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*SHORT REPORT*

# The live ultrasound measurements to assess slaughter value of meat-type male kids

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**The application was evaluated of the ultrasound *in vivo* measurements in estimating the slaughter value of meat-type male kids. Ultrasound measurements were found to be useful in the estimation of weight of meat, fat and bone, as well as fat and bone content (%) of a half-carcass. The proposed multiple regression equations improve the accuracy of *in vivo* estimating the carcass tissue composition in male kids.**

**KEY WORDS: carcass / kids /regression equations / slaughter value / ultrasound**

The ultrasound technique is routinely used *in vivo* to assess slaughter value of pigs [Szabo *et al*. 1999, Kuhlers *et al*. 2001], cattle [Houghton *et al*. 1992, Perkins *et al*. 1992] and sheep [Edwards *et al*. 1989, Stanford *et al*. 1998]. Relatively little is known on the feasibility of this method to assess the carcass tissue composition in goats [Stanford *et al*. 1995, Delfa *et al*. 1996a]. In light of this, the aim of the presents study was to determine the suitability of *in vivo* ultrasound measurements for evaluation of slaughter value in meat-type male kids.

## Material and methods

The investigations were conducted at the Złotniki Experimental Station of the Department of Sheep and Goat Breeding, Agricultural University of Poznań, on 38 $F_1$ male kids out of White Improved females, by Boer bucks. Kids came from twin pregnancies and were born in the years 2000-2002. Weaning was performed at the age of about 60 days. Then, after a 10-day preliminary period the kids were fattened individually with all-mash diet offered *ad lib*. until the age of 100 ±5 days. In the preliminary period the CJ concentrate mix, rolled oats and hay were gradually replaced with pelleted all-mash. One kg of pelleted feed contained 127 g crude protein and 6.9 MJ net energy. Feed and water were easily available throughout the fattening period. Immediately before slaughter kids were weighed and the image of the *longissimus dorsi* muscle (LD) was ultrasonically monitored on the right side, perpendicularly to the spine, behind the last rib. The measurements were taken using a Pie Medical 100LC device with an 8.0 MHz linear probe. Ultrasound images were collected in the form of disc files (bit maps) and analysed using the MultiScan software package [Multiscan 2001]. In the images the thickness of the skin was measured together with subcutaneous fat, and separately fat depth over the LD, as well as LD depth, width and loin eye area.

Kids were slaughtered according to the procedure developed for lambs at the National Research Institute of Animal Production [Nawara *et al*. 1963]. Cold dressing percentage was determined after a 24-hour carcass cooling at 2-4°C. The tissue composition of carcass was determined on the basis of complete dissection into lean meat, fat and bone.

Simple and multiple correlations were estimated between the results of live ultrasound measurements and major traits defining the post-slaughter value of kids. In order to estimate carcass quality multiple regression equations were derived using the RSQUARE of the SAS software package [SAS/STAT 1989]. The independent variables included: slaughter body weight, backfat depth over the LD, skin thickness with fat over the LD, and the LD depth, LD width and LD cross-section area (loin eye). The coefficients of multiple correlation ($R$) and the mean error of prediction ($MEP$) were calculated for each equation.

## Results and discussion

Means for *in vivo* and post-slaughter traits in kids are presented in Table 1.

Simple correlation coefficients ($r$) between all *in vivo* ultrasound measurements and cold dressing percentage, valuable cuts content and lean meat content of carcass appeared low and were not found significant (Tab. 2). The other estimated correlation coefficients (from 0.40 to 0.88) were significant at $P \leq 0.05$ or $P \leq 0.01$, the highest being found between body weight at slaughter and weight of valuable cuts, weight of lean, fat and bones, and fat and bones content of half-carcass. High correlations were observed between both fat depth measurements and the LD cross-section area, as well as between the weight of valuable cuts and weight of lean meat of the half-carcass.

**Table 1**. Means (n=38) and their variation coefficient (V) for traits considered in fattened kids

| Trait | Mean | V% | Minimum | Maximum |
|---|---|---|---|---|
| *In vivo* | | | | |
| slaughter body weight (kg) | 24.85 | 10.53 | 20.50 | 29.60 |
| fat depth over LD (mm) | 0.89 | 41.61 | 0.42 | 1.45 |
| LD depth (mm) | 21.92 | 6.13 | 20.34 | 24.53 |
| LD width (mm) | 48.73 | 6.03 | 44.42 | 54.35 |
| LD cross-section area ($mm^2$) | 805.28 | 10.94 | 640.73 | 925.85 |
| Post-slaughter | | | | |
| cold dressing percentage | 46.92 | 2.35 | 45.35 | 48.45 |
| valuable cuts | | | | |
| kg | 2.041 | 9.72 | 1.670 | 2.390 |
| % | 34.61 | 4.37 | 32.62 | 36.68 |
| lean meat of half-carcass | | | | |
| kg | 3.578 | 10.66 | 2.86 | 4.11 |
| % | 62.24 | 3.53 | 59.77 | 65.21 |
| fat of half-carcass | | | | |
| kg | 0.747 | 27.46 | 0.538 | 1.147 |
| % | 13.15 | 17.78 | 10.87 | 16.74 |
| bones of half-carcass | | | | |
| kg | 1.404 | 10.01 | 1.263 | 1.646 |
| % | 24.61 | 9.27 | 21.72 | 28.70 |

