

## Assessment of slaughter value of sheep on the basis of linear measurements made on carcass digital images

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**Abstract:** *Assessment of slaughter value of sheep on the basis of linear measurements made on carcass digital images.* The aim of this study was to develop a method of assessing slaughter value of sheep using digital carcass images. Research material consisted of 38 ovine carcasses. Carcasses were classified in the EUROP grading system in terms of muscle and fat and photographed from three sides and then computer image analysis were used. Analyzed data of linear and area measurements of sheep carcasses using computer image analysis and compare them with the results of slaughter analysis conducted by the conventional method. To compare obtained results statistical analysis was performed. The correlation between computer linear measurements and meat cuts weight and EUROP classification were examined. The preliminary analysis showed the possibility of using computer image analysis to evaluate the meat yield of sheep, and the resulting measurements are correlated to the proportion of meat cuts and tissues, but in order to obtain high accuracy results further studies are needed.

*Key words:* meat yield, linear measurements, digital images, sheep carcasses

### INTRODUCTION

The increasing consumer demands as well as increasingly stringent regulations

exposes the producers to problem of providing high and repeatable quality (Bro-snan and Sun 2004). A study by Luong (1997) pointed out that food industry destined 1.5–2% of annual income from total production for monitoring the quality. In the connection to the above-mentioned trend more and more studies in field of engineering and manufacturing technology focuses on the development of a fully automated and objective method of quality control and product assessment. Over the past few years scientist have tried to develop method that would meet the above requirements, but also minimize time-consuming and cost effectiveness of product evaluation. The result of this study was, i.a., application in the food industry computer tomography and ultrasound (Abdullah et al. 2004). However, none of mentioned methods was fully effective. After application of the computer image analysis expected result were obtained. Computer image analysis as a non-destructive method, allowing to obtain fast, repeatable and objective evaluation of the quality, more and more often is used to measure and

predict the quality of raw materials in almost every industry sector. Currently, image analysis is widely used in chemical engineering, medicine, textiles and even architecture (Iqbal et al. 2010). In agriculture computer image analysis is used, among others, in the studies of plant protection products (identification of pests and diseases) to evaluate the efficacy of active substances. It might be also used to evaluate the quality of agricultural products, as well as may be used in agricultural technology, were it becomes an integral part of the technological processes. Assessment based on image analysis enable determine the colour, damage and defects in the surface of vegetables, fruits and meat. It is also possible to estimate the quality level, size and texture. Moreover, products such as bread, cereals and some type of chees could also be tested (Frączek 2005). It should be noted that computer image analysis was widely used also in classification of pig and beef carcasses. Measurements performed by this method are characterised by high accuracy and repeatability, moreover, it is not vitiated by an error resulting from a subjective approach of classifier (Olivier et al. 2010). Those features enabled Meat and Livestock Commission approved computer image analysis as the official method for grading pig carcasses. Different countries have already begun taking significant steps to put method based on video image analysis into effect on slaughter lines to enhance precision of the official EUROP carcass classification system for beef, pigs and lambs (Rius-Vilarrasa et al. 2009).

The aim of this study was to analyse the data of linear and surface measure-

ments of ram lambs carcasses of two Polish breeds using computer images and compare them with the results of slaughter analysis conducted by the conventional method.

## MATERIAL AND METHOD

The study was conducted at the Department of Breeding Sheep and Goats SGGW in Warsaw. The material consisted of 38 ram lambs carcasses derived from the Experimental Farms Sheep and Goats SGGW in Żelazna, Poland. Rams two breeds – Polish lowland sheep (28 animals) and Wrzosówka sheep (10 animals), were slaughtered after reaching weight 35–40 kg of live weight. The animals were slaughtered at the abattoir according to standard commercial procedures. The hot carcass weight (CW) was determined after dressing. The carcasses were then chilled at 4°C for 24 h and graded using the six EUROP conformation class notation system (from 6 for S to 1 for P) and the three fat cover class notation system (Council Regulation 1183/2006).

