## Introduction
The feeding level and chemical content of feed mixtures affects animal growth, hormones, metabolism as well as the quantity and quality of fat deposited during daily weight gain [Żak and Pieszka 2009]. The basic rule in composing feed recipes for fatteners is to cover their nutrient needs, energy, minerals and vitamins in order to optimize their daily gains, feed consumption, slaughter value and meat quality. In the concentrated feed mixtures for pigs mainly barley, wheat and corn are generally used.

Barley is the most popular grain in pig feed in many European countries. It contains relatively high levels of protein and amino acids, but is also rich in fiber. Simultaneously, barley has lower, than other cereals, regarding the level of starch and sugars [Cervantes – Pahm et al. 2014a; Cervantes – Pahm et al. 2014b; Micek 2008]. The digestibility of the majority of exogenous amino-acids in barley is 70% to 80% and is slightly lower than in other cereals (by approx. 4-5 p.p.). Barley can be added ad libitum in the diets of all pigs age groups due to the low level of anti-nutritional substances, however, its usability in modern pig breeds feed is limited due to the relatively low energy content [Cervantes – Pahm et al. 2014a; Cervantes – Pahm et al. 2014b; Micek, 2008].

Wheat is richer in antinutrients than barley, although, its most important advantage is a higher level of metabolic energy, making wheat much more preferable feed material for intensive pig production [Cervantes – Pahm et al. 2014a; Cervantes – Pahm et al. 2014b; Micek, 2008]. The problem is that wheat is dedicated to human nutritional needs and cannot be used in swine feeding without limits.

Corn is the most popular grain used in pig feeding in many countries (especially in the USA) [Stein et al. 2016], but not in Poland. However, due to the relatively high grain yield the cultivation of corn is becoming more and more popular in central Europe, including Poland.

A high yield of corn grain is associated with the highest income per hectare among feed grains, which results from the following comparison of yields and prices (see Table 1).

Corn turns out to be an unrivaled cereal in terms of revenue per hectare, which is the main reason for its popularity among feed grains. A comparison of chemical composition of grain shows higher starch and fat content and lower protein and fiber content in corn compared to wheat and barley [Micek 2008].

**Table 1.** Comparison of grain yields and prices

| Grain | Yields from 1 ha in T | Price in zł/t | Receipts in zł/ ha |
|---|---|---|---|
| **Rye** | 3,55 | 506,20 | 1797,01 |
| **Triticale** | 4,54 | 610,63 | 2772,26 |
| **Barley** | 4,04 | 608,27 | 2457,41 |
| **Corn** | 7,29 | 763,00 | 5562,27 |

According to Stein et al. [2016] wheat grain contains on average 16.2 (± 1.3) MJ/kg gross energy, 140 (± 21) g/kg crude protein, 11 (± 1.9) g/kg crude fat and 576 (± 63) g/kg starch, barley contains 16,1 (± 1.3) MJ/kg gross energy, 30 (± 15 g/kg crude fat, 108 (± 17) g/kg crude protein and 497 (± 59) g/kg starch, and corn contains 16,7 (± 0.7) MJ/kg gross energy, 29 (± 1.9) g/kg crude fat, 81 (± 11) g/kg crude protein and 621 (± 51) g/kg starch. The chemical composition of commercial corn grains used in an experiment by Prandini et al. (2011) was as follows: net energy 2424 kcal/kg, crude protein 80.2 g/kg, ether extract 32g/kg, starch 729 g/kg. These dates confirmed that corn in comparison to wheat and barley grains is poorer in protein content but richer in starch content. A similar level of crude protein in corn grain was noted by Della Casa et al. (2010), from 9.09% to 10.49% according to linoleic acid content. The fatty acids profile in corn grain is importantly different from wheat and barley [Micek 2008].

