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THE USE OF A COMPUTER DIGITAL ANALYSIS FOR EVALUATING THE QUALITY OF PORK TRIMMINGS

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Abstract. The present studies aimed at evaluating whether it is possible to use this method to estimate the fat content in pork from trimming of the loin, bacon and shoulder. The high correlation coefficients obtained between the share of white fields determined by computer digital analysis and the fat content determined by the Soxhlet method indicate that it is possible to use this method to estimate the fat content in pork trimmings, irrespectively of the type of cut trimmed. Moreover, the correlations calculated between components R, G and B of meat, fat and image and the selected indicators of the technological quality of pork obtained from trimming the loin, bacon and shoulder indicate the value of this method for meat quality estimation.

Key words: computer digital analysis, pork trimmings, quality

INTRODUCTION

Class II pork trimmings are obtained during cutting of pork carcass into basic cuts and preliminary trimming. In the case of industrial lines it is obtained at over a dozen work stations, which means that the tissue composition of class II pork is not uniform. The differences are determined on the one hand by the class of carcass sides subjected to dressing and on the other by the type of basic cuts trimmed [Kowalski et al. 1973]. This variability may have a significant effect on the composition of the product obtained from trimmings, because class II pork trimmings comprise a basic component of many types of sausages [Pikielna 1973 a, b].

The greatest problem in the standardization of meat trimmings on industrial cutting lines is the lack of quick, precise and simultaneously cheep methods, that would render possible a quality determination. Thus a search is conducted for methods which would be marked by a sufficient reliability, precision, would be simple to perform and quickly present a result and simultaneously be comparatively cheep. One of the methods which may be introduced into industrial cutting lines is the computer digital analysis.

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There are many possibilities of applying the computer digital analysis in food technology. The results of numerous studies on its application in industrial conditions point to a possibility of using this method in practice. As reported by many authors this method may be used for the estimation of pork, beef and poultry meat, for evaluating the carcass meat deposition, the quality of batters and of the ready product. It renders it possible to substitute the human eye by a camera and computer technique. Among the advantages of the computer digital analysis several authors mentioned speed, repeatability and noninvasiveness [Lewicki 1995, Makała 1995, Kuchida et al. 2000, Dasiewicz 2001, Brosnan and Sun 2002, Florowski 2003, Pisula et al. 2004, Szorc 2004, Słowiński 2005].

In a majority of Polish meat industry plants the segregation of pork trimmings is based on a visual evaluation. This method is burdened by a considerable error and leads to a marked differentiation in the quality of both the raw material and ready product. Simultaneously, it leads to economic losses. For several years work has been conducted at the Warsaw Agricultural University, Department of Meat Technology on the standardization of pork trimmings. The work conducted by Dasiewicz and Szymański [2005] indicates, that the conditions in which measurements are performed and the use of a computer digital analysis for estimating the fat content in pork trimmings (type of lighting, colour background, degree of meat chopping) have a significant effect on the precision of the method. Hitherto there is no information about the use of the computer digital analysis method for the estimation of fat content and quality of pork trimmings (taking into consideration the type of cut trimmed). For this reason the present work aimed at determination of relationship between colour, technological and chemical properties of pork trimmings. The goal was also determining the possibility of using the computer digital analysis for the estimation of the quality of pork trimmings, obtained by trimming of the loin, bacon and shoulder.

MATERIAL AND METHODS

The material for testing consisted of class II pork trimmings obtained as result of separating basic pork cuts at one of the largest meat processing plants in Poland.

The tests were made at a measurement stand ensuring standard lighting conditions, a standard distance between the lens and the object photographed and the same position of containers in the measurement chamber. The tests covered 20 containers with class II pork, obtained from cutting and trimming of the loin, bacon and shoulder. Each meat sample in the container was photographed before and after chunking in an industrial grinder with a kidney plate. Next, representative samples (about 500 g) were placed in coolers and transported to the Warsaw Agricultural University, Department of Meat Technology, where the following laboratory analyses were conducted: content of basic chemical components – fat according to the method by Soxhlet [PN-ISO 1444 2000], protein according to the method by Kjeldahl [PN-75/A-04018] and water by drying [PN-ISO 1442 2000] as well as selected indicators of technological value – pH and thermal drip (30 g of meat heated in a water bath for 30 minutes at a temperature of 70°C). On the photographs made, the computer software for image analysis separated and next made a quantitative estimation of the areas of white fields (fat), calculating the per cent share in relation to the total photograph area and determined the colour compo-

nents R, G, B (red, green, blue). The results obtained were subjected to a statistical analysis based on a single-factor analysis of variance and correlation (Statgraphics 4.1).