During the evaluation carcasses were hanging in a specially prepared for this purpose rack, and then using an Konica Minolta Z2 digital camera three pictures were taken – from the dorsal, ventral and left lateral side. Carcasses were classified in the EUROP system in terms of muscle and fat, and then weighed. Also the pH<sub>24</sub> was studied, measured depth, perimeter and length of the leg, the surface and the width and depth of the loin eye. Besides it was defined the thickness of the fat layer of subcutaneous fat over the *musculus longissimus dorsi* and the mass and percentage of kidney with the fat in carcass

weight. Carcasses were divided into meat cuts: front and rear shank, ham, lamb neck, shoulder, ribeye, flank, saddle, tenderloin and haunch. Received meat cuts were weighed and their percentage in the carcass was calculated. There were also conducted leg dissection, which enabled the determination of the percentage and muscle, fat and bones weight in this element.

The ten linear measurements of carcasses, using the computer images has been elaborated. Carcass measurements on the pictures were carried out using MultiScan (MultiScanBase v. 18.03, Computer Scanning Systems Ltd, Poland), which is a measurement system operating in a Windows environment. On the picture showing the dorsal side of carcass (Fig. 1) seven measurements were performed: haunch length measured as distance from pastern to the tail point ( $L_1$ ), the widest position below the groin point ( $W_1$ ), the rump width at the base of the tail ( $W_2$ ), width at the rump narrowest point ( $W_3$ ), the widest point of the carcass ( $W_4$ ), the thinnest width below  $W_4$  and above shoulder ( $W_5$ ) and area of the rump ( $A_1$ ). Then pictures were analysed on the left side of the carcass, which set three values (Fig. 2): the widest position of the haunch ( $D_1$ ), the widest position of the chest ( $D_2$ ) and the length of the carcass from tail point to base of the neck ( $L_2$ ).

Statistical processing of the data was carried out using SPSS version 23.0 (SPSS for Windows). The data obtained were analyzed statistically by the analysis of variance where the effect of breed, EUROP conformation and EUROP fatness grade, and body weight at slaughter as a covariate were included in the

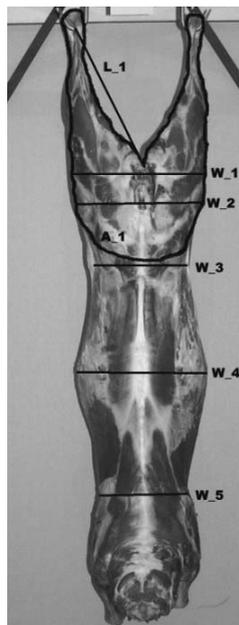


FIGURE 1. The measurements performed on the dorsal side of carcass

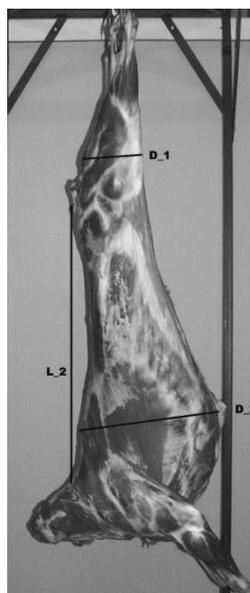


FIGURE 2. The measurements performed on the left side of carcass

model. Furthermore, the correlation between traits has been analysed. The data was summarized in the tables in the form of least squares means marked as (*LSM*) and standard error (*SE*).

