KRMIVA

COMPARATIVE INVESTIGATION OF STERNUM SURFACE AREA AND BREAST MUSCLE VOLUME OF DIFFERENT BROILER GENOTYPES BY MEANS OF COMPUTER TOMOGRAPHY

USPOREDNO ISTRAŽIVANJE PODRUČJA POVRŠINE STERNUMA I OBUJMA PRSNOG MIŠIĆA RAZNIH GENOTIPOVA BROJLERA POMOĆU KOMPJUTORSKE TOMOGRAFIJE

Gabriella Andrassy-Baka, R. Romvári, Z. Sütõ

Original scientific paper - Izvorni znanstveni članak
UDC: 636.5.:636.03.637.03
Received - Primljeno: 18 may-svibanj 2002.

ABSTRACT

Arbor Acres (AA) standard genotype and foxy chick were investigated at the 2,3,4,5,6,7,8,9 weeks of age by meansjof computer tomography. Breast muscle volume and sternum surface data were processed and a special imaging process was applied to handle the 2D slices, then segmentation method was used to generate the boundary data.

Breast muscle volume data were 63 cm^3, 198 cm^3, 589 cm^3, 724 cm^3 and 48 cm^3, 156 cm^3, 426 cm^3, 564 cm^3 in AA and foxy strains, respectively at 2, 4, 7, 9 weeks of age. Sternum surface area (107 cm^2, 95 cm^2 and 140 cm^2, 120 cm^2, AA and foxy strains respectively) indicated more intensive bone tissue development in AA birds at 6 and 7 weeks of age.

Breast muscle volume falling on unit sternum surface was demonstrated by creating index values from the surface and the volume data. Values were 0,43, 0,52 and 0,22, 0,26 in AA and foxy strains respectively at 2 and 9 weeks of age.

In vivo morphology of breast muscle and sternum were investigated by mean of the 3D reconstruction method. This approach gives possibility to investigate these organs in original conditions.

Key words: computer tomography, breast muscle, sternum

INTRODUCTION

As a deleterious consequence of the selection for increased muscle production in broilers constitution changes cause substantial decrease of the product in intensively growing stocks. In the background of this problem there are genetic traits, nutritional and several environmental conditions in addition to divergent growth characteristic of the bone and the muscle tissues. During the growth of the body developing order of different tissues are the following: nerve-, bone-, muscle and fat tissues (Huxley, 1932). Growth of the muscle in meat production selected broiler strains is quite intensive till 7^{th} week of age. Following the more meat production in the less time basic principal an

Ph. D staüfe/tf Gabriella Andrassy-Baka, Ph. D. Robert Romvári, Ph. D. Zoltan Sütõ, University of Kaposvar, Faculty of Animal Science - Hungary - Mađarska.

important problem had arisen. Growth of the skeletal system is already unable keep step with the fast .development of the skeletal muscle. Breast muscles give more than 60% of all muscles in broilers. It is important to know about growth characteristics of these muscles and their originating surface, the sternum because it is possible that growth of the sternum limits the breast muscle development. Well known is a positive correlation between the length of the breastbone and tibia, the quantity of the breast muscle and the bodyweight (r=0,4; 0,5; 0,5) (Malik et al., 1997). Besides, different developing processes occur in ossification of different genotypes (Dolmany et al., 1991). Comparing Hybro and Tetra strains they found that the absolute weight of the breastbone and the breast muscle grew in both genotypes till the end of the keeping period. Breastbone developed at the early growing period in Tetra genotype while in Hybro strain growth rate of the breastbone was twofold last week of growing period.

In studies on chicken (Bentsen and Sehested 1989; Svihus and Katie (1993) and Romvari et al. (1994), turkey (Brenoe and Kolstad 2000) it has been shown that the computer tomography (CT) is a suitable non-invasive technique to measure the volume or mass of the pectoralis muscle and abdominal fat permitting single or repetitive measurements.

In the present study the development of the breastbone and the breast muscle were compared in two divergent genotypes by means of computer tomography. The method was based on a new in vivo real 3D reconstruction to estimate the breast muscle of broiler chickens by Romvari et al. (2000).

MATERIALS AND METHODS

The examinations were performed on two divergent genotypes of broilers, Arbor Acres (AA) standard genotype and foxy chick at the 2, 3, 4, 5, 6, 7, 8, 9 weeks of age. The birds forming the experimental group originated from the stock used in comparative performance studies performed at the University of Kaposvar Department of Poultry Breeding Science, and, as such, were housed in a livestock building operating under closed, intensive conditions, with deep litter and a cubicle system, at the Experimental Livestock Production Site of the University faculty. The broilers were fed in accordance with the standard two-phase programme specified by the distributor.

