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CHARACTERISTICS OF FEMUR AND HUMERUS IN TUROPOLJE PIG – AN AUTOCHTHONOUS CROATIAN BREED

Marija Đikić [(1)], K. Salajpal [(1)], D. Karolyi [(1)], D. Đikić [(2)], Marija Pavić [(1)], I. Jurić [(1)]

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SUMMARY

Since 1996, Turopolje pig breed–autochthonous Croatian breed has been in the state of renewal and protection. The size of breeding population was 137 sows and 13 boars in 2006. The aim of this study was to present some bones characteristics of femur and humerus (weight, length, circumference, diameters of diaphysis and epiphysis proximalis and distalis) of the hogs of Turopolje pig breed (T) in comparison to selected pigs, Swedish Landrace breed (SL) and Hypor (Hy) pigs. The hogs T (n=19, live weight 100.3±4.9 kg) were produced by traditional Croatian technologies of low feed input in outdoor system. The selected hogs (SL and Hy, n=62 and 53, live weight 103.3±5.3 and 104±5.8 kg) were produced by conventional technologies of fattening in large farm. Characteristics of femur and humerus at hogs T were as follows: weights 271.4 and 256.6 g, length 202.0 and 194.9 mm, diameters of epiphysis proximalis 58.3 and 67.9 mm, and epiphysis distalis 49.0 and 42.0 mm, the minimum and maximum diameters of diaphysis 19.0 and 18.9 mm and 23.0 and 25.8 mm and circumference of diaphysis 78.1 and 77.0 mm. Significantly higher values for all traits of femur and humerus except for length and circumference of diaphysis were found in hogs SL and Hy. The length of both femur and humerus were significantly higher in T than in SL and Hy pigs. The results should be the contribution to explanation of carcass composition and distribution of tissues in the carcass of Turopolje pig breed.

Key-words: femur, humerus, Turopolje pig breed

INTRODUCTION

Turopolje pig breed is Croatian autochthonous breed and one of the older European pig breeds (Grunenfelder, 1994; Robić et al., 1996). A number of scientific and professional papers (Đikić et al., 2002) on the origin, historical and economic importance the factors which brought this breed into the FAO list of endangered and disappearing breeds (World Watch List for Domestic Animal Diversity, Loftus and Scherf, 1993) was published. The list was formed after signing the Convention on Biological Diversity (CBD) in Rio de Janeiro in June 1992. The Croatia signed CBD on January 5th, 1997 and in 1999 Croatia passed the strategy of biological diversity (flora and fauna) which includes Turopolje pig breed also. Since 1996, this breed has been in the state of renewal and *in situ* protection. The organization Universitas Commnitas Nobilium Campi Turopolia (old land community, established in 13th century and legally suppressed by socialistic lows in 1947) registered the breeding population and opened the herd book of Turopolje pig breed at Croatian Livestock Center (CLC). In 2006, the size of breeding population was 137 sows and 13 boars (CLC, 2006). It is important to emphasize that the traditional Croatian technology of low input pig production in the outdoor ecosystem of flood forest (*Quercus robur* L.) and marsh meadows (*Deschampsietum caespitosae*), typical for the Turopolje pig breed, is a part of Croatian cultural heritage. In the past ten years researches were focused on the determination of numerous biological traits of Turopolje pig population at phenotypic and genetic level (Đikić et al., 2002, 2004, 2006; Harcet et al., 2006; Margeta et al., 2006), thus given results could be support in re-establishment and increase of the population.

(1) PhD. Marija Đikić, Full Professor; MSc. Krešimir Salajpal; PhD. Danijel Karolyi; Marija Pavić, BSc. student; PhD. Ivan Jurić, Full Professor - Faculty of Agriculture University of Zagreb, Svetošimunska c. 25, 10000 Zagreb Croatia; (2) PhD. Domagoj Đikić - Faculty of Science University of Zagreb, Roosweltov trg 6 10000 Zagreb, Croatia

The aim of this paper was to present some characteristics of femur and humerus bones (weight, length and diameters of epiphysis and diaphysis) in comparison to selected pigs. Results will be used in better explanation of carcass composition of Turopolje pig and distribution of tissues in the carcass, especially of leg and shoulder.