## RESULTS AND DISCUSSION

The results of analysis of selected features of slaughter value are presented in Table 1. Obtained by linear measurements made on digital carcass images results allow to conclude that there are differences between carcasses of Polish lowland sheep and Wrzosówka sheep. Both in terms the linear traits measured using a computer method and the results of the dissection higher values can be assigned to the lowland sheep. A significant difference was observed in the mass of valuable parts and percentage of haunch in the carcass. Suchlike results were reported by Rant (2013) where slaughter value of Wrzosówka and Polish lowland ram lambs have been considered. Results of haunch dissection showed that a higher percentage of meat and the lower fat content were observed in Wrzosówka sheep. However this trend is not reflected in the relation to the value specified in kilograms. Similar results have been obtained by Kiyanzad (2004), comparing the two Iranian sheep breeds Moghani and Makui. According to Ramsey studies (1991), this discrepancy may be due to differences in nutrition and date of slaughter, and thus the degree fatness of animals. Values of computer measurement such as the length and width of the five areas of the carcass Polish lowland sheep were slightly higher than in Wrzosówka. This translates to the larger surface of rump. The results relat-

ing to the value of selected features of the slaughter value and computer linear measurement depending on the classification scale EUROP shown in Table 2. It was found that the carcasses classified as U were characterized by a highly significantly higher value of traits measured directly on the carcass. These differences concern: the depth and weight of the haunch the weight of valuable meat cuts and fat weight in the round compared to the class O and P. Likewise the linear measurements obtained by the computer measurements ( $W_1$ ,  $W_2$ ,  $W_3$ ,  $W_4$ ,  $W_5$ ,  $D_1$ ,  $L_2$ ) were significantly higher. Also in the carcasses qualified for the R class was demonstrated a highly significantly higher value of the studied traits than in the carcasses classified into lower classes of conformation. Similar dependences were presented in study of Oliver et al. (2010), where the relationship between body weight, affiliation to the EUROP class and computer analysis of linear measurements of carcasses of regional breeds Spanish bulls have been studied. Another experiment was conducted by Rius-Vilarrasa (2008). In his work has studied the possibility of the application of computer image analysis to the EUROP classification system for sheep carcasses. Results of his studies indicated that without considering the carcass weight and degree of fatness, computer analysis is a poor predictor of slaughter value. Thereby, this confirmed results obtained in previous studies of Kempster (1981) and Horgan et al. (1995). Analogous results were obtained by Craigie et al. (2013) in the study focused on relationship between image analysis (VIA system), visual classification and meat yield of cattle of different breed and

TABLE 1. Selected features of the slaughter and computer linear measurements depending on the breed

| Trait                   | PLS                 |        | WRS                 |        |
|-------------------------|---------------------|--------|---------------------|--------|
|                         | LSM                 | SE     | LSM                 | SE     |
| Circuit of haunch       | 37.18 <sup>a</sup>  | 0.483  | 34.95 <sup>b</sup>  | 0.794  |
| Depth of haunch         | 19.78               | 0.296  | 19.35               | 0.486  |
| Length of haunch        | 24.94               | 0.190  | 24.65               | 0.313  |
| Width of loin eye       | 5.93                | 0.076  | 5.73                | 0.124  |
| Depth of loin eye       | 2.74                | 0.069  | 2.50                | 0.114  |
| Thickness of fat        | 0.92                | 0.113  | 0.54                | 0.186  |
| Rib eye weight (kg)     | 0.51 <sup>a</sup>   | 0.019  | 0.43 <sup>b</sup>   | 0.031  |
| Rib eye content (%)     | 6.43                | 0.103  | 6.14                | 0.169  |
| Saddle weight (kg)      | 0.52 <sup>a</sup>   | 0.018  | 0.43 <sup>b</sup>   | 0.030  |
| Saddle content (%)      | 6.57                | 0.129  | 6.18                | 0.212  |
| Haunch weight (kg)      | 2.24 <sup>A</sup>   | 0.076  | 1.86 <sup>B</sup>   | 0.125  |
| Haunch content (%)      | 28.06 <sup>a</sup>  | 0.252  | 26.67 <sup>b</sup>  | 0.414  |
| Valuable meat cuts (kg) | 3.27 <sup>A</sup>   | 0.109  | 2.72 <sup>B</sup>   | 0.180  |
| Meat in haunch (kg)     | 1.58 <sup>a</sup>   | 0.047  | 1.36 <sup>b</sup>   | 0.077  |
| Fat in haunch (kg)      | 0.23 <sup>a</sup>   | 0.018  | 0.15 <sup>b</sup>   | 0.029  |
| Bone in haunch (kg)     | 0.39                | 0.016  | 0.34                | 0.026  |
| L_1                     | 23.21               | 0.188  | 22.69               | 0.309  |
| W_1                     | 20.99               | 0.247  | 20.32               | 0.405  |
| W_2                     | 21.28               | 0.300  | 20.20               | 0.493  |
| W_3                     | 15.21               | 0.273  | 14.51               | 0.448  |
| W_4                     | 21.79               | 0.371  | 20.95               | 0.610  |
| W_5                     | 13.93 <sup>a</sup>  | 0.227  | 13.04 <sup>b</sup>  | 0.374  |
| A_1                     | 572.50 <sup>a</sup> | 13.084 | 511.71 <sup>b</sup> | 21.499 |
| D_1                     | 10.50               | 0.194  | 10.19               | 0.320  |
| D_2                     | 23.64               | 0.257  | 23.64               | 0.423  |
| L_2                     | 50.65               | 0.676  | 50.09               | 1.111  |