At the age of 2, 3, 4, 5, 6, 7, 8 and 9 weeks 5 experimental birds of each sex were subjected to CT examination after being fasted for ten hours. These examinations were performed from the 9th cervical vertebra to symphysis of femur and tibia by means of the Siemens Somatom S40 equipment of the Diagnostics and Oncoradiologic Institute, the slice thickness used being 3 mm and the step 3 mm; 25-70 CT images per bird were taken. The birds were examined lying in a prone position, without the use of anaesthetic.

Breast muscle volume and sternum surface data were processed special imaging process was applied to handle the 2D slices, than segmentation method was used to generate the boundary data. Finally surface rendering was undertaken to obtain the real 3D view of the sternum and the breast muscle.

RESULTS

The mean of the breast muscle volume increased consistently till 9th week of age in both genotypes. The deviation of breast volumes of genotypes became more marked from the 4th week of age when the muscle growth increased considerably in the AA strain. Breast muscle data were 63 cm^3 198 cm^3, 589 cm^3, 724 cm^3 and 48 cm^3, 156 cm^3, 426 cm^3, 564 cm^3 in AA and foxy strains, respectively at 2, 4, 7, 9 weeks of age (Figure.1).

Sternum surface area increased in both genotypes during the experimental period (Figure 2.) From the second week of age AA strain showed higher values, especially at 6 and 7 weeks of age (107 cm^2, 95 cm^2 and 140 cm^2, 120 cm^2, AA and foxy strains respectively) indicating more intensive bone tissue development in AA birds. Nevertheless, at 9 weeks of age the difference in surface values decreased between the two genotypes (AA: 161 cm^2, foxy: 156 cm^2).

Figure 1. Changes of the breast muscle volume in AA and foxy genotypes
Slika 1. Promjene obujma prsnog mišića kod AA i foxy genotipova

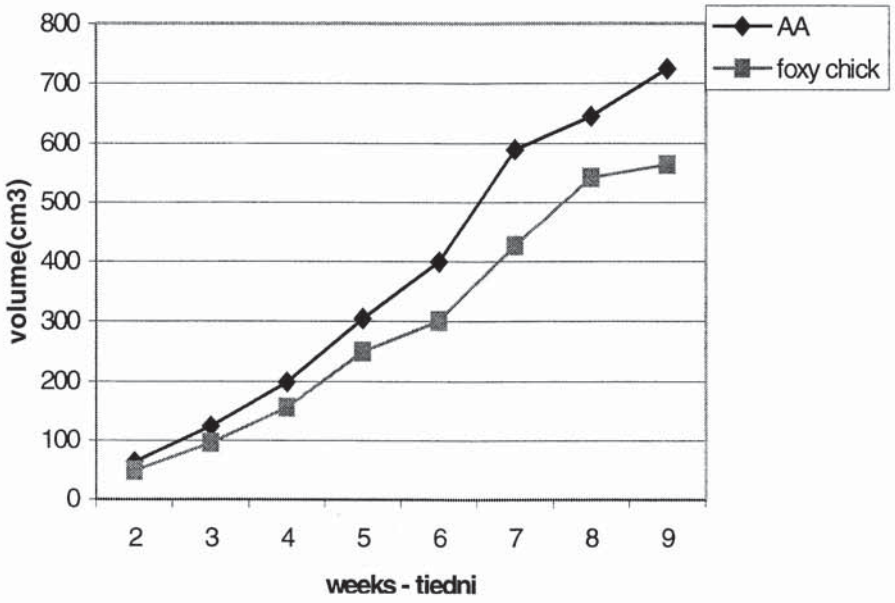
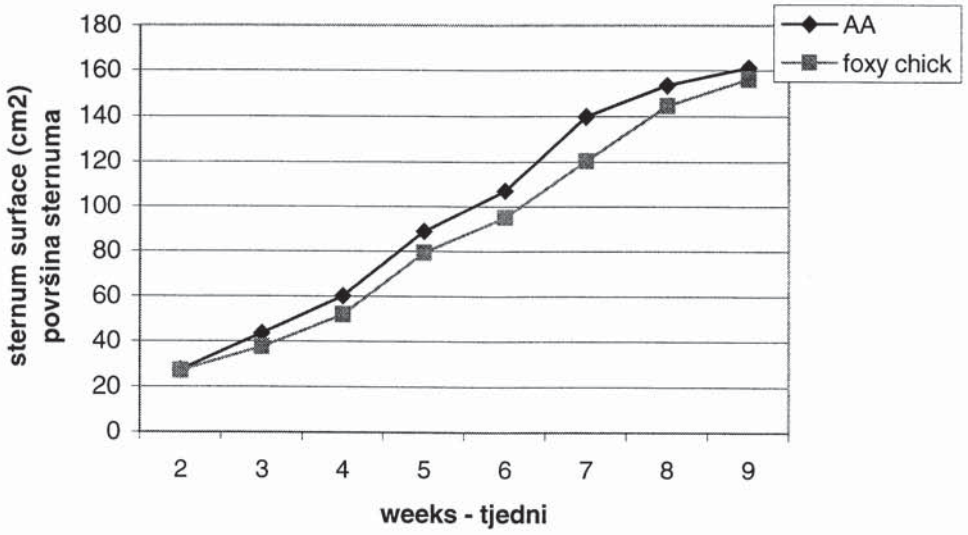
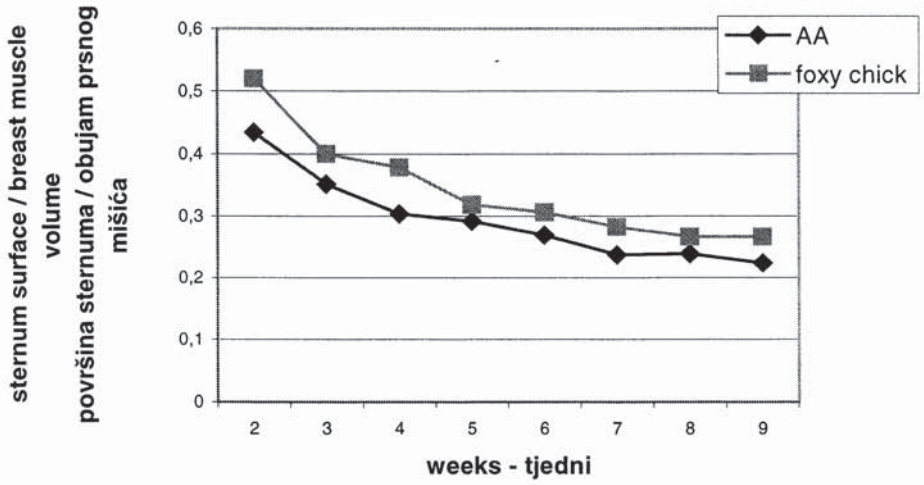


