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CORRELATION BETWEEN MEAT WATER-SOLUBLE PROTEIN CONTENT AND CARCASS AND MEAT QUALITY TRAITS IN FATTENERS DIFFERING IN MEATINESS*

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Studies covered 180 carcasses of fatteners with an average carcass weight of 82.1 kg, approximate in type to Polish Large White (PLW) and Polish Landrace (PL), classified to the respective classes of EUROP system (36 carcasses each: 18 gilts and 18 boars) based on their meatiness estimated with the help of an Ultra-Fom 100 apparatus.

It was found that water-soluble protein content (both in regard to meat weight and total protein content) was positively correlated ($p \leq 0.05$ and $p \leq 0.01$) with carcass weight and length and backfat thickness. Moreover, positive coefficients of correlation were found between meat water--soluble protein content and sensory evaluation of meat colour, wateriness and texture and water-binding capacity, dominant wavelength and colour saturation as well as meat quality indices: pH_U, pH_S and O_{11}. In addition, negative coefficients of correlation were found between that trait and thermal drip value and meat colour lightness. Meat technological usefulness improved significantly with an increase in water-soluble protein content in meat and total protein with a simultaneous lessening of carcass musculature.

INTRODUCTION

Meat water-soluble protein content is considered to be one of traits determining its quality and differentiating it from normal meat (*i.e.* meat with desirable qualities or defective meat) and is extracted the least from watery meat (PSE) and the most from DFD meat [Kotik, 1974; Lopez--Boote *et al.*, 1989].

There are correlations between meat water-soluble protein level and the value of other meat quality traits determining its technological value [Karamucki *et al.*, 1999 a, b; Kortz, 1986] as well as carcass parameters and its slaughter value [Kauffman, 1996]. As is well known, the quality of meat obtained from carcasses worsens together with an increase in its meatiness, at the same time the meat frequently presents PSE traits [Borzuta & Pospiech, 1999; Koćwin-Podsiadła *et al.*, 1993]. As one can thus expect, meat water-soluble protein content should decrease together with an increase in meatiness and a decrease in carcass fatness.

The aim of the study was to determine the correlation degree between the meat water-soluble protein content and carcass and meat traits in porkers differing in meatiness.

MATERIAL AND METHODS

The experiment was carried out on an industrial technological line in the "Agryf" Meat Plant in Szczecin. Studies covered 180 carcasses of fatteners with an average weight of 82.1 kg, approximate in type to Polish Large White (PLW) and Polish Landrace (PL). To obtain material differentiated in respect of musculature, groups were selected with 36 carcasses each (18 gilts and 18 boars), classified into the respective classes of EUROP system based on their meatiness estimated with the help of an Ultra-Fom 100 apparatus. Measurements of backfat and LD muscle thickness and estimation of carcass percentage content were made with the use of the above-mentioned apparatus approximately 45 min after the slaughter. At the same time, pH_1 measurement was done in the *musculus longissimus dorsi* in the region between lumbar vertebrae 4 and 5. After cooling for about 24 h, the carcasses were weighed and the measurements were made on the right half-carcasses determining their length and backfat thickness on a 5-point scale according to the method used at SKURTCH (Pig Slaughter Testing Station, PSTS) [Różycki, 1996]. When these measurements were taken, the carcasses were subjected to dissection during which, among others, the height, width and the area of cross-section of the *musculus longissimus dorsi* (of the so-called 'eye muscle') were determined. The meat pH_U was recorded and meat samples for further laboratory assays were collected from the lumabar region of the LD muscle.

Approximately 48 h after the slaughter, a sensory evaluation of raw meat colour, wateriness, texture and marbling [Różyczka *et al.*, 1975] was carried out at the laboratory as well as dominant wavelength and colour lightness, saturation [Różyczka *et al.*, 1968] and stability [Kortz, 1966] as percentage of colour change [Różyczka & Michalski, 1978] were determined along with meat water-binding capacity [Pohja & Niinivaara, 1957]. In addition, the value of ther-

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mal drip was recorded [Walczak, 1959]. The remaining part of the meat sample was frozen for 1–2 months. In these samples, defrosted successively, dry matter, total protein, lipids and ash contents [A.O.A.C., 1990] as well as the content of water-soluble protein [Kotik, 1974] were determined.