Values in rows with different letters differ significantly: a, b ( $P \leq 0.05$ ), A, B ( $P \leq 0.01$ ); PLS – Polish lowland sheep; WRS – Wrzosówka sheep; L\_1 – haunch length; W\_1 – widest position below the groin point; W\_2 – the rump width at the base of the tail; W\_3 – width at the rump narrowest point; W\_4 – widest point of the carcass; W\_5 – thinnest width below; W4 and above shoulder; A\_1 – area of the rump; D\_1 – widest position of the haunch; D\_2 – widest position of the chest; L\_2 – length of the carcass from tail point to base of the neck

TABLE 2. Selected features of the slaughter value and computer linear measurements depending on the EUROP classification

| Trait                  | U                  |           | R                  |           | O                  |           | P                  |           |
|------------------------|--------------------|-----------|--------------------|-----------|--------------------|-----------|--------------------|-----------|
|                        | <i>n</i> = 9       |           | <i>n</i> = 12      |           | <i>n</i> = 10      |           | <i>n</i> = 7       |           |
|                        | <i>LSM</i>         | <i>SE</i> | <i>LSM</i>         | <i>SE</i> | <i>LSM</i>         | <i>SE</i> | <i>LSM</i>         | <i>SE</i> |
| Circuit of haunch (cm) | 37.67 <sup>B</sup> | 0.704     | 38.38 <sup>B</sup> | 0.737     | 34.50 <sup>A</sup> | 0.707     | 34.25 <sup>A</sup> | 1.581     |
| Depth of haunch (cm)   | 20.74 <sup>B</sup> | 0.406     | 19.76 <sup>A</sup> | 0.424     | 19.00 <sup>A</sup> | 0.407     | 18.25 <sup>A</sup> | 0.911     |
| Length of haunch (cm)  | 24.65              | 0.323     | 24.50              | 0.722     | 25.08              | 0.336     | 24.81              | 0.322     |
| Width of loin eye (cm) | 6.11               | 0.116     | 5.90               | 0.121     | 5.72               | 0.116     | 5.55               | 0.260     |
| Depth of loin eye (cm) | 2.73               | 0.114     | 2.86               | 0.119     | 2.50               | 0.115     | 2.62               | 0.256     |
| Thickness of fat (mm)  | 0.86 <sup>B</sup>  | 0.104     | 1.51 <sup>C</sup>  | 0.109     | 0.49 <sup>A</sup>  | 0.104     | 0.38 <sup>A</sup>  | 0.233     |
| Rib eye (kg)           | 0.55 <sup>B</sup>  | 0.020     | 0.55 <sup>B</sup>  | 0.027     | 0.39 <sup>AB</sup> | 0.026     | 0.42 <sup>A</sup>  | 0.058     |
| Saddle (kg)            | 0.55 <sup>B</sup>  | 0.024     | 0.57 <sup>B</sup>  | 0.025     | 0.40 <sup>AB</sup> | 0.024     | 0.46 <sup>A</sup>  | 0.055     |
| Haunch (kg)            | 2.37 <sup>B</sup>  | 0.104     | 2.41 <sup>B</sup>  | 0.109     | 1.76 <sup>AB</sup> | 0.105     | 1.72 <sup>A</sup>  | 0.234     |