RESULTS AND DISCUSSION

The content of basis chemical components in the pork trimmings analysed was significantly determined by the type of basic cut separated and trimmed. A significantly higher mean fat content and lower protein and water content was recorded for meat trimmings obtained from trimming the shoulder, while meat obtained from the trimming of loin demonstrated a reverse relation (Table 1). Mean results of chemical composition (water, protein and fat contents) were in accordance with the data for pork trimmings (class 2) given in the literature. The meat examined, irrespectively of the cut from which it originated, was characterized by a similar pH. A significantly highest thermal drip was recorded for meat obtained from cutting and trimming of bacon (Table 1). The statistical analysis performed, irrespectively of the degree of chunking, did not indicate a significant effect of the type of basic cuts on the colour components R, G, B, determined by way of a digital computer analysis (Table 2). However, significant differences were observed in the share of white fields, depending on the degree of chunking – a significantly higher share of white fields was recorded for meat that was not chunked (Table 2).

Table 1. Technological properties of pork trimmings from trimming of the loin, bacon and shoulder
Tabela 1. Właściwości fizykochemiczne drobnego mięsa wieprzowego z wykrawania schabu, boczku i łopatki

Pork trimmings from trimming Drobne mięso wieprzowe z wykrawania	Fat content Soxhlet method Zawartość tłuszczu metodą Soxhleta %	Protein content Zawartość białka %	Water content Zawartość wody %	pH	Cooking loss Ilość wycieku po obróbce termicznej %
Loin – Schabu	29.2^{a}	15.5^{a}	59.4^{a}	6.1^{a}	14.1^{a}
Bacon – Boczku	$36.4^{a.b}$	$14.8^{a.b}$	$52.2^{a.b}$	6.1^{a}	20.0^{b}
Shoulder – Łopatki	40.0^{b}	14.7^{b}	47.7^{b}	6.1^{a}	11.6^{a}

Means followed by the same numbers in superscripts are not significantly different $p < 0.05$.
Średnie oznaczone tymi samymi literami nie różnią się istotne statystycznie przy $p < 0,05$.

In order to determine the value of the computer digital analysis for the estimation of the fat content and quality of pork trimmings obtained as result of cutting and dressing ot the carcass elements analysed, a correlation analysis was conducted between the share of white fields, colour components R, G and B, determined by the computer digital analysis (for meat before and after grinding; KAO_1 and KAO_2) and the fat content and indicators of technological quality.

The correlation analysis between the share of white fields determined by way of a computer digital analysis and the fat content determined according to the method by Soxhlet, demonstrated significant relations in the case of chunked meat (KAO_2) and the

Table 2. Colour value R, G, B, and areas of white fields estimated with VIA methods of pork trimmings from trimming of the loin, bacon and shoulder
Tabela 2. Składowe barwy R, G, B oraz udział pól białych wyznaczonych metodą komputerowej analizy obrazu w drobnym mięsie wieprzowym z wykrawania schabu, boczku i łopatki

Pork trimmings from trimming Drobne mięso wieprzowe z wykrawania	Areas of white fields Udział pól białych %		Colour values Składowe barwy					
	KAO_1 VIA_1	KAO_2 VIA_2	R_1	G_1	B_1	R_2	G_2	B_2
Loin – Schabu	34.0[a]	27.4[a]	171.9[a]	97.6[a]	88.7[a]	172.9[a]	96.6[a]	90.4[a]
Bacon – Boczku	42.7[b]	37.4[b]	170.0[a]	101.5[a]	92.3[a]	169.8[a]	98.8[a]	91.5[a]
Shoulder – Łopatki	41.4[a.b]	33.9[a.b]	170.6[a]	96.0[a]	85.3[a]	169.7[a]	95.3[a]	87.1[a]

Means followed by the same numbers in superscripts are not significantly different $p < 0.05$.
Średnie oznaczone tymi samymi literami nie różnią się istotne statystycznie przy $p < 0,05$.