MATERIAL AND METHODS

Characteristics of femur and humerus (weight, length, diameters of diaphysis proximalis and distalis, as well as circumference) of Turopolje breed hogs (T) and selected pigs Swedish Landrace (SL) breed and hybrid Hypor (Hy) were investigated. The hogs T (n=19, live weight 100.3±4.9 kg and age 679±20 days) were produced by traditional Croatian technology of low input feed (0.5 kg of corn seed/animal /day) in outdoor system of forest biocenosis (*Quercus robour* L.), marsh meadows (*Deschampsietum caespitosae*) and continental climate in the Turopolje area (about 40 km from Zagreb). The selected hogs SL and Hy (n=62 and 53, live weight 103±5.3 and 104±5.8 kg and age 180±10 days respectively) were produced by conventional fattening technologies in large farm. The pigs were fed *ad libitum* by feed mixture ST1, 16% CP/kg and 13,1 MJME/kg in the first period to 60 kg live weight and in with ST2, 14%CP and 13,6 MJME/kg in the finishing period. After the slaughtering and the chilling carcasses (+4 ^{o}C/24h), the left halves of carcasses were cut by Weniger method (1963) and femur and humerus were separated from leg and shoulder after total tissues dissection. The bones were completely trimmed from muscle and connective tissue and ligaments excluding the joint cartilages. The bones were individually weighed. The length and diameter of proximal and distal epiphysis and diaphysis was measured by slide caliper, while the circumference of diaphysis was ascertained with a measuring tape. The length of bones was measured from the most distal point of the epiphysis distalis to the most proximal point of trocheanter major on the femur and to the most proximal point of tuberculum majus on the humerus. The diameter of bones proximal epiphysis was gauged between the trochanter major and the most medial point on the caput femoris on femur and on the humerus from the outermost point's caput humeri and tuberculum majus (lateral side of humerus). The diameter of femur and humerus distal epiphysis was gauged from the most lateral point on the epicondylus lateralis to the most medial point on epicondylus medialis. The maximal (i.e. width) and minimal (i.e. thickness) diameters of femur and humerus corpus were measured on the thinnest place on the femur and humerus as well as the circumference. The data were analyzed by analysis of variance (testing - Tukey multiple comparison.) using PROC GLM, SAS (1999).

RESULTS AND DISCUSION

Carcass (cold) weights and proportions of leg, shoulder and the tissues of these parts in the carcass of investigated pigs are shown in Table 1.

Table 1. Carcass weights and proportions of leg, shoulder and tissues of these parts in the carcass

Characteristics	Turopolje pig $\bar{x}$ ± SD	Swedish Landrace $\bar{x}$ ± SD	Hypor $\bar{x}$ ± SD
Carcass c. weight (kg)	78.1 ± 4.4	79.3 ± 4.59	79.7 ± 5.23
Leg (%)	25.7 ± 0.53 ^{A}	28.9 ± 1.12 ^{B}	30.5 ± 1.35 ^{B}
- muscle (%)	12.7 ± 0.77 ^{A}	18.3 ± 1.44 ^{B}	20.9 ± 1.99 ^{B}
- fat (%)	10.6 ± 0.95 ^{A}	7.5 ± 1.12 ^{B}	6.1 ± 1.28 ^{B}
- bone (%)	2.4 ± 0.26 ^{A}	3.1 ± 0.29 ^{B}	3.6 ± 0.73 ^{B}
Shoulder (%)	15.5 ± 0.20 ^{A}	12.9 ± 0.89 ^{B}	13.5 ± 0.67 ^{B}
- muscle (%)	8.2 ± 0.52	8.3 ± 0.78	8.9 ± 0.77
- fat (%)	5.7 ± 0.58 ^{A}	2.7 ± 0.47 ^{B}	2.50 ± 0.50 ^{B}
- bone (%)	1.6 ± 0.48 ^{A}	1.9 ± 0.16 ^{B}	2.1 ± 0.17 ^{C}

Different letters indicate difference between groups at P<0.05 level of significance

The results (Table 1) showed that the hogs of Turopolje breed had significantly lower proportions of leg, muscle and bony tissue of leg and more of fat tissue in the carcass than selected pigs. The hogs of

Turopolje breed had significantly higher proportions of shoulder, fat tissue of shoulder ($p<0.05$) while the proportion of bony tissue in the carcass was lower than in selected pigs SL and Hy ($p<0.05$). The differences between hogs of SL and Hy were also estimated. The proportions of muscle tissue of shoulder were not statistically different between investigated groups.

Obtained results (Table 1) and estimated differences between the hogs of Turopolje pig breed and selected pigs, as well as the some differences between selected pigs could be attributed to the processes of breeding, selection, and management in pig industry in the last three decades of the last century (Fortin et al., 1987, Bichard 1982; Senčić et al., 1997; Petričević et al., 2001; Kušec et al., 2004). Today in meat processing industry, a profitable use of the carcass beside meat quality, depends upon the relation and distribution of muscular fat and bone tissues. Bones as well as fatty tissue are undesirable and the quantity of tissues most often is described as the relation muscle : fat and fat : bones tissues. By Sisson and Grossman (1962) the bones have a share of 10-12% in the body and their function is to support the body muscular (and fat) mass.