The digestibility of corn grain nutrients is relatively high for monogastric animals, because of the low fiber level, e.g. starch digestibility varies from 90% to 96% and goes up with grain refinement [Rojas and Stein 2015]. Theoretically, corn may be added to the diets of all pig groups even as the only grain component, however, there is a negative relation between feeding finishers with a high level of corn and swine fat quality, mainly because of the high content of unsaturated fatty acids in corn grain [Apple et al. 2009; Della casa et al. 2010; Wood et al. 2003]. That is why it is recommended to limit corn in feed mixtures for at least 3-4 weeks before slaughter and to replace it with other grain.

An increase of corn popularity because of economic reasons makes it important to recognize the influence of corn on swine production parameters and meat quality. That is why the aim of this research was to study the effect of different amounts of corn in pigs' diets on fattening parameters, slaughter value, meat quality (sensory, physical- and chemical analysis) and fatty acids profile. This research is especially important for meat technology because as we know from a few references that, feeding swine with corn can influence the quality of the raw material used by the meat industry.

## Material and methods

### Experimental design: animals and diets

The experiment utilized 100 Polish Landrace fatteners fed in a two-phase cycle – grower and finisher. The fattening of the pigs started from the average weight of 28 ± 5 kg and continued till the weight of approximately 110 ± 9 kg. The animals were housed in the same building, in individual pens, fed ad libitum with concentrated feed including wheat and barley middling (Artist and Kosmos cultivars respectively) and a corn Figaro cultivar in different amounts (see Table 2).

**Table 2.** Experimental design and chemical composition of the pig feed

| Specification | Amount of corn in the diet (%) | | | |
|---|---|---|---|---|
| | **0 (A)** | **20 (B)** | **40 (C)** | **60 (D)** |
| **Number of pigs** | 25 | 25 | 25 | 25 |
| Grower diet | | | | |
| Crude protein (%) | 18.88 | 18.13 | 18.37 | 19.10 |
| Lysine (%) | 0.932 | 0.961 | 0.987 | 0.997 |
| Crude fat (%) | 2.03 | 2.09 | 2.08 | 2.51 |
| Starch (%) | 45.95 | 49.45 | 45.54 | |
| Crude fiber (%) | 2.06 | 2.28 | 1.81 | 1.71 |
| Metabolic energy (MJ) | 13.02 | 13.01 | 13.05 | 13.12 |
| Finisher diet | | | | |
| Crude protein (%) | 15.10 | 14.79 | 15.34 | 15.90 |
| Lysine (%) | 0.709 | 0.752 | 0.756 | 0.771 |
| Crude fat (%) | 1.96 | 2.02 | 2.35 | 2.81 |
| Starch (%) | 47.40 | 54.81 | 51.62 | 50.40 |
| Crude fiber (%) | 2.58 | 2.16 | 2.12 | 1.91 |
| Metabolic energy (MJ) | 12.97 | 12.93 | 12.97 | 12.99 |

The feed in the control group included 50:50 wheat and barley middlings. The feeds for the experimental groups, were composed excluding equal parts of barley and wheat and including, 20%, 40% or 60% of corn grain. The average fattening time was 79 ± 2.4 days. The animals were weighed individually at the beginning of the experiment and then again before slaughter. After fattening the pigs were transported from the National Animal Research Institutes' Experimental Station in Chorzelów to the slaughterhouse in Kasinka Mała located 170 km from the experimental station. After 2-hours rest, the animals were slaughtered using 2-electrode stunning of the following parameters: 50 Hz frequency, 250 V voltage, 1.4 A amperage and 7 s electric current application time. The slaughter value traits were also determined. On the left, the hot and hanging carcasses lean meat content (meatiness) measurement using an Ultra-Fom 300 ultrasonic device was taken. Hot carcasses were weighed individually after 45 min post slaughter on the electronic scales with measurements at 100 g accuracy. After 24 hours of cooling at 4°C the longissimus lumborum (LL) muscle over the three first lumbar vertebrae were cut from all 100 carcasses for further lab tests and the carcass cutting was made according to the Polish procedure [PN-89/A-2002]. The share of the cuts was calculated as a percentage of chilled left half carcass weight.