| VMC (kg)               | 3.47 <sup>B</sup>  | 0.146     | 3.54 <sup>B</sup>  | 0.153     | 2.55 <sup>AB</sup> | 0.107     | 2.60 <sup>A</sup>  | 0.328     |
| L_1                    | 23.20              | 0.326     | 23.270             | 0.341     | 22.749             | 0.327     | 22.40              | 0.731     |
| W_1                    | 21.45 <sup>B</sup> | 0.293     | 21.57 <sup>B</sup> | 0.307     | 19.84 <sup>A</sup> | 0.295     | 18.89 <sup>A</sup> | 0.659     |
| W_2                    | 21.79 <sup>B</sup> | 0.339     | 22.08 <sup>B</sup> | 0.354     | 18.52 <sup>A</sup> | 0.760     | 19.55 <sup>A</sup> | 0.340     |
| W_3                    | 16.00 <sup>B</sup> | 0.338     | 15.72 <sup>B</sup> | 0.353     | 13.90 <sup>A</sup> | 0.339     | 13.01 <sup>A</sup> | 0.759     |
| W_4                    | 22.20 <sup>B</sup> | 0.477     | 23.08 <sup>B</sup> | 0.499     | 20.13 <sup>A</sup> | 0.479     | 19.09 <sup>A</sup> | 1.071     |
| W_5                    | 14.46 <sup>B</sup> | 0.242     | 14.49 <sup>B</sup> | 0.253     | 12.27 <sup>A</sup> | 0.243     | 12.36 <sup>A</sup> | 0.543     |
| D_1                    | 10.78 <sup>B</sup> | 0.267     | 10.89 <sup>B</sup> | 0.279     | 9.64 <sup>A</sup>  | 0.268     | 9.75 <sup>A</sup>  | 0.599     |
| D_2                    | 24.08              | 0.375     | 24.33              | 0.392     | 22.62              | 0.377     | 22.72              | 0.843     |
| L_2                    | 51.59 <sup>B</sup> | 0.993     | 52.18 <sup>B</sup> | 1.038     | 47.62 <sup>A</sup> | 0.997     | 48.63 <sup>A</sup> | 2.229     |

A, B, C – values in rows with different letters differ significantly ( $P \leq 0.01$ ); VMC – valuable meat cuts; L\_1 – haunch length; W\_1 – widest position below the groin point; W\_2 – the rump width at the base of the tail; W\_3 – width at the rump narrowest point; W\_4 – widest point of the carcass; W\_5 – thinnest width below; W4 and above shoulder; D\_1 – widest position of the haunch; D\_2 – widest position of the chest; L\_2 – length of the carcass from tail point to base of the neck

gender. Table 3 shows the parameters of selected features of the slaughter value measured directly on carcasses and computer measurements according to class of fatness in the EUROP system. As in the Hinz's studies (2007) shown that almost all of the analysed features demonstrated significantly higher values in carcasses

selected for a third, the highest fatness class compared to the carcasses belonging to the first and the second class. Furthermore, highly significant differences were also observed between the second and first class. Correlations between the computer measurements and the weight of valuable meat cuts shown in Table 4.