The correlations between the amount of muscle and fat tissues in the carcass as well as between bone and fat tissues are negative, while its positive between the muscle and bone. The same relations are in parts of the carcass (Đikić and Jurić, 1996). The coefficients of regressions are in the same directions but different values and dependent by genotype and sex and live weight differences of proportions of tissues in the carcass (Richmond and Berg, 1972; Richmond et al., 1979; Đikić and Jurić, 1996). The authors estimated the coefficients of correlations between the muscle : fat and fat : bone tissues in values from – 0.86-to – 0.96 and - 0.51 to - 0.66, and muscle : bone 0.33 to 0.52.

Table 2 and 3 show the characteristics of femur and humerus in Turopolje pig breed and selected pigs SL and Hy.

Table 2. Morphometric characteristics of *femur*

Traits	Turopolje pig $\bar{x}$ ± SD	Swedish Landrace $\bar{x}$ ± SD	Hypor $\bar{x}$ ± SD
Weight (g)	271.4 ± 26.5 ^{A}	306.8 ± 24.29 ^{B}	327.7 ± 31.2 ^{B}
Length (mm)	202.0 ± 7.11 ^{A}	197.23 ± 6.65 ^{B}	199.2 ± 6.74 ^{B}
Diameter *epiphysis* (mm)			
- *proximalis*	58.3 ± 2.65 ^{A}	66.1 ± 2.95 ^{B}	67.2 ± 2.54 ^{B}
- *distalis*	49.0 ± 2.32 ^{A}	60.2 ± 2.52 ^{B}	61.1 ± 3.0 ^{B}
Diameter *diaphysis* (mm)			
- minimum	19.0 ± 1.3	22.8 ± 1.44	23.9 ± 1.52
- maximum	23.0 ± 2.04 ^{A}	25.6 ± 1.65 ^{B}	26.6 ± 2.17 ^{B}
Circumference diaphysi (mm)s	78.1 ± 3.50 ^{AB}	77.8 ± 3.81 ^{A}	80.2 ± 4.48 ^{B}

Different letters indicate difference between groups at $P<0.05$ level of significance

Table 3. Morphometric characteristics of *humerus*

Traits	Turopolje pig $\bar{x}$ ± SD	Swedish Landrace $\bar{x}$ ± SD	Hypor $\bar{x}$ ± SD
Weight (g)	256.6 ± 37.23 ^{A}	276.8 ± 20.82 ^{B}	293.1 ± 29.3 ^{B}
Length (mm)	194.90 ± 4.31 ^{A}	177.4 ± 6.72 ^{B}	176.8 ± 7.17 ^{B}
Diameter *epiphysis* (mm)			
- *proximalis*)	67.9 ± 3.23 ^{A}	73.06 ± 3.89 ^{B}	72.7 ± 3.38 ^{B}
- d*istalis*	42.0 ± 2.46 ^{A}	51.8 ± 3.61 ^{B}	52.9 ± 4.6 ^{B}
Diameter *diaphysis* (mm)			
- minimum	18.9 ± 1.1	19.34 ± 1.20	19.9 ± 1.32
- maximum	25.8 ± 2.67 ^{A}	27.7 ± 1.67 ^{B}	28.6 ± 1.84 ^{B}
Circumference *diaphysis* (mm)	77.0 ± 5.15 ^{AB}	77.9 ± 3.81 ^{A}	80.1 ± 4.38 ^{B}

Different letters indicate difference between groups at $P<0.05$ level of significance

The femur and humerus in the hogs of Turopolje breed were significantly ($p<0.05$) lighter and longer than in the hogs of selected pigs, while between the selected pigs differences were not statistically

significant. In addition, the diameter of proximal and distal epiphysis of femur and humerus at hogs of Turopolje breed were significantly lower ($p<0.05$) than in selected pigs. The maximal diameters (i.e. width) of diaphysis of femur and humerus in hogs of Turopolje breed were lower ($P<0.05$) than in selected pigs.
The significant differences ($p<0.05$) between the hogs of SL and Hy existed in circumference of diaphysis of femur and humerus.
The lower weights and longer bones of femur and humerus in the hogs of Turopolje breed could be explained with lower diameters of these bones than in selected pigs.
The diameters of proximal and distal epiphyis and diaphysis of femur and humerus indicate differences in the diameters of joints at investigated pigs. The obtained results about the characteristics of femur and humerus, beside the results of fiber characteristics (Đikić et al., 2006), offer much better understanding why the leg and shoulder of Turopolje pigs are very long, narrow and thin, concluded by Horvat study (1939).
Taking into consideration the function of skeleton as a support of muscular mass in the body, it is not enough to know only anatomical traits of particular bones. In addition, it is necessary to know the relation among the traits of same bones as well as relations among the traits of different bones.