### Analytical determinations

Dry matter, ash, crude protein and other extracts in the diets were determined according to AOAC [2004] (procedure numbers 934.01, 942.05, 954.01, 920.39 respectively). Fiber content was determined according to Van Soest et al. [1991] using an Ankom220 Fiber Analyzer (ANKOM Technology, NY, USA) with heat-stable amylase and expressed inclusive of residual ash. Starch content was determined by an enzymatic method [Faisant et al. 1995].

The physical traits of the 100 LL muscle samples were analyzed 48 hours post mortem as well as its' basic chemical composition, sensory traits and fatty acids profile. The pH of the meat and the electrical conductivity were measured using respectively: a Sydel pH-meter with a dagger electrode, 45' and 48 hours after slaughter and a MT-03 conductometer, after 48 hours. Meat color was determined on the muscle LL cross section using a Minolta Chroma Metters CR 200 device produced by Konica Minolta and the color parameters were measured in L*a*b* scale (light source D65, observer 2o, head slot 8 mm, calibration on the white standard: L*-97.83; a*-0.45; b*-1.88) [AMSA, 2012].

Water holding capacity (WHC) was measured with the Grau and Hamm method (1952) modified by Pohja and Niinivaara [1957]. The fat content was determined using the Soxhlet method (ISO:1444). Water content was estimated according to the standard method (ISO:1442). The total protein content was measured according to the Polish standard with the Kjeldahl method, using the Tecator device [PN-75/A-04018].

The LL muscle samples were cooked in water to the temperature of 70ºC inside the muscle. The cooking losses were calculated based on the differences between the muscle samples' weight before and after cooking. The sensory estimation of the cooked muscle was performed in a 5-point scale including aroma, juiciness, tenderness and palatability (overall acceptability). The sensory test was done by 4 scientists (experts) from the Prof. Wacław Dąbrowski Institute of Agricultural and Food Biotechnology, trained and tested for sensory sensitiveness [Baryłko-Pikielna and Matuszewska 2014]. The assessment was made in daylight at room temperature. The following grading scale was used: aroma: 1-very unacceptable; 5- very acceptable; juiciness 1- very dry; 5-very juicy; tenderness; 1-very tough; 5- very tender; palatability; 1- very unacceptable; 5- very acceptable.

In the intramuscular fat from the raw LL muscle the fatty acids profile was determined. The methyl esters of the fatty acids samples were prepared according to the PN-EN ISO 5509 method. The fatty acids composition was determined by gas chromatography using a Hewlett Packard HP 6890 device (Agilent Technologies) equipped with a flame-ionic detector and a high polarized column with a BPX 70 phase. The column was 60 m long, the layer thickness 0.25 µm, whereas its internal diameter was 0.22 mm. The analyses were performed in the programmed temperature and time. Individual fatty acids were identified by comparison of the retention times to those of a standard FAME mixture (Supelco 37 Component FAME Mix and C18 FAME Isomers, Sigma-Aldrich Co.) and expressed as a relative proportion of all of the FA in the sample.

## Statistical analysis

The results were statistically analyzed by calculating the means and SEM. Data were checked for normal distribution and variance homogeneity by the Shapiro-Wilk test. A one factor variance analysis (ANOVA) was also performed for the studied groups. The Statistical 6.0 software was used [Statsoft, 2001]. The Tukey test was used for the means comparison to probability levels of P≤0.05 and 0.01.

## Ethics statement

All experimental procedures performed on live animals followed the EU Directive 2010/63/EU for animal experiments and the Polish law for the care of animals used in research and education. According to Polish law, the ethical approval of research is not formally required if experiments involve only the standard operating procedures typically carried out on a commercial farm. The slaughter of animals aimed at obtaining tissues for laboratory analyses is not formally considered as a research procedure and the ethical approval of such action is not required.