Figure 2. Changes of the sternum surface in AA and foxy genotypes
Slika 2. Promjene površine sternuma kod AA i foxy genotipova



Breast muscle volume falling on unit sternum surface was demonstrated by creating index values from the surface and the volume data. Decreasing value of the ratio indicates that the muscle volume unit becomes larger during growth (Figure 3). Values were 043; 0,52 and 0,22; 0,26 in AA and foxy strains respectively at 2 and 9 weeks of ages. According to values the AA genotype built more muscle tissue than the foxy strain on an approximately same sternum surface.

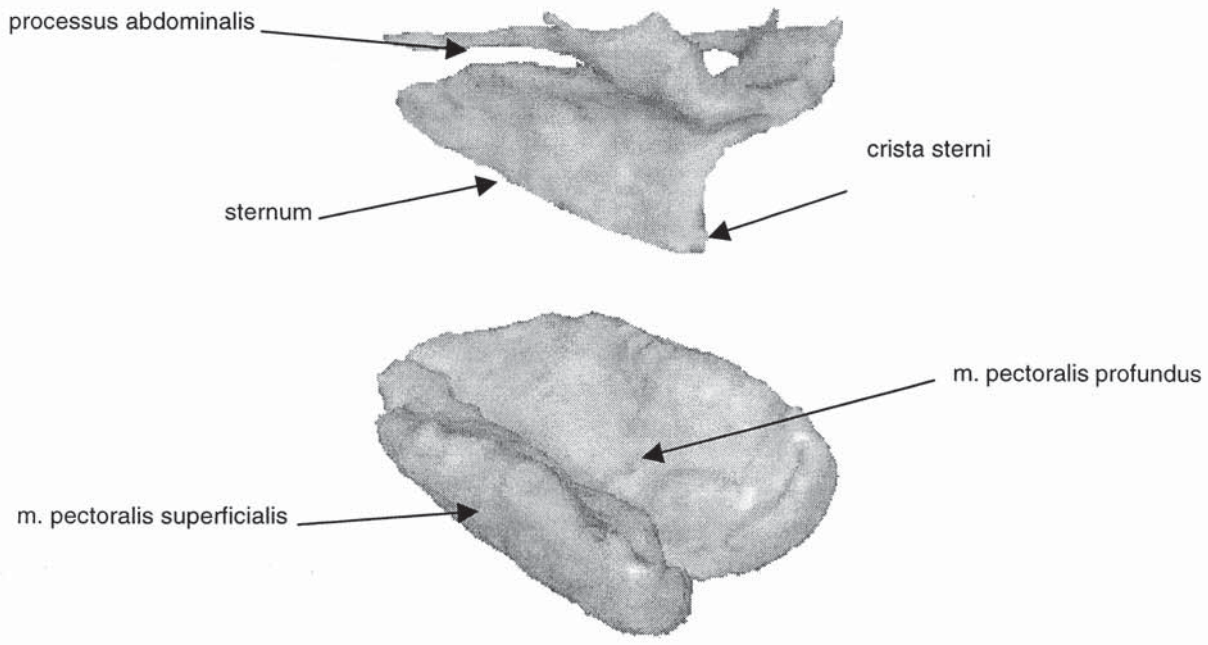
Figure 3. Changes of the sternum surface and breast muscle volume ratio
Slika 3. Promjene površine sternuma i omjer obujma prsnog mišića