**Table 2**. Linear correlations between body weight, *in vivo* LD measurements and slaughter performance traits in fattened kids

| Trait | SBW | FT | FTST | LDD | LDW | LDA |
|---|---|---|---|---|---|---|
| Cold dressing percentage | 0.169 | 0.326 | 0.343 | 0.113 | 0.317 | 0.390 |
| Valuable cuts | | | | | | |
| kg | 0.949** | 0.829** | 0.844** | 0.738** | 0.633** | 0.793** |
| % | -0.379 | -0.380 | -0.391 | -0.221 | -0.329 | -0.379 |
| Lean meat of half-carcass | | | | | | |
| kg | 0.971** | 0.811** | 0.835** | 0.639** | 0.680** | 0.752** |
| % | -0.240 | -0.368 | -0.372 | -0.189 | -0.161 | -0.153 |
| Fat of half-carcass | | | | | | |
| kg | 0.879** | 0.876** | 0.875** | 0.555* | 0.635** | 0.591* |
| % | 0.789** | 0.833** | 0.841** | 0.424* | 0.590* | 0.490* |
| Bones of half-carcass | | | | | | |
| kg | 0.653** | 0.511* | 0.548* | 0.638** | 0.401* | 0.665** |
| % | -0.809** | -0.762** | -0.769** | -0.387 | -0.548** | -0.499* |

SBW – slaughter body weight; FT – fat thickness at the last thoracic vertebra; FTST – fat and skin thickness at the last thoracic vertebra; LDD – LD depth at the last thoracic vertebra; LDW – LD width at the last thoracic vertebra; LDA – LD cross-section area at the last thoracic vertebra.
*P≤0.05; **P≤0.01.

**Table 3**. Coefficients of multiple correlation between body weight and ultrasound measurements and carcass quality traits in fattened kids

| L | *R* | MEP | SBW | FT | FTST | LDD | LDW | LDA |
|---|---|---|---|---|---|---|---|---|
| | | | Cold dressing percentage | | | | | |
| 2 | 0.521 | 1.57 | + | | | | + | |
| 3 | 0.545 | 1.73 | + | | | + | + | |
| 4 | 0.603 | 1.86 | + | + | | + | | + |
| 5 | 0.637 | 2.08 | + | + | + | + | | + |
| 6 | 0.643 | 2.44 | + | + | + | + | + | + |
| | | | Valuable cuts (kg) | | | | | |
| 2 | 0.966 | 0.08 | + | | | | | + |
| 3 | 0.971 | 0.09 | + | | | | + | + |
| 4 | 0.979 | 0.08 | + | + | + | | | + |
| 5 | 0.985 | 0.08 | + | + | + | | + | + |
| 6 | 0.987 | 0.09 | + | + | + | + | + | + |
| | | | Valuable cuts (%) | | | | | |
| 2 | 0.644 | 1.51 | + | | | | + | |
| 3 | 0.734 | 1.51 | + | | | | + | + |
| 4 | 0.812 | 1.46 | + | + | | | + | + |
| 5 | 0.833 | 1.60 | + | + | | + | + | + |
| 6 | 0.849 | 1.81 | + | + | + | + | + | + |
| | | | Lean meat in half-carcass (kg) | | | | | |
| 2 | 0.976 | 0.13 | + | | | | | + |
| 3 | 0.977 | 0.14 | + | | | | + | + |
| 4 | 0.980 | 0.15 | + | | + | | + | + |
| 5 | 0.981 | 0.17 | + | + | + | | + | + |
| 6 | 0.983 | 0.19 | + | + | + | + | + | + |
| | | | Lean meat of half-carcass (%) | | | | | |
| 2 | 0.408 | 2.27 | + | | + | | | |
| 3 | 0.426 | 2.49 | + | | + | | | + |
| 4 | 0.444 | 2.82 | + | | + | | + | + |
| 5 | 0.445 | 3.26 | + | | + | + | + | + |
| 6 | 0.448 | 3.84 | + | + | + | + | + | + |
| | | | Fat in half-carcass (kg) | | | | | |
| 2 | 0.912 | 0.13 | + | + | | | | |
| 3 | 0.917 | 0.14 | + | + | | | + | |
| 4 | 0.921 | 0.15 | + | + | | | + | + |
| 5 | 0.922 | 0.18 | + | + | + | | + | + |
| 6 | 0.923 | 0.21 | + | + | + | + | + | + |
| | | | Fat of half-carcass (%) | | | | | |
| 2 | 0.849 | 2.08 | + | | + | | | |
| 3 | 0.873 | 2.15 | + | | + | + | | |
| 4 | 0.889 | 2.29 | + | | + | | + | + |
| 5 | 0.889 | 2.64 | + | | + | + | + | + |
| 6 | 0.889 | 3.13 | + | + | + | + | + | + |
| | | | Bones in half-carcass (kg) | | | | | |
| 2 | 0.716 | 0.12 | + | | | | | + |
| 3 | 0.778 | 0.12 | + | | | | + | + |
| 4 | 0.783 | 0.13 | + | + | | | + | + |
| 5 | 0.792 | 0.15 | + | + | + | | + | + |
| 6 | 0.792 | 0.15 | + | + | + | + | + | + |
| | | | Bones of half-carcass (%) | | | | | |
| 2 | 0.815 | 1.81 | + | | | | | + |
| 3 | 0.897 | 1.54 | + | | | | + | + |
| 4 | 0.897 | 1.74 | + | | | + | + | + |
| 5 | 0.898 | 2.01 | + | + | | + | + | + |
| 6 | 0.898 | 2.37 | + | + | + | + | + | + |