## Results

## Fattening, slaughter and physical traits

The different corn amounts in the diet of the pigs did not affect (P>0.05) growth rate, feed conversion ratio, the carcass weight, lean meat content nor the backfat and loin thickness and the content of the main cuts (Table 3). The average values of the slaughter traits observed in the experimental groups fed with different corn amounts did not differ significantly compared to the control group (P>0,05). The average lean meat content in the carcasses of all of the investigated groups was between 56% and 57%, which corresponds to class E in the SEUROP classification system (EU Council No 1308/2013). Among the physical traits significant differences between the control and experimental groups was only observed in WHC (Table 4). Worse water holding capacity was stated only in the group fed with 20% of corn in the diet (P ≤ 0.01).

The fatteners fed with corn did not show significant differences (P>0,05) in muscle acidity in both, hot and chilled carcasses. However, a detailed analysis of individual cases showed an increasing number of muscles with pH < 6 in groups fed on diets with increased amounts of corn (4.0%, 4.4%, 8.3%, 29.2% in A, B, C, D respectively (P≤0.05)). No effect of corn addition was observed on meat lightness, redness, and yellowness (P>0.05).

**Table 3.** Fattening and slaughter value traits of pigs fed with different amounts of corn grain

| Fattening and slaughter traits | Addition of corn grain in diet (%) | | | | SEM | P value |
|---|---|---|---|---|---|---|
| | 0 (A) | 20 (B) | 40 (C) | 60 (D) | | |
| Daily gain (g) | 892.8 | 927.9 | 906.8 | 907.0 | 12.1 | 0.781 |
| Feed consumption (kg) | 195.6 | 208.1 | 201.9 | 198.0 | 3.2 | 0.513 |
| Feed conversion ratio (kg/kg) | 2.75 | 2.92 | 2.84 | 2.79 | 0.05 | 0.660 |
| Hot carcass weight (kg) | 75.31 | 78.53 | 77.38 | 77.61 | 0.938 | 0.667 |
| Meatiness (%) | 57.32 | 56.50 | 55.85 | 57.04 | 0.307 | 0.339 |
| Fat thickness at point F1 (mm) | 14.13 | 15.04 | 15.39 | 14.71 | 0.397 | 0.727 |
| Fat thickness at point F2 (mm) | 14.49 | 14.95 | 16.85 | 14.60 | 0.399 | 0.129 |
| Loin thickness at point M2 (mm) | 51.13 | 51.71 | 51.65 | 53.70 | 0.717 | 0.591 |
| Tenderloin content (%) | 1.47 | 1.47 | 1.52 | 1.36 | 0.205 | 0.362 |
| Loin content (%) | 10.92 | 10.63 | 10.91 | 10.69 | 0.107 | 0.420 |
| Neck content (%) | 7.10 | 7.11 | 6.85 | 7.15 | 0.081 | 0.085 |
| Leg content (%) | 26.20 | 25.99 | 26.20 | 25.90 | 0.133 | 0.103 |
| Shoulder content (%) | 14.62 | 14.36 | 14.45 | 14.72 | 0.152 | 0.342 |
| Belly content (%) | 13.24 | 13.80 | 13.44 | 13.37 | 0.128 | 0.226 |
| Back fat content (%) | 3.10 | 3.35 | 3.50 | 3.15 | 0.077 | 0.741 |

Means marked by lowercase letters are significant at P≤0.05 and marked by uppercase letters are significant at P≤0.01

**Table 4.** Physical traits of the longissimus *lumborum* muscle of pigs fed with different amounts of corn grain in the diet

| Physical traits | Addition of corn grain in the diet (%) | | | | SEM | P value |
|---|---|---|---|---|---|---|
| | 0 (A) | 20 (B) | 40 (C) | 60 (D) | | |
| pH 45’ | 6.34 | 6.39 | 6.41 | 6.29 | 0.027 | 0.440 |
| pH 48h | 5.58 | 5.60 | 5.61 | 5.57 | 0.009 | 0.405 |
| Electrical conductivity 48h(mS) | 4.54 | 5.27 | 4.92 | 4.75 | 0.210 | 0.662 |
| WHC (%) | 31.63 $^{B}$ | 34.56 $^{A,D}$ | 32.06 | 31.23 $^{B}$ | 0.368 | 0.007 |
| Lightness L* | 51.43 | 50.68 | 49.85 | 51.61 | 0.272 | 0.083 |
| Redness a* | 5.44 | 5.48 | 5.69 | 5.79 | 0.134 | 0.762 |
| Yellowness b* | -0.88 | -0.23 | -0.78 | -0.28 | 0.157 | 0.330 |