In vivo morphology of breast muscle and sternum were investigated by means of 3D reconstruction method (Figure 4). This approach gives possibility to investigate these organs, in original conditions. Visible main parts of the breastbone: two processus abdominalis, crista stemi and the sternum.

Two muscles of the breast are the musculus pectoralis superficialis and the musculus pectoralis pro fundus on which the impression of the sternum was distinctly visible.

Figure 4. 3D reconstruction of sternum and breast muscle of an Arbor Acres broiler at nine weeks of age
Slika 4. 3D rekonstrukcija sternuma i prssnog mišića jednog Arbor Acres brojlera u dobi od 9 tjedana



CONCLUSION

The applied in vivo CT examination method seems to be suitable to follow muscle and bone tissue development. According to results intensity of sternum growth did not follow the substantial muscle tissue development in AA genotypes. Divergent growth of the muscle and bone tissue development could set limits to maximal exploitation of genetical basis.

REFERENCES

1. Bentsen, H. B., E. Sehested (1989): Computerized tomography of chickens. Br. Poultry Sci., 30: 575-585.
2. Dolmany, T., T. Gippert, L. Gati (1991): Comparison of the Hybro and Tetra broilers. Allattenyesztes es Takarmanyozas, 40. No. 2. 173-178.
3. Huxley, J. S. (1932): Problems of relative growth. Methnen London, 276pp.
4. Brenoe, U.T., K. Kolstad (2000): Body composition and development measured repeatedly by computer tomography during growth in two types of turkeys. Poultry-Science. 79: 4, 546-552.
5. Malik, B. N., P. K. Mishra, S. C. Mishra (1997): Inheritance of 6-week body weight, breast angle, shank length and keel length in broiler chicken, Indian Journal of Poultry Science. 32: 3, 249-252; 16 ref.
6. Romvari, R., M. Perenyi, P. Horn (1994): In vivo measurement of total body fat content of broiler chickens by X-ray computerized tomography. Znan. Prak. Poljopr. Technol., 24. (1), 215-220.
7. Romvari, R., G. Andrasy-Baka, I. Repa, F. Zavoda, Z. Süto, P. Horn (2000): In vivo 3D evaluation of breast muscle of broiler chickens by means computer tomograph XXI World's Poultry congress , Montreal, august 20-24, Proccedings CD P11-14.
8. Svihus, B., J. Katie (1993): Computerised tomography as a tool to predict composition traits in broilers. Comparisons of results across samples and years. Acta Agriculturae Scandinavia. Section A, Animal Science. 43: 4, 214-218.

SAŽETAK

Istraživani su standardni genotipovi Arbor Acres (AA) i foxy chick u dobi od 2, 3, 4, 5, 6, 7, 8, i 9 tjedana pomoću kompjutorske tomografije. Obrađeni su podaci o obujmu prsnog mišica i površine sternuma te primijenjen posebni imaging postupak za 2D isječke a zatim su metodom segmentacije dobiveni granični podaci.

Podaci za obujam prsnog mišića bili su: 63 cm^3, 198 cm^3, 589 cm^3, 724 cm^3 i 48 cm^3, 156 cm^3, 426 cm^3, 564 cm^3 kod AA odnosno foxy tipova u dobi od 2, 4, 7 i 9 tjedana. Područje površine sternuma (107 cm^2, 95 cm^2 odnosno 140 cm^2, 120 cm^2 kod AA i foxy tipova) je pokazalo intenzivniji razvoj koštanog tkiva kod AA pilića u dobi od 6 i 7 tjedana.

Podudaranje, obujma prsnog mišića s jedinicom površine sternuma prikazano je stvaranjem indeksnih vrijednosti podataka površine i obujma. Vrijednosti su bile: 0,43, 0,52 i 0,22, 0,26 kod AA odnosno foxy tipova u dobi od 2 i 9 tjedana.

Istraživana je in vivo morfologija prsnog mišića i sternuma pomoću 3D metode rekonstrukcije. Ovaj pristup omogućuje istraživanje ovih organa u izvornim uvjetima.

Ključne riječi: kompjutorska tomografija, prsni mišić, sternum