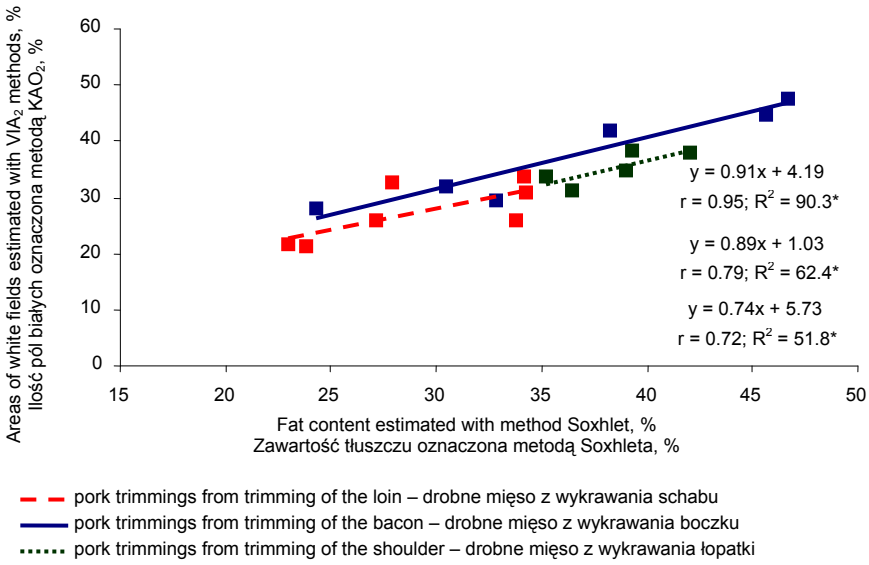

Fig. 1. The correlation coefficients of fat contents ground pork trimmings from trimming of the loin, bacon and shoulder estimated with method Soxhlet and areas of white fields estimated with VIA_2 methods, *significance of the coefficient at $\alpha < 0.05$
Rys. 1. Krzywa korelacji pomiędzy zawartością tłuszczu w rozdrobnionym mięsie z wykrawania schabu, boczku i łopatki oznaczanego metodą Soxhleta a udziałem pól białych wyznaczonych metodą komputerowej analizy obrazu (KAO_2), *wyróżnik istotny statystycznie przy $\alpha < 0,05$

following correlation coefficients were recorded: for meat obtained from loin trimming r = 0.72, from bacon trimming r = 0.95 and from shoulder trimming r = 0.79 (Fig. 1). In the case of meat that was not chunked no significant correlations were observed between the fat content and share of white fields, determined by the computer digital analysis. In the experiment of Dasiewicz [2001] high statistical correlations were also found between results of fat analysis by Soxhlet and Video Image Analysis (ground pork trimmings class 2) method. This author used manual subjective system of photos analysis.

Irrespectively of the type of basic cuts, the correlation coefficients obtained indicated a series of significant relations between the R, G and B colour components and the examined indicators of technological value (Table 3). The greatest number of statistically significant correlation coefficients was observed between the colour components, measured by the computer digital analysis method, and thermal drip for not chunked pork obtained from trimming the shoulder and bacon. For chunked meat, irrespectively of the type of cut trimmed, no significant relations were observed (Table 3). An analysis of the correlations obtained between the R, G and B colour components and pH of chunked meat demonstrated the presence of significant relations only in the case of meat obtained from bacon trimming. Despite a series of significant correlation coefficients obtained between the R, G and B colour components and the content of basic chemical components, it is difficult to draw univocal conclusions, as significant correlations are obtained randomly both for chunked and not chunked meat. Such a differentiation was observed also in the case of significant correlation coefficients occurring for pork trimmings obtained from the trimming of different cuts (Table 3).

Table 3. The correlation coefficients between colour value R, G, B, and technological properties of pork trimmings from trimming of the loin, bacon and shoulder
Tabela 3. Analiza korelacji między składowymi barwy R, G, B a wybranymi właściwościami technologicznymi drobnego mięsa z wykrawania schabu, boczku i łopatki

Parameter Wyróżnik	Colour value – Składowa					
	R_1	G_1	B_1	R_2	G_2	B_2
1	2	3	4	5	6	7
Pork trimmings from trimming of the loin Drobne mięso wieprzowe z wykrawania schabu						
pH	–0.11	–0.08	–0.002	0.34	0.39	0.45
Cooking loss Ilość wycieku po obróbce termicznej	0.30	0.26	0.32	**0.50***	0.34	0.27
Fat content Zawartość tłuszczu	**0.55***	**0.51***	**0.59***	–0.17	0.34	0.25
Protein content Zawartość białka	–0.37	–0.35	–0.43	0.21	–0.22	–0.14
Water content Zawartość wody	**–0.58***	**–0.58***	**–0.65***	0.11	–0.37	–0.31
Pork trimmings from trimming of the bacon Drobne mięso wieprzowe z wykrawania boczku						
pH	–0.36	0.20	0.24	**0.67***	**0.85***	**0.80***

Table 3 – cont.