Means marked by uppercase letters are significant at P≤0.01 and marked by lowercase letters are significant at P ≤0.05

**Table 5.** Basic chemical content and sensory traits of the longissimus lumborum muscle of pigs fed with different amounts of corn grain in the diet

| Quality traits | Addition of corn grain in the diet (%) | | | | SEM | P value |
|---|---|---|---|---|---|---|
| | 0 (A) | 20 (B) | 40 (C) | 60 (D) | | |
| Water content, (%) | 73.46 | 73.75 | 73.33 | 73.45 | 0.097 | 0.490 |
| Fat content, (%) | 1.62 | 1.82 | 1.76 | 1.61 | 0.050 | 0.381 |
| Protein content, (%) | 23.56 | 23.10 | 23.59 | 23.59 | 0.096 | 0.218 |
| Smell, (points) | 4.08 | 4.03 | 4.03 | 4.05 | 0.023 | 0.825 |
| Palatability, (points) | 3.90 | 3.82 | 3.85 | 3.76 | 0.028 | 0.316 |
| Juiciness, (points) | 3.81 | 3.70 | 3.70 | 3.63 | 0.037 | 0.395 |
| Tenderness, (points) | 3.83 | 3.87 | 3.72 | 3.77 | 0.040 | 0.622 |

Means marked by uppercase letters are significant at P≤0.01 and marked by lowercase letters are significant at P ≤0.05

## Basic chemical contents and quality traits of the longissimus lumborum muscle

No significant effect (P>0.05) of all of the tested corn doses on the chemical composition of the LL muscle was found (Table 5). The LL muscle composition was similar to the control group in all of the experimental groups of pigs fed with corn. This chemical composition was typical for lean pork and in all groups reached approximately 73% water, approximately 23% protein and approximately 1.6-1.8% fat content.

Corn addition in pigs’ diets did not affect (p>0.05) all of the tested sensory traits of the LL muscle, i.e. aroma, palatability, juiciness and tenderness (Table 5). All of these traits obtained a score between 3.6 to 4.1 points on the 5-point scale.

## Fatty acids profile of the *longissimus lumborum* muscle

A varied effect of the tested addition of corn grain on the fatty acid profile in the LL muscle was observed (Table 6). It was observed that the lower content of SFA acids (only stearic C18:0 acid) was in the groups of pigs fattened with corn (P ≤ 0.01) but only with its highest addition to diet (60%). The lower addition of corn did not differentiate the content of the SFA level which was similar to the control group. The contrary direction of changes was observed in PUFA content, where the share was higher in those groups with 40% and 60% corn addition (approximately 2 and 3 percentage points respectively) in comparison to the control group (P≤0.01). Significant changes were observed in the content of three studied PUFA acids e.g. C18:2, C18:3 and C20:2.

It was also observed that the content of MUFA was not dependent on corn fattening up to the 60% addition of this grain to the fatteners diet (P>0.05).

The content of PUFA n-6 and PUFA n-3 in the meat was influenced by the corn ration level in the diet. In the pig groups fed with corn especially with higher corn rations i.e. 40% and 60% a very significant increase of PUFAn-6 and a decrease of PUFAn-3 content were observed (P<0.01).

The consequence of different polyunsaturated fatty acids content in the meat of the tested fatteners groups was different with the PUFA n-6 to PUFA n-3 ratio. This factor was influenced by the corn addition to the diet in the fatteners (P≤0.01). The most favorable ratio was observed in the control pigs fed with wheat and barley middling’s. In the pig groups fed with corn the PUFA n-6/n-3 ratio increased starting from 13.05 in the control group to 16.04; 18.61 and 21.57 respectively in the experimental groups (P≤0.01).