TABLE 3. Selected features of the slaughter value and computer linear measurements depending on the degree of fatness in EUROP classification

| Trait                  | 1                   |        | 2                   |        | 3                   |        |
|------------------------|---------------------|--------|---------------------|--------|---------------------|--------|
|                        | n = 19              |        | n = 11              |        | n = 8               |        |
|                        | LSM                 | SE     | LSM                 | SE     | LSM                 | SE     |
| Circuit of haunch (cm) | 35.91 <sup>A</sup>  | 0.623  | 37.64 <sup>A</sup>  | 0.772  | 39.01 <sup>B</sup>  | 0.968  |
| Depth of haunch (cm)   | 19.88               | 0.359  | 19.43               | 0.444  | 20.19               | 0.558  |
| Length of haunch (cm)  | 24.66               | 0.285  | 24.89               | 0.352  | 25.19               | 0.442  |
| Width of loin eye (cm) | 5.83                | 0.102  | 5.87                | 0.127  | 6.12                | 0.159  |
| Depth of loin eye (cm) | 2.71                | 0.101  | 2.72                | 0.125  | 2.81                | 0.157  |
| Kidney weight (kg)     | 0.12 <sup>A</sup>   | 0.012  | 0.19 <sup>B</sup>   | 0.015  | 0.17 <sup>A</sup>   | 0.019  |
| Thickness of fat (mm)  | 0.61 <sup>A</sup>   | 0.092  | 0.88 <sup>B</sup>   | 0.114  | 1.90 <sup>C</sup>   | 0.143  |
| Rib eye (kg)           | 0.47 <sup>A</sup>   | 0.023  | 0.53 <sup>B</sup>   | 0.028  | 0.59 <sup>C</sup>   | 0.036  |
| Saddle (kg)            | 0.49 <sup>A</sup>   | 0.022  | 0.53 <sup>B</sup>   | 0.027  | 0.61 <sup>C</sup>   | 0.033  |
| Haunch (kg)            | 2.01 <sup>A</sup>   | 0.092  | 2.29 <sup>B</sup>   | 0.114  | 2.60 <sup>C</sup>   | 0.143  |
| VMC (kg)               | 2.97 <sup>A</sup>   | 0.129  | 3.36 <sup>B</sup>   | 0.160  | 3.80 <sup>C</sup>   | 0.201  |
| L_1                    | 22.75               | 0.288  | 23.29               | 0.357  | 23.48               | 0.448  |
| W_1                    | 20.19 <sup>A</sup>  | 0.260  | 21.39 <sup>B</sup>  | 0.321  | 22.12 <sup>C</sup>  | 0.403  |
| W_2                    | 20.18 <sup>A</sup>  | 0.300  | 21.74 <sup>B</sup>  | 0.371  | 22.74 <sup>B</sup>  | 0.466  |
| W_3                    | 14.58 <sup>A</sup>  | 0.299  | 15.42 <sup>A</sup>  | 0.370  | 16.46 <sup>B</sup>  | 0.465  |
| W_4                    | 20.76 <sup>A</sup>  | 0.422  | 22.17 <sup>A</sup>  | 0.523  | 23.83 <sup>B</sup>  | 0.656  |
| W_5                    | 13.31 <sup>A</sup>  | 0.214  | 14.26 <sup>B</sup>  | 0.265  | 14.87 <sup>B</sup>  | 0.333  |
| A_1                    | 522.93 <sup>A</sup> | 13.511 | 601.29 <sup>B</sup> | 16.727 | 627.45 <sup>C</sup> | 20.992 |
| D_1                    | 10.55               | 0.236  | 10.31               | 0.292  | 10.83               | 0.367  |
| D_2                    | 23.41               | 0.332  | 24.24               | 0.411  | 24.22               | 0.516  |
| L_2                    | 50.22               | 0.878  | 51.57               | 1.087  | 51.77               | 1.365  |

A, B, C – values in rows with different letters differ significantly ( $P \leq 0.01$ ); VMC – valuable meat cuts; L\_1 – haunch length; W\_1 – widest position below the groin point; W\_2 – the rump width at the base of the tail; W\_3 – width at the rump narrowest point; W\_4 – widest point of the carcass; W\_5 – thinnest width below; W4 and above shoulder; A\_1 – area of the rump; D\_1 – widest position of the haunch; D\_2 – widest position of the chest; L\_2 – length of the carcass from tail point to base of the neck

