EVALUATION OF LEANNESS *IN VIVO* AND *IN VITRO* OF PIGS

ČEDOMIR RADOVIĆ, MILICA PETROVIĆ*, NENAD BRKIĆ**, BRANISLAV ŽIVKOVIĆ, NENAD PARUNOVIĆ***, DRAGAN RADOJKOVIĆ*, MARIJA GOGIĆ

Institute for Animal Husbandry, Autoput 16, 11080 Belgrade-Zemun, Republic of Serbia

*Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080 Belgrade-Zemun, Republic of Serbia

**Ministry of Agriculture, Forestry and Water Management - Directorate for Water, 11000, Belgrade, Republic of Serbia

***Institute of Meat Hygiene and Technology, Kaćanskog 13, 11000, Belgrade, Republic of Serbia

In determining the leanness of meat, the ultrasound machine was used in order to accurately determine the leanness of breeding animals. Along with the development and application of modern technology in ultrasound machines, the most precise determination performed at the same time determining the most appropriate device and the location for measurement of back fat thickness in live animals. These methods are aimed to increase the accuracy of the measurement of the traits. Various factors affect the accuracy of measurements using ultrasound machines such as the size of the probe, the frequency range in which it works, the angle at which it is measured, movements of animals during the measurement, the variation between the consistency of fat tissue as individual trait of an animals and defects which are caused by the work of operators and ultrasound apparatus. Back fat thickness measurement and testing of different ultrasound machines have been examined by the following authors: **Kempster et al.** (1979), **Mersmann** (1982), **Kanis et al.** (1986), **Demo et al.** (1996), **Krљka et al.** (2002), **Youssao et al.** (2002) and **Tyra et al.** (2011).

At different anatomic locations or with different ultrasound machines, the mentioned authors have performed measurement of backfat thickness on the animal body (withers, last rib, last lumbar vertebra, and between 5 to 8 cm lateral from the medial line) to determine the most suitable location to ensure satisfactory accuracy of measurements using the ultrasound machines and the best estimate of leanness.

The coefficients of heritability for growth traits and carcass quality were moderate to high (**Gorjanc et al.,** 2003 **Radović et al.,** 2003 **Petrović et al.,** 2006) so that the selection of purebreds can greatly contribute to the improvement of these traits. Increased selection of meat content causes a significant reduction of subcutaneous fat (**Bahelka et al.,** 2007). Breeding value of young animals can be used for assessing the breeding value of the parents, and therefore choose the best combination of parents for breeding, and thus provide a significant increase in the production and quality of pork in the country (**Jukna et al.,** 2009).

MATERIAL AND METHODS

To determine the meatiness of live animals ultrasound PIGLOG 105 was used, of the Danish manufacturer, SFK-Technology Ltd.. This device measures the thickness of the back fat depth of *musculus longissimus* (ML) and calculates the percentage of meat in the carcass side. The measurement using the ultrasound (PIGLOG 105) was performed on the following anatomic locations:

- fat thickness in the lumbar area (FT1) between 3rd and 4th lumbar vertebra (measured from the last lumbar vertebra), 7 cm lateral to the back line,
- fat thickness in the dorsal part (FT2) between 3rd and 4th back ribs, 7 cm lateral to the back line, and
- ML depth in the dorsal area between 3rd and 4th back ribs, 7 cm lateral to the back line.

In order to determine the reliability of the measurements using PIGLOG 105 fat thickness (FT1 and FT2) and ML depth were measured on live and slaughtered animals, total of 170 heads. The measurement locations for back fat thickness and depth of the ML's were previously marked by tattooing on live animals. After cooling of carcass sides measures for fat thickness were taken (FT1 and FT2) and the depth of ML.

In order to determine the lean meat in carcass sides compared to PIGLOG 105 170 heads were dissected. When performing dissections, tests were carried out on fattening pigs of following genotypes: Swedish Landrace (*n*=70) and F_1 (SLxLY) (*n*=100) (castrated males, *n*=80; female animals, *n*=90).

After transport animals rested 16 to 18 h, and only after the expiration of this period, they were slaughtered (during this period, animals were not fed). After slaughtering and primary processing of carcass sides, both hot carcass sides were weighed, fat thickness at the middle of the back (FTMB) and middle of the rump (FTMR) in order to evaluate the leanness (JUS) of carcass sides according to the Rulebook on the quality of slaughtered pigs and pork categorization (Official Gazette, 2/1985).

After cooling of carcasses (24 h to a temperature of meat of +4^{0}C) weight of both cooled carcass sides was measured. Fat thickness was measured with the skin.