The cholesterol level in the LL muscle from pigs fed with different corn amounts was similar and was not significantly different from the control group (P>0.05) The groups of pigs fed with corn cholesterol content ranged from 72.68 to 74.32 mg/100g (Table 6).

**Table 6.** Fatty acid profile of the longissimus lumborum of pigs fed with different corn doses in the diet.

| Fatty acids | Addition of corn grain in the diet (%) | | | | SEM | P value |
|---|---|---|---|---|---|---|
| | 0 (A) | 20 (B) | 40 (C) | 60 (D) | | |
| C12:0 (%) | 0.10 | 0.07 | 0.07 | 0.10 | 0.01 | 0.662 |
| C14:0 (%) | 1.10 | 1.17 | 1.15 | 1.09 | 0.02 | 0.365 |
| C16:0 (%) | 23.57 | 23.68 | 23.31 | 22.82 | 0.13 | 0.082 |
| C16:1 (%) | 1.98$^{b}$ | 2.21$^{a}$ | 2.01 | 2.04 | 0.03 | 0.041 |
| C18:0 (%) | 15.60$^{cD}$ | 14.55 | 14.24$^{a}$ | 13.40$^{A}$ | 0.17 | 0.000 |
| C18:1 trans (%) | 0.19 | 0.18 | 0.18 | 0.20 | 0.01 | 0.251 |
| C18:1 cis 9 (%) | 37.99 | 38.7 | 37.78 | 38.35 | 0.17 | 0.235 |
| C18:2 (%) | 12,43$^{CD}$ | 12.45$^{CD}$ | 14.46$^{AB}$ | 15.13$^{AB}$ | 0.23 | 0.000 |
| C18:3 (%) | 0.95B$^{CD}$ | 0.76A | 0.77A | 0.70$^{A}$ | 0.02 | 0.000 |
| C20:0 (%) | 0.29 | 0.31 | 0.31 | 0.29 | 0.01 | 0.100 |
| C20:1 (%) | 1.00 | 1.02 | 1.00 | 1.03 | 0.02 | 0.884 |
| C20:2 (%) | 0.62$^{CD}$ | 0.61$^{CD}$ | 0.71$^{AB}$ | 0.76$^{AB}$ | 0.01 | 0.000 |
| SFA (%) | 41.16 $^{D}$ | 40.24 $^{D}$ | 39.52 | 38.18 $^{A B}$ | 0.26 | 0.000 |
| MUFA (%) | 43.97 | 45.06 | 43.63 | 44.34 | 0.19 | 0.067 |
| PUFA (%) | 14.81 $^{C D}$ | 14.60 $^{C D}$ | 16.72 $^{AB}$ | 17.40 $^{A B}$ | 0,25 | 0.000 |
| PUFA n-6 (%) | 13.50 $^{C D}$ | 13.53 $^{C D}$ | 15.64 $^{A B}$ | 16.39 $^{A B}$ | 0.24 | 0.000 |
| PUFA n-3 (%) | 1.04 $^{B CD}$ | 0.83 A | 0.84 $^{A}$ | 0.76 $^{A}$ | 0.02 | 0.000 |
| PUFA n-6/n-3 ratio | 13.05 $^{B C D}$ | 16.04 $^{A C D}$ | 18.61 $^{A B D}$ | 21.57 $^{A BC}$ | 0.29 | 0.000 |
| Cholesterol (mg/100g) | 73.76 | 74.29 | 74.32 | 72.68 | 0.90 | 0.916 |

Means marked by uppercase letters are significant at P≤0.01
and marked by lowercase letters are significant at P ≤0.05