Meat quality indices, *i.e.* pH_S, I_2 and Q_{11}, were calculated on the basis of the methods given by Kortz [1986]. Normal and defective meat frequencies were estimated on the grounds of their boundary values [Kortz, 1986]. The collected results were subjected to the statistical analysis based on Statistica computer software.

RESULTS AND DISCUSSION

Table 1 presents the mean values and standard deviations for carcass traits, meat chemical composition and meat quality traits and indices in the examined material, whereas Table 2 presents the simple correlation coefficients between meat water-soluble protein content and other carcass and meat traits. The content of the protein under discussion (expressed as % in meat and as % in total protein) was significantly positively correlated ($p \leq 0.05$ and $p \leq 0.01$) with cooled carcass weight (r=0.22** and r=0.19**, respectively), carcass length (r=0.18* and r=0.28**) and respective backfat thickness measurements (r=0.33**-0.38** and r=0.35**-0.40**). Karamucki *et al.* [1999 a, 1999 b] did not find, despite individual cases, significant correlations between meat water-soluble protein content and backfat thickness or a distinct effect of backfat thickness on the value of coefficients of simple correlation between that protein content and meat quality traits and indices. It should be emphasized at the same time that the studies were made on material not much differentiated in respect to fatness. On the other hand, Kortz *et al.* [1996] found positive coefficients of correlation between meat water-soluble protein content and backfat thickness in two genetic groups of crossbreed pigs: Polish Large White (PLW) × Belgian Landrace (r=0.71**) and Polish Large White (PLW) × (Hampshire × Pietrain), while in the case of pure Polish Large White (PLW), the discussed correlation proved to be low and non-significant. In groups of pigs in which the level of the said protein correlated positively with mean backfat thickness, the authors simultaneously claimed a negative correlation with carcass meat percent content and eye muscle area. In the present experiment, water-soluble protein content decreased significantly in respect to meat and total protein together with an increase in carcass meat content (r=-0. 31** and r=-0.33**, respectively). Moreover, a negative coefficient of correlation (r=-0.15*) was stated between the percentage content of the discussed protein in the total protein and eye muscle area.

Water-soluble protein content also increased in meat total protein content together with its increase (r=0.21**), whereas its contribution in total protein decreased (r=-0.12). No significant coefficients of correlation were found between the contribution of this protein in meat and total protein and the content of dry matter, lipids or ash.

The contribution of water-soluble protein (expressed as % in meat and as % in total protein) proved to be significantly positively correlated ($p \leq 0.01$) with the results of sensory evaluation for meat colour (r=0.58** and r=0.57**, respectively), wateriness (r=0.53** and r=0.55**) and texture (r=0.47** and r=0.55**), water-binding capacity (r=0.53** and r=0.54**), dominant wavelength (r=0.43** and r=0.48**), colour saturation (r=0.22** and r=0.22**) and meat quality indices: pH_U (r=0.63** and r=0.70**), pH_S (r=0.34** and r=0.32**), I_2 (r=0.18* and r=0.15*) and Q_{11} (r=0.52** and r=0.53**), and significantly negatively correlated ($p \leq 0.01$) with thermal drip value (r=-0.56** and r=-0.57**) and meat colour lightness (r=-0.43** and r=-0.52**). The correlations mentioned above corroborate the findings of Karamucki *et al.* [1999 a, b],

TABLE 1. Mean values ($\bar{x}$) and standard deviations (s) of examined carcass traits, basic meat chemical composition and its quality traits and indices.