1	2	3	4	5	6	7
Cooking loss Ilość wycieku po obróbce termicznej	–0.44	**–0.50***	**–0.53***	–0.10	0.25	0.19
Fat content Zawartość tłuszczu	**–0.48***	–0.11	–0.07	0.38	**0.69***	**0.60***
Protein content Zawartość białka	–0.08	–0.35	–0.45	–0.15	–0.36	–0.22
Water content Zawartość wody	0.22	–0.14	–0.15	–0.21	**–0.56***	–0.45
Pork trimmings from trimming of the shoulder Drobne mięso wieprzowe z wykrawania łopatki						
pH	–0.02	–0.13	–0.18	–0.13	0.09	0.06
Cooking loss Ilość wycieku po obróbce termicznej	**–0.77***	**–0.54***	**–0.56***	0.21	–0.01	0.03
Fat content Zawartość tłuszczu	**0.54***	0.26	0.27	**–0.73***	**–0.73***	**–0.75***
Protein content Zawartość białka	–0.05	0.11	0.16	**0.90***	**0.89***	**0.89***
Water content Zawartość wody	–0.42	–0.21	–0.30	0.19	0.37	0.36

*Significance of the coefficient at $\alpha < 0.05$.

R_1 – colour components R_1 pork trimmings, G_1 – colour components G_1 pork trimmings, B_1 – colour components B_1 pork trimmings, R_2 – colour components R_2 ground pork trimmings, G_2 – colour components G_2 ground pork trimmings, B_2 – colour components B_2 ground pork trimmings.

*Wyróżnik istotny statystycznie przy $\alpha < 0{,}05$.

R_1 – czerwona składowa barwy drobnego mięsa wieprzowego, G_1 – zielona składowa barwy drobnego mięsa wieprzowego, B_1 – niebieska składowa barwy drobnego mięsa wieprzowego, R_2 – czerwona składowa barwy rozdrobnionego mięsa wieprzowego, G_2 – zielona składowa barwy rozdrobnionego mięsa wieprzowego, B_2 – niebieska składowa barwy rozdrobnionego mięsa wieprzowego.

CONCLUSIONS

On the basis of the analyses conducted and results obtained it is possible to draw the following conclusions:

It is possible to use the computer digital analysis to estimate the content of fat in pork trimmings obtained from the trimming of loin, bacon and shoulder. This is confirmed by the high correlation coefficients between the share of white fields determined by computer digital analysis and fat content determined according to the Soxhlet reference method.

The estimation of the content of fat in class II pork conducted by the computer digital analysis method should be preceded by chunking the meat, as the correlation coefficients obtained were higher for chunked meat.

The correlation coefficients calculated between the R, G, B colour components and selected indicators of technological value of pork obtained from the dressing of loin, bacon and shoulder are of a random character. This points to the necessity of conducting

further studies on the value of the computer digital analysis method for estimating the quality of class II pork trimmings.

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ZASTOSOWANIE KOMPUTEROWEJ ANALIZY OBRAZU DO OCENY JAKOŚCI DROBNEGO MIĘSA WIEPRZOWEGO

Streszczenie. Celem badań była ocena możliwości użycia metody komputerowej analizy obrazu do szacowania zawartości tłuszczu w drobnym mięsie wieprzowym uzyskiwanym z wykrawania schabu, boczku i łopatki. Wyznaczone wysokie współczynniki korelacji pomiędzy udziałem pól białych wyznaczonych metodą komputerowej analizy obrazu a zawartością tłuszczu oznaczoną odwoławczą metodą Soxhleta wskazują na możliwość wykorzystania tej metody do szacowania zawartości tłuszczu w drobnym mięsie wieprzowym niezależnie od rodzaju wykrawanego elementu. Ponadto wyliczone liczne korelacje pomiędzy składowymi R, G, B mięsa, tłuszczu i obrazu a wybranymi wyróżnikami jakości technologicznej mięsa wieprzowego z wykrawania schabu, boczku i łopatki wskazują na przydatność tej metody do szacowania jego jakości.

Słowa kluczowe: komputerowa analiza obrazu, drobne mięso wieprzowe, jakość

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