## Discussion

### Slaughter and physical traits

The research results showed that balanced nutrients in the feed and the amount of corn did not have any significant influence on the lean meat content in the carcass nor on the backfat thickness and yield of the main cuts. Similar results were obtained by Whitney et al. (2006) who proved that fatteners slaughtered with approximately 116 kg body weight fed with about 70% of corn in the diet had similar carcass lean meat content (53%) but higher backfat thickness and loin depth (21 and 56 mm respectively). These effects of corn feeding are the result of the low level of antinutrient substances that diminish the digestibility of the feed. Similar results were indicated by Myries et al. (2008) evaluating the effect of different antinutritional substances doses on pig development. It was found that hemicelluloses fiber level typical for commercial diets based on barley or wheat bran reduces the intestinal digestibility of amino acids by increasing the endogenic losses of the weight of the animals.

The research results did not show any clear effect of pigs feeding with corn on physical meat traits such as pH, electrical conductivity, color lightness, redness and yellowness parameters. Only the WHC of meat in the group fed with 20% of corn was worse than in the control group and in the group with 60% of corn in the diet. This result could be recognized as an accidental. The effect of corn addition to the diet on the physical meat traits may be regarded as insignificant.

### Chemical and quality traits

The research showed that adding corn to the pigs' diet did not affect the LL muscle's basic chemical composition that was not significantly different (P>0.05) in the control and research groups. The basic chemical meat composition was similar to typical lean pork which according to the most recent research for the longissimus dorsi of class E carcass is as follows: water ca. 72.25%, fat ca. 1.92% protein ca. 22.54% [Collective work 2015]. Also, the research of Turyk et al. [2015] and Chapman et al. [2015] confirmed a similar chemical composition of meat from fatteners fed with cereal grain.

The LL muscle organoleptic estimation results were not affected by any amount of corn addition to the diet and they were similar to the control group. However, there is a tendency to lower the score for the tested sensory characteristics of meat from pigs fed with higher doses of corn grain, by approximately 0.2 points, compared to the control group.

### Fatty acids profile

Today's current lifestyles and our eating habits make us prone to delivering surplus amounts of energy to our bodies with all the undesired health consequences. Dieticians recommend reducing fat consumption to the level when energy is delivered by fat in not more than 25-30% of daily intake [Codex Alimentarius 1984]. These recommendations are aimed at delivering optimal amounts of nutrients with the fat dose and zero or limited amounts of undesirable ingredients [Collective work 2006]. Such undesirable ingredients are saturated fatty acids which when consumed excessively make people prone to heart disease due to their hyper -cholesteroleic effect i.e., by increasing the total cholesterol level and its LDL fraction as well as the atherogenic effect i.e. causing arteriosclerosis. The Study has shown that the lower addition of corn in the diet of the pigs had no effect on the SFA content in the LL muscle. Only 60% of corn addition caused a decreasing level of SFA from about 41% in the control group to about 38% in the experimental group (P<0.01). This decreasing concern mainly being stearic acid.

The most interesting results were observed in the changes of linoleic and linolenic acids. The worse results were found in pigs fed with corn addition. Consequently, the n-6/n-3 PUFA ratio increased significantly (P≤0.01) with the increasing addition of corn in the diet. The high PUFA n-6/n-3 ratio was also confirmed in the bacon of pigs fed with corn by Dahlen et al. (2011), where the average was 19.51 whereas in the pigs fed with dried distilled grain soluble (DDGS) it was as high as 25.97. The high n-6/n-3 ratio in the bacon fat of pigs fed with corn or with DDGS was also reported by White et al. (2009), reaching 29.63 and 35.06 respectively.