It should be emphasized that all the correlations were statistically significant and highly significant. The strongest linear relationship reaching values in the range of 0.76–0.88 exists between the weight

of meat cuts and surface of rump. Also highly statistically significant correlations were found between measurements determining the width of the rump (W\_1, W\_2) with weight of haunch. Similar

TABLE 4. Correlations of computer linear measurements with weight of selected meat cuts

| Trait | Rib eye (kg) | Saddle (kg) | Haunch (kg) | Valuable meat cuts (kg) | Haunch dissection |          |           |
|-------|--------------|-------------|-------------|-------------------------|-------------------|----------|-----------|
|       |              |             |             |                         | meat (kg)         | fat (kg) | bone (kg) |
| L_1   | 0.33*        | 0.33*       | 0.42**      | 0.41*                   | 0.44**            | 0.37*    | 0.50**    |
| W_1   | 0.73**       | 0.68**      | 0.83**      | 0.81**                  | 0.82**            | 0.73**   | 0.76**    |
| W_2   | 0.78**       | 0.75**      | 0.87**      | 0.86**                  | 0.87**            | 0.75**   | 0.79**    |
| W_3   | 0.57**       | 0.62**      | 0.69**      | 0.68**                  | 0.67**            | 0.58**   | 0.60**    |
| W_4   | 0.64**       | 0.64**      | 0.72**      | 0.72**                  | 0.66**            | 0.70**   | 0.60**    |
| W_5   | 0.72**       | 0.73**      | 0.75**      | 0.77**                  | 0.70**            | 0.73**   | 0.61**    |
| A_1   | 0.80**       | 0.80**      | 0.89**      | 0.89**                  | 0.86**            | 0.79**   | 0.76**    |
| D_1   | 0.49**       | 0.55**      | 0.58**      | 0.58**                  | 0.56**            | 0.35*    | 0.52**    |
| D_2   | 0.41*        | 0.33*       | 0.43**      | 0.42*                   | 0.45**            | 0.36*    | 0.30*     |
| L_2   | 0.59**       | 0.62**      | 0.61**      | 0.63**                  | 0.51**            | 0.60**   | 0.53**    |

\*correlation significant at  $P \leq 0.05$ ; \*\*correlation significant at  $P \leq 0.01$ .

L\_1 – haunch length; W\_1 – widest position below the groin point; W\_2 – the rump width at the base of the tail; W\_3 – width at the rump narrowest point; W\_4 – widest point of the carcass; W\_5 – thinnest width below W4 and above shoulder; A\_1 – area of the rump; D\_1 – widest position of the haunch; D\_2 – widest position of the chest; L\_2 – length of the carcass from tail point to base of the neck

results were obtained also by Oliver et al. (2010). They allow to state that with increasing width of the rear quarter of the carcass increases its content of valuable meat cuts. Correlation analysis of computer linear measurement and classification in EUROP grading system (Table 5) showed highly significant linear relationship. The highest value of the correlation coefficient ( $r = 0.73$ ) were obtained for the EUROP scale and width in the throat behind the shoulders. The estimated value of the correlation was similar to that defined by La Ville (1996) ( $r = 0.69$ ) in the study of young Charolais bulls. In the present study also found a strong relationship between the surface area of rump and conformation classification. Correlations between the

computer measurement has shown that the strongest relationship occurs between hindquarter surface area and width. For the measurement at the W\_1 point correlation coefficient was  $r = 0.91$ , and for the point W\_2  $r = 0.95$ . The lowest linear relationship was demonstrated for the length of the haunch and EUROP classification and between the length and depth of the haunch. This may be due to the fact that in ovine the haunch is longer the flatter it is and visual degree of “occupancy rate” of muscularity is lower (Hopkins 1996). The results indicate that computer measurements of ovine carcasses can be used to determine the amount of valuable meat cuts, as well as to estimation of other parameters representing the slaughter value. Due to