CONCLUSION

In Turopolje pigs the femur and humerus bones were characterized by significantly greater length but lower weight, diameters of proximal and distal epiphysis and maximal (i.e. width) diameters of diaphysis than in some type of selected pigs.
Different proportions of leg and shoulder as well as the muscle fat and bone tissues of these parts in the carcass of Turopolje pig breed and selected pigs could be attributed to the different processes of selection, breeding and production management.

REFERENCES

1. Bichard, M. (1982): Current in pig breeding. Outlook on Agriculture, 11(4):69-73.
2. Croatian Livestock Center (2006): Pig breeding – annual report 71–97.
3. Đikić, M., Jurić, I., (1996): Influence of the carcass weight on the content and distribution of bony tisse in pigs. Poljoprivredna znanstvena smotra, 61(2):45-53.
4. Đikić, M., Jurić, I., Kos, F. (2002): Turopoljska svinja – autohtona hrvatska pasmina – turopoljka. Ed.: Plemenita Općina Turopoljska, V. Gorica, pp 181.
5. Đikić, M., Salajpal, K., Karolyi, D., Jurić, I., Rupić, V. (2004): Distribution of tissues in carcass of Turopolje pig, an autochthonous Croatian breed. Acta agriculture slovenica, 84(2):153-159.
6. Đikić, M., Salajpal, K., Karolyi, D., Čubrić Čurik, V., Đikić, D., Mihelčić, M., Rupić, V., Jurić, I. (2006): Carcass and tissues composition at Turopolje pig breed autochthonous Croatian breed. Acta Agraria Kaposváriensis, 10(2):63-69.
7. Fortrin, A., Wood, J.D, Whelehan, O.P. (1987): Breed and sex effects on the development and proportions of muscle, fat and bone partition of fat in pig. Journal of Agriculture Science Cambridge, 108:39-45.
8. Grunenfelder, H.P. (1994): Saving the turopolje pig – an international pilot project in Croatia in collaboration with EURONATUR. Stočarstvo, 48(9-10):361-364.
9. Harcet, M., Đikić, M., Gamulin, V. (2006): Low genetic diversity of the Turopolje pig breed. Food Technology and Biotechnology, 44(1):105-109.
10. Horvat, B. (1939): Rezultati kontrolnog tova kod svinja turopoljske pasmine i baguna. Arhiv Ministarstva poljoprivrede – Smotra naučnih radova, 6:55-76.
11. Kušec, G., Kralik, G., Petričević, A., Margeta, V., Gajčević, Z., Gutzmirtl, D., Pešo, M. (2004): Differences in slaughtering characteristics between crossbred pigs with Pietrain and Duroc as terminal sire. Acta Agriculturae Slovenica, Supl. 1:121-127.
12. Loftus, R., Scherf, B. (1993): World watch list for domestic animal diversity. Ed.: FAO, UNEP, Rome, I. pp 245.

13. Margeta, V., Frajman, P., Kralik, G., Dovč, P. (2006): Determination of PPRGC1 Cys-430Ser polymorphism and MHS genotype in autochthonous pig breeds. Acta Agraria Kaposvariensis, 10(2):333-339.
14. Petričević, A., Kralik, G., Tolušić, Z., Škrtić, Z., Kušec, G. (2001): Percentage and distribution of tissues in pig carcasses in relation to (S)EUROP classes. Kmetijstvo, Supl. 31:205-211.
15. Richmond, R.J., Berg, R.T. (1972): Bone growth and distribution in swine as influenced by live weight, breed, sex and ration. Canadian Journal of Animal Science, 59(9):471-479.
16. Richmond, R.J., Jones, S.D., Price, M.A., Berg, R.T. (1979): Effect of breed and sex on the relative growth and distribution of bone in pig. Canadian Journal of Animal Science, 59(9):471-479.
17. Robić, Z., Đikić, M., Jurić, I., Stipić, N., Rupić, V., Mužic, S., Božac, R., Liker, B. (1996): Turopolje pig one of the oldest European race; its saving and renewal. In: Proceedings of the 4th international symposium "Animal Science Days". Kaposvar, 90-94.
18. Senčić, Đ., Kralik, G., Jurić, I., Petričević, A., Antunović, Z. (1997): Pig slaughter values according to the S-EUROP commercial classes (level of meatness). Agriculture Conspectus Scientificus 62(1):174-181
19. SAS (1999): SAS/STAT® User's Guide: version 8.1, SAS Institute, Cary, NC.
20. Sisson, S., Grossman, J.D. (1962): Anatomija domaćih životinja. Izd.: Poljoprivredni Nakladni Zavod, Zagreb, 180-203.
21. Weniger, H.J., Steinhanf, D., Pahl, G. (1963): Musculare topography of carcass. BLV., München.

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