The differences in the profile of the LL muscle fatty acids in pigs fed with different grains and different amounts were caused by their different level in the diets. The research of Micek (2008) showed that C18:2 content in wheat, barley and corn was 34.9%, 42.6% and 49.0% respectively whereas the C18:3 content was 3.5%, 4.4%and 1.3%, respectively. That is why the C18:2 n-6 to C18:3 n-3 ratio was 13.05 for control group and 16.04 to 21.57 for the corn groups. But a worse PUFA n-6/ PUFA n-3 ratio in the meat of pigs fed with corn cannot disqualify this cereal as a feed component because its positive trait is the effect on animal growth and production costs. The low content of these two acids is easily covered in the human diet and other foods contain the same substances, e.g. fish and vegetable oils [Wood et al. 2009]. This knowledge is needed for dietetics who create diets for consumers from different social groups. There is also an alternative to this coefficient in the meat of pigs fed with corn by adding to the diet feed components rich in acid content from the n-3 group for example flax oil, rape oil, soya oil, and flax grains [Lisiak et al 2013]. The profile lipid acids can also be corrected by replacing corn in pigs diet with other cereals at the end of the feeding period [Renfrow et al. 2003]. The research of many authors indicated that the higher PUFA content in pork lipids may have a negative effect on the shelf-life and palatability of fresh pork [Apple et al. 2009; Wood et al. 2003; Morel et al. 2006] as well as on the sensory traits of raw-maturing hams [Musella et al. 2009]. Also, the results obtained in this research proved that PUFA content in the LL muscle increased significantly ($P \leq 0.01$) at 40% and 60% of corn in the feed amount. According to American requirements included in Pork Composition and Quality Assessment Procedures [NPPC 2000] pork fat should contain <15% PUFA. Fat containing >14% linoleic acid is classified as soft fat. In many cases these limits cannot be reached and make the fat suitability worse for some products [Della Casa et al. 2010; Rentfrow et al. 2003; Benz et al. 2011; Van Boa et al. 2019]. Fatteners fed with the control feed and fed with small doses of corn in the diet (20%) fulfilled American quality requirements for fat [NPPC 2000], because it was not classified as the soft one which made it more useful for some products especially for pork belly and bacon [Rentfrow et al. 2003]. The higher addition of corn to the diet makes the fat too soft. It should be emphasized that the profile of fatty acids in the meat of pigs fed with corn, which is worse for health, will be less important, e.g. in pork loin with low fat content (approx. 1.8%), than, for example, in pork belly (25.59% in class E, according to Blicharski et al. al., 2015).

Different amounts of corn in the pig's diet did not affect the cholesterol level in the LL muscle lipids. The cholesterol content varied from approximately 72 to 74 mg/100g and was typical for pork meat [Honikel and Ameth 1996]. The results obtained in the fatty acid profile of meat in pigs fed with different cercal correspond with their content in the feed component. Wheat and barley has a similar profile and corn has lower SFA, especially palmitic acid C16:0 (Table 3) but more PUFA. So the ratio of PUFA n-6/n-3 in corn grain is about four times higher than in wheat and barley. That affected the profile of the fatty acids in the meat of the pigs fed with this feed. So the rule of precise dependence between fatty acids compound in feed and in the meat of monogastric animals was confirmed [Wood et al. 2003; Wood and Rearon 2009].

## Conclusions

The research showed that feeding pigs with diets of different amounts of corn (from 20% to 60%) did not affect the main cuts yield, backfat thickness nor the carcass lean meat content. No significant effect of these grain additions neither on the majority of the meats physical traits nor on the basic composition, cholesterol level and LL muscle sensory traits was observed.

It was found that the tested corn levels had a significant effect on the fatty acid profile especially on the PUFA content, linoleic and linolenic acids content as well as on the PUFA n-6/n-3 ratio in the LL muscle. More favorable values for these acids were observed in the control pigs fed with barley and wheat. It was found that the higher the amount of corn in the feed the worse the fatty acids profile results were. To conclude, the pigs' feeding in the grower and finisher phase with corn addition did not affect the slaughter, physical and chemical as well as sensory meat traits but caused a negative effect on the fatty acid profile especially by increasing the PUFA n-6/n-3 ratio. In summary, the meat of the pigs fattened with barley and wheat was the same in the physical and sensory traits as the pigs fattened with corn but was more favorable for human health in the fatty acid profile. A higher PUFA content in the meat of pigs fed with corn is associated with a worse texture and faster fat oxidation, and therefore a worse technological suitability of the raw material.

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