TABLE 5 : Correlations of computer linear measurement and EUROP classification

| Traits | EUROP | L_1  | W_1    | W_2    | W_3    | W_4    | W_5    | A_1    | D_1    | D_2    | L_2    |
|--------|-------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| EUROP  |       | 0.22 | 0.62** | 0.67** | 0.64** | 0.52** | 0.73** | 0.70** | 0.38*  | 0.46** | 0.47** |
| L_1    |       |      | 0.54** | 0.55** | 0.44** | 0.52** | 0.44** | 0.55** | 0.18   | 0.32   | 0.42** |
| W_1    |       |      |        | 0.96** | 0.81** | 0.81** | 0.78** | 0.91** | 0.44** | 0.61** | 0.68** |
| W_2    |       |      |        |        | 0.83** | 0.86** | 0.85** | 0.95** | 0.51** | 0.58** | 0.71** |
| W_3    |       |      |        |        |        | 0.82** | 0.79** | 0.84** | 0.45** | 0.41** | 0.57** |
| W_4    |       |      |        |        |        |        | 0.85** | 0.82** | 0.45** | 0.53** | 0.68** |
| W_5    |       |      |        |        |        |        |        | 0.89** | 0.55** | 0.59** | 0.70** |
| A_1    |       |      |        |        |        |        |        |        | 0.51** | 0.57** | 0.72** |
| D_1    |       |      |        |        |        |        |        |        |        | 0.44** | 0.48** |
| D_2    |       |      |        |        |        |        |        |        |        |        | 0.54** |
| L_2    |       |      |        |        |        |        |        |        |        |        |        |

\*correlation significant at  $P \leq 0.05$ ; \*\*correlation significant at  $P \leq 0.01$ .

L\_1 – haunch length; W\_1 – widest position below the groin point; W\_2 – the rump width at the base of the tail; W\_3 – width at the rump narrowest point; W\_4 – widest point of the carcass; W\_5 – thinnest width below W4 and above shoulder; A\_1 – area of the rump; D\_1 – widest position of the haunch; D\_2 – widest position of the chest; L\_2 – length of the carcass from tail point to base of the neck

the small number of observations in this study, the work on this issue requires further continuation.

## CONCLUSION

The method of linear measurements made on digital carcass images can be considered as a supplement to the assessment of sheep carcasses in EUROP grading system. It enables objectively estimate the meat yield and valuable meat cuts content, and thus the profitability of the production of lamb. It was found that preliminary analysis shows the possibility of using this method to assess the slaughter value of sheep, and the resulting measurements are correlated to the proportion of meat cuts and tissues, however, to obtain high accuracy results further studies are needed on populations of large numbers.

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**Streszczenie:** Ocena wartości rzeźnej tusz owczych z wykorzystaniem komputerowych pomiarów tusz. Materiał badawczy stanowiło 38 tusz. Tusze fotografowano z trzech stron, a zdjęcia poddano komputerowym pomiarom. Tusze klasyfikowane były w systemie EUROP pod względem umięśnienia oraz otluszczenia. Następnie prze-

prowadzono analizę wartości rzeźnej tusz. W celu porównania otrzymanych wyników przeprowadzono analizę statystyczną. Zbadano korelacje między poszczególnymi komputerowymi pomiarami liniowymi z masą wybranych wyrębów oraz klasyfikacją EUROP. Obliczono średnie wartości oraz błąd standardowy wszystkich badanych cech. Stwierdzono, iż wstępna analiza wykazuje możliwości zastosowania komputerowej analizy obrazu do oceny wartości rzeźnej owiec, a otrzymane pomiary są skorelowane z proporcjami wyrębów i tkanek, jednak dla uzyskania dużej dokładności wyników niezbędne są dalsze badania na populacji o dużej liczebności.

*Słowa kluczowe:* wartość rzeźna, komputerowe pomiary liniowe, tusze owcze

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