Acknowledgements - Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31081

Before cutting of the cooled right carcass sides into main parts, its measurement was performed. Cutting of cooled carcass sides was carried according to the Weniger method (**Weniger et al., 1963**). The mere carcass equalization was performed with respect to the individual deviation from ideal right carcass side was less than 1 kg. All the components of the separation of the carcass side were measured separately and then dissected with the separation and measurement of muscle, fat with skin and bone. Dissection did not cover by-carcass parts: the head, cheeks, legs and tail, because they are treated as inferior parts (cheeks and fat are treated as adipose tissue).

The experimental data were processed using Statistica for Windows (StatSoft Inc., 2008). Main parameters of descriptive statistics were calculated: mean value, standard deviation and variation coefficient. Statistical significance of the effect investigated traits and assessment methods for assessing meatiness on the observed properties was determined by t-test using 0.05 and 0.01 levels of significance.

RESULTS AND DISCUSSION

Table 1 shows the average values and variability of indicators of leanness resulting from the data processing using PIGLOG 105, dissection and JUS. The average weight of the sample was 110.40 kg and mass of hot (both) carcass sides was 88.84 kg, while the mass of cold (both) carcass sides was 84.95 kg.

Average back fat thickness determined using PIGLOG 105 was FT1 = 20.27 mm, FT2 = 17.42 mm, while the thickness of fat determined by dissection in the same location was FT1 = 23.42 mm and FT2 =19.59 mm. *ML* depth determined with PIGLOG 105 was 46.59 mm and the depth of *ML* obtained by dissection was greater (54.58 mm). Percentage and meat yield determined with PIGLOG 105, dissection and JUS were: 51.87% and 43.84 kg, 55.72% and 47.26 kg and 41.62% and 36.84 kg, respectively. Based on these results we can see that the JUS showed more deviations compared to PIGLOG 105 and dissection in regard to meat percentage and meat yield.

From the results shown in Table 2 one can see significance of differences in indicators for leanness between PIGLOG 105 and dissection. Based on these average values determined using PIGLOG 105 and dissection: FT1 = 20.27 and 23.42 mm, FT2 = 17.42 and 19.59 mm, *ML* = 46.59 and 54.58 mm, meat percentage = 51.87 and 55.72% and meat yield = 43.84 and 47.26 kg, differences were statistically significant (P <0.01).

Table 3 shows the significance of differences in the percentage of meat (%) and meat (kg) tested by t-test between

Table 1. **Average values and variability for the indicators of lean meat**

Trait[1)]	$\bar{x}$	*SD*	S □	*CV*
Pre-slaughter mass, kg	110.40	11.34	0.86	10.27
Mass of warm carcass side, kg	88.84	9.90	0.75	11.14
Mass of cold carcass side, kg	84.95	9.50	0.72	11.18
PIGLOG 105				
FT1, mm	20.27	5.31	0.40	26.18
FT2, mm	17.42	5.52	0.42	31.71
ML, mm	46.59	5.18	0.39	11.11
Share of meat in carcass sides, %	51.87	4.84	0.37	9.34
Meat yield in carcass sides, kg	43.84	4.75	0.36	10.83
DISSECTION				
FT1, mm	23.42	6.95	0.53	29.69
FT2, mm	19.59	6.56	0.50	33.47
ML, mm	54.58	7.13	0.54	13.05
Share of meat in carcass sides, %	55.72	3.99	0.30	7.16
Meat yield in carcass sides, kg	47.26	5.38	0.41	11.39
JUS				
FTMB, mm	23.17	6.34	0.48	27.37
FTMR, mm	22.58	5.82	0.44	25.75
Share of meat in carcass sides, %	41.62	2.78	0.21	6.68
Meat yield in carcass sides, kg	36.84	3.64	0.27	9.87

[1)]FT1-fat thickness in the lumbar area, FT2-fat thickness in the dorsal part, ML-depth of *musculus longissimus*, JUS- evaluate the leanness by Rulebook, FTMB-fat thickness at the middle of the back, FTMR-fat thickness at the middle of the rump

Table 2. **The significance of differences indicators of meatiness between PIGLOG105 and dissection**

Trait[1)]	PIGLOG 105 $\bar{x}$	DISSECTION $\bar{x}$	t-test
FT1, mm	20.27	23.42	**[2)]
FT2, mm	17.42	19.59	**
ML, mm	46.59	54.58	**
Share of meat in carcass sides, %	51.87	55.72	**
Meat yield in carcass sides, kg	43.84	47.26	**