Specification	$\bar{x}$	s
Cooled carcass weight (kg)	82.13	6.76
Carcass length (cm)	84.02	3.68
Carcass meat content (%)(Ultra-Fom 100)	47.68	7.57
Eye muscle areas (cm^2)	38.19	7.77
Backfat thickness (cm):		
– over shoulder	4.14	0.79
– on back	2.84	0.68
– in sacral region I	3.14	0.95
– in sacral region II	2.37	0.88
– in sacral region III	3.15	1.02
– average from 5 measurements	3.30	0.79
Water-soluble protein content:		
– % in meat	9.34	1.17
– % in total protein	42.74	5.27
Proximate chemical composition (%):		
– dry matter	26.53	1.36
– total protein	21.87	0.91
– lipids	3.46	1.45
– ash	1.10	0.11
Sensory evaluation (points):		
– colour	3.15	0.72
– wateriness	2.95	0.54
– texture	2.95	0.48
– marbling	2.07	0.75
Physico-chemical traits:		
– water-binding capacity (% bound water in total water)	79.40	5.87
– thermal drip (%)	25.76	3.84
Colour:		
– dominant wavelength (nm)	587.86	2.92
– lightness (%)	20.89	3.74
– saturation (%)	24.73	3.16
– stability (% of colour change)	7.63	5.97
Quality indices:		
– pH_1	6.34	0.33
– pH_U	5.50	0.22
– pH_S	5.86	0.25
– I_2	3.45	0.72
– Q_{11}	3.36	0.39

TABLE 2. Coefficients of simple correlation between meat water-soluble protein content and carcass traits, meat chemical composition and its quality traits and indices (water soluble protein content in meat was expressed as % in meat and as % in total protein).

Specification	Water-soluble protein (% in meat)	Water-soluble protein (% in total protein)
Cooled carcass weight (kg)	0.22**	0.19**
Carcass length (cm)	0.18*	0.28**
Eye muscle area (cm^2)	-0.03	-0.15*
Carcass meat content (%) (Ultra-Fom 100)	-0.31**	-0.33**
Backfat thickness (cm):		
– over shoulder	0.33**	0.35**
– on back	0.38**	0.38**
– in sacral region I	0.33**	0.36**
– in sacral region II	0.36**	0.40**
– in sacral region III	0.37**	0.40**
– average from 5 measurements	0.37**	0.40**
Proximate chemical composition (%):		
– dry matter	0.00	-0.09
– total protein	0.21**	-0.12
– lipids	-0.12	0.00
– ash	-0.04	-0.09
Sensory evaluation (points):		
– colour	0.58**	0.57**
– wateriness	0.53**	0.55**
– texture	0.47**	0.55**
– marbling	0.10	0.20**
Physico-chemical traits:		
– water-binding capacity (% bound water in total water)	0.53**	0.54**
– thermal drip (%)	-0.56**	-0.57**
Colour:		
– dominant wavelength (nm)	0.43**	0.48**
– lightness (%)	-0.43**	-0.52**
– saturation (%)	0.22**	0.22**
– stability (% of colour change)	-0.12	-0.09
Quality indices:		
– pH_1	0.07	0.04
– pH_U	0.63**	0.70**
– pH_S	0.34**	0.32**
– I_2	0.18*	0.15*
– Q_{11}	0.52**	0.53**

Explanations: * – significant at p≤0.05; ** – significant at p≤0.01

who demonstrated that the value of coefficients of correlation between meat water-soluble protein content and meat traits and quality indices was influenced by the frequency of meat defects in the examined material, in particular of PSE meat. The coefficients of correlation obtained in the present experiment are mostly higher than those in the works of the authors mentioned above. However, as one can suppose, the value of correlation was influenced rather by the frequency of partly DFD and DFD meat than by that of PSE meat. In the material only one case of PSE meat was found, whereas partly DFD and DFD meat was found in 41 and in two carcasses, respectively. In general, 24.45% carcasses showed defective meat and 75.55% were normal (Table 3). However, it could be expected that in the case of a higher frequency of PSE meat, a higher significance level of the examined correlations would probably have been found.