[1)]FT1-fat thickness in the lumbar area, FT2-fat thickness in the dorsal part, ML-depth of *musculus longissimus*;
[2)]** ►P<0.01; * ►P<0.05; NS ►P>0.05

Table 3. **The significance of differences for lean meat content (%, kg) between PIGLOG105:JUS, Dissection:PIGLOG105 and Dissection:JUS**

Trait	PIGLOG 105 $\bar{x}$	JUS[1)] $\bar{x}$	t-test
Share of meat in carcass sides, %	51.87	41.62	**[2)]
Meat yield in carcass sides, kg	43.84	36.84	**
Trait	DISSECTION $\bar{x}$	PIGLOG 105 $\bar{x}$	t-test
Share of meat in carcass sides, %	55.72	51.87	**
Meat yield in carcass sides, kg	47.26	43.84	**
Trait	DISSECTION $\bar{x}$	JUS $\bar{x}$	t-test
Share of meat in carcass sides, %	55.72	41.62	**
Meat yield in carcass sides, kg	47.26	36.84	**

[1)]JUS- evaluate the leanness by Rulebook, [2)]** ►P<0.01; * ►P<0.05; NS ►P>0.05

PIGLOG 105 and JUS, dissection and PIGLOG 105 as well as dissection and JUS. Based on the results presented in the table, in case of PIGLOG 105 the average meat percentage of 51.87% was determined and JUS 41.62% and 43.84 kg to 36.84 kg of meat. T-test showed a statistically significant difference (P<0.01), between back fat (% kg) determined by PIGLOG 105 and JUS.

Also, there was a statistically significant difference (P<0.01) in regard to leanness (%, kg) between dissection and PIGLOG 105, and between dissection and JUS. By dissection the average percentage of meat and meat yield of 55.72% and 47.26 kg were determined, and JUS 41.62% and 36.84 kg of meat.

Our results were consistent with a number of authors (**Kempster et al.**, 1979; **Mersmann**, 1982; **Kanis et al.**, 1986; **Demo et al.**, 1996; **Krška et al., 2002**) as confirmed by the results of their examination of ultrasound machines, as well as anatomical measurement locations (withers, last rib, last lumbar vertebra, and from 3 to 8 cm lateral from the medial line), in which they found that the highest measurement accuracy was achieved when measured above the last rib and 8 cm lateral from the medial line.

Krška et al. (2002) found a lower average lean meat content was determined by dissection (from 55.67%) compared to the estimated lean meat content *in vivo*, with an average body weight of 104.5 kg was estimated one day before slaughter, by the apparatus PIGLOG-105 (56.03%) and SONOMARK SM-100 apparatus (57.16%). The best estimated value obtained by the use of ultrasound Aloka 500 (55.83%). Consistent to our results, **Tyara et al.** (2011) have obtained a higher average estimated lean meat content by dissection compared to ultrasound (PIGLOG-105 and Aloka 500). In comparison to the optical probe (Fat Lean Meter), PIGLOG-105 and Pie Medical 200 Scaner **Youssao et al.** (2002) found a highly statistically significant difference (P<0.001) for the estimated lean meat content (LSMean estimated lean meat content to 64.97%, 63.90% and 65.68%, respectively).

CONCLUSION

It can be concluded that the PIGLOG 105 determined the thickness of the back fat, depth of the ML and the percentage of meat in live animals with a lesser degree of accuracy in relation to dissected animals. The differences found in the fat thickness, depth of ML, yield and share of meat in carcass sides were statistically significant (*P*<0.01). Minor errors in the assessment of leanness were achieved using more sophisticated ultrasound devices such as Pie Medical Scanner 200, Aquila vet and Aloka 500. It should be noted that the accuracy of measurements of backfat thickness and depth of the *ML* using an ultrasound apparatus under the influence of following factors: body weight at the end of the test, the number of fascia on the back fat, the movements of the animals during the measurement, the probe apparatus (size and frequency at which the probe is running), mistake made by ultrasound in the measurement, and the systematic errors made by our operators during the measurement.

REFERENCES

1. Bahelka, I., Tomka J., Hanusova E., 2007. The effects of probe type and intensity of ultrasound on accuracy of intramuscular fat prediction in Longissimus dorsi muscle of pigs. Biotechnology in Animal Husbandry, 23, 5-6, 87-95.

2. Jukna, V., Jukna Č., Pečiulaitiene N., Meškinute-Kaušiliene E., 2009. The effect of boars and sows on meat quality and calorific values in the progeny. Biotechnology in Animal Husbandry, 25, 3-4, 161-172.