No significant coefficients of correlation (p≤0.05 and p≤0.01) were found between the content of the discussed protein and the stability of meat colour and pH_1 index value. The lack of correlation with pH_1 index value is particularly striking. The reasons for that may be as it has been already mentioned, that in the material examined only one case of PSE meat was found and a relatively high percentage of partly DFD and DFD meat; as stated by Kortz [1986] pH_1 measurement differentiates normal meat better from PSE meat than that from DFD meat, as opposed to pH_U measurement.

Summing up, a relatively close correlation was found between the level of water-soluble protein and meat quality traits and a lesser correlation between the level of that protein and carcass quality traits. Meat technological usefulness has been improving significantly together with an increase in water-soluble protein content in meat and total protein with a simultaneous lessening of carcass musculature. The obtained results show that it is still impossible to combine the desirable effects of meatiness growth of carcasses while maintaining satisfactory meat quality.

CONCLUSIONS

1. Water-soluble protein percentage (in regard both to meat and total protein) was significantly positively correlated (p≤0.05 or p≤0.01) with carcass weight and length and backfat thickness.

2. Positive correlation coefficients (p≤0.01) occurred between the meat water-soluble protein content and sensory evaluation results for meat colour, wateriness and texture, water-binding capacity, dominant wavelength and colour saturation as well the meat quality indices: pH_U, pH_S and Q_{11}, whereas negative correlations were found between the level of that protein and the value of thermal drip and meat colour lightness.

3. Meat technological usefulness increased and carcass musculature lessened together with an increase in water-soluble protein contribution in meat and in total protein.

TABLE 3. Frequency of normal and defective meat in the examined material.

PSE		Partly PSE		Normal		Partly DFD		DFD	
n	%	n	%	n	%	n	%	n	%
1	0.56	-	-	136	75.56	41	22.78	2	1.10

4. The obtained results show that it is still impossible to combine desirable effects of meatiness growth of carcasses while maintaining satisfactory meat quality.

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ZALEŻNOŚĆ MIĘDZY ZAWARTOŚCIĄ W MIĘSIE BIAŁKA ROZPUSZCZALNEGO W WODZIE A CECHAMI JAKOŚCIOWYMI TUSZY I MIĘSA U TUCZNIKÓW ZRÓŻNICOWANYCH POD WZGLĘDEM MIĘSNOŚCI

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Badaniami objęto 180 tusz tuczników o średniej masie tuszy 82,1 kg, zbliżonych pokrojem do rasy wielkiej białej polskiej (wbp) i polskiej białej zwisłouchej (pbz) zaliczonych po 36 tusz (18 tusz loszek i 18 tusz wieprzków) do poszczególnych klas systemu EUROP na podstawie mięsności oszacowanej za pomocą urządzenia Ultra-Fom 100.

Stwierdzono, że zawartość procentowa białka rozpuszczalnego w wodzie (w odniesieniu do masy mięsa jak i do zawartości białka ogólnego) była dodatnio skorelowana ($p \leq 0{,}05$ i $p \leq 0{,}01$) z masą i długością tuszy oraz grubością słoniny (tab. 2) Ponadto odnotowano dodatnie współczynniki korelacji ($p \leq 0{,}01$) między zawartością w mięsie białka rozpuszczalnego w wodzie a oceną sensoryczną barwy, wodnistości i sprężystości mięsa oraz wodochłonnością, dominującą długością fali i nasyceniem barwy, a także wskaźnikami jakości mięsa: pH_U, pH_S i Q_{11} (tab. 2). Stwierdzono równocześnie ujemne współczynniki korelacji tej cechy z wielkością wycieku termicznego i jasnością barwy mięsa. Wraz ze wzrostem udziału w mięsie i w białku ogólnym białka rozpuszczalnego w wodzie istotnie polepszała się przydatność technologiczna mięsa a równocześnie malało umięśnienie tusz (tab. 2).