3. Gorjanc, G., Malovrh Š., Kovač M., Glavač-Vnuk M., Zrim J., 2003. Proučavanje možnosti vključivte klavnih lastnosti v napoved plemenske vrednosti pri prašičih. Zbornik Biotehniške Fakultete Univerze v Ljubljani, Kmetijstvo Zootehnika, 82, 2, 89-96.

4. Demo, P., Poltarsky J., Kučera J., 1996. Prediction of meatiness of pig dressed carcasses on the basis of eye muscle area and backfat area and their relations. Zivocisna Vyroba, 39, 7, 629 - 642.

5. Kanis, E., Van Der Steen H. A. M., De Roo K., De Groot P. N. , 1986**:** Prediction of lean parts and carcass price from ultrasonic backfat measurements in live pigs. Livestock Production Science, 14, 55-64.

6. Kempster, J. A., Cuthbertson A., Owen G. M., Alliston C. J. 1979**:** A comparison of four ultrasonic machines (Sonatest, Scanogram, Ilis Observer and Danscanner) for predicting the body composition of live pigs. Animal Production, 29: 175-181.

7. Krška, P., Bahelka I., Demo P., Peškovičová D., 2002. Meat content in pigs estimated by various methods and compared with objective lean meat content. Czech J. Anim. Sci., 47, 5, 206–211.

8. Mersmann, H. J. (1982): Ultrasonic determination of backfat depth and loin area in swine. Journal of Animal Science, 54, (2), 268-275.

9. Petrović, M., Pušić M., Radojković D., Mijatović M., Radović Č., Živković B., 2006. Fenotipska i genetska varijabilnost osobina kvaliteta polutki i mesa. Biotehnologija u stočarstvu, 22, 5-6, 1-10.

10. Radović, Č., Petrović M., Josipović S., Živković B., Kosovac O., Fabjan M., 2003. Uticaj različitih genotipova, očeva i sezone klanja na klanične osobine svinja. Biotehnologija u stočarstvu, 19, 1-2, 11-16.

11. Weninger, A. J., Steinkuoj D., Paker G., 1963. Musculature topography of carcasses. B.L.G. Verlagsellshoft, München.

12. Youssao, K. A. I., Verleyen V., Michaux C., Leroy L. P., 2002. A comparison of the Fat Lean Meter (CGM), the ultrasonic device Pie Medical 200 and the Piglog 105 for estimation of the lean meat proportion in Pie´train carcasses. Livestock Production Science, 78, 107–114.

** 1985. Rulebook on quality of slaughtered pigs and categorization of pig meat. Official Gazette SFRJ, 2, 20-30.

EVALUATION OF LEANNESS *IN VIVO* AND *IN VITRO* OF PIGS

Č. Radović, M. Petrović, N. Brkić**, B. Živković, N. Parunović***,*
DR. Radojković, M.A Gogić*
Institute for Animal Husbandry, Autoput 16, 11080 Belgrade-Zemun, Republic of Serbia
**Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080 Belgrade-Zemun, Republic of Serbia*
***Ministry of Agriculture, Forestry and Water Management - Directorate for Water,*
11000, Belgrade, Republic of Serbia
****Institute of Meat Hygiene and Technology, Kaćanskog 13, 11000, Belgrade, Republic of Serbia*

SUMMARY

The study aimed to determine the accuracy of the measurements (fat thickness, depth of *musculus longissimus* (*ML*) and estimated lean meat) by ultrasound apparatus PIGLOG 105 compared with dissection (by the Weniger method) and the applicable regulations on the quality of slaughtered pigs and categorization of pork meat (Official Gazette, 2/1985). In order to determine the accuracy of the measurement using PIGLOG 105, 170 animals were dissected. When performing dissections, tests were carried out on fattening pigs of following genotypes: Swedish Landrace (n = 70) and F_1 (SLxLY) (n = 100) (castrated males, n = 80; female animals, n = 90). It was found that the values obtained by measuring fat thickness *in vivo* were higher than the values determined *in vitro*. Estimated lean meat content *in vivo* was lower (51.87%) compared to the values determined by dissection (55.72%). The differences found between PIGLOG 105, dissection and Regulations in regard to fat thickness, depth of *ML*, yield and share of meat in carcass sides were statistically significant (P <0.01).

Key words: *fat thickness, carcass side leanness, PIGLOG 105, dissection*

Corresponding author: cedomirradovic.izs@gmail.com
Original scientific paper