L – number of variables; *R* – multiple correlation coefficient; MEP – mean error of prediction; SBW – slaughter body weight; FT – fat thickness at the last thoracic vertebra; FTST – fat and skin thickness at the last thoracic vertebra; LDD – LD depth at the last thoracic vertebra; LDW – LD width at the last thoracic vertebra; LDA – LD cross-section area at the last thoracic vertebra.

Similarly high correlations were found between both measurements of fat and bone content of half-carcass (from 0.75 to 0.88). Smaller, but still significant were correlations between the measurements of the LD area and fat and bone content of half-carcass. Gruszecki *et al*. [1999] in male kids of a dairy breed found much lower coefficients of correlation between the LD cross-section area and the weight of valuable cuts, weight of lean meat and fat, and the bone content of carcass.

Multiple correlation coefficients (*Rs*) estimated between the investigated carcass quality indicators and body weight and *in vivo* ultrasound measurements are shown in Table 3 where, however, only those are presented which appeared highest when 2 to 6 independent variables were considered. Multiple correlation coefficients, especially those considering valuable cuts and individual tissues content of carcass, were higher than simple correlation coefficients.

**Table 4**. Regression equations to estimate slaughter value indicators of meat-type male kids

| Equation | *R* | MEP |
|---|---|---|
| Cold dressing percentage (%)<br>$Y= 50.068 - 0.226x_1 + 2.417x_2 - 0.395x_4 + 0.011x_6$ | 0.603 | 1.87 |
| Valuable cuts (kg)<br>$Y = 0.424 + 0.062x_1 - 0.008x_5 + 0.0008x_6$ | 0.971 | 0.09 |
| Valuable cuts (%)<br>$Y = 53.851 - 0.599x_1 + 2.858x_2 - 0.317x_5 + 0.012x_6$ | 0.812 | 1.46 |
| Lean meat of half-carcass (kg)<br>$Y = - 0.081 + 0.125x_1 + 0.008x_5 + 0.0003x_6$ | 0.977 | 0.14 |
| Lean meat of half-carcass (%)<br>$Y = 61.618 + 0.215x_1 - 3.351x_3 + 0.094x_5 + 0.00001x_6$ | 0.444 | 2.82 |
| Fat of half-carcass (kg)<br>$Y = - 0.692 + 0.032x_1 + 0.273x_2 + 0.006x_5$ | 0.917 | 0.14 |
| Fat of half-carcass (%)<br>$Y = - 9.964 + 0.435x_1 + 3.387x_3 + 0.222x_5 - 0.013x_6$ | 0.873 | 2.15 |
| Bones of half-carcass (kg)<br>$Y = 1.118 + 0.017x_1 - 0.014x_5 + 0.00009x_6$ | 0.778 | 0.12 |
| Bones of half-carcass (%)<br>$Y = 48.404 - 0.655x_1 - 0.317x_5 + 0.013x_6$ | 0.897 | 1.54 |

$x_1$ – slaughter body weight; $x_2$ – fat thickness at the last thoracic vertebra; $x_3$ – fat and skin thickness at the last thoracic vertebra; $x_4$ – depth of LD at the last thoracic vertebra; $x_5$ – width of LD at the last thoracic vertebra; $x_6$ – area of LD at the last thoracic vertebra; *R* – multiple correlation coefficient; MEP – mean error of prediction.

Multiple regression equations were derived which may be suitable to estimate the slaughter value of meat-type male kids (Tab. 4). As a rule, higher accuracy was obtained in case of equations estimating fat or bone contents of carcass rather than those estimating the lean meat content. Similarly, equations used to estimate meat and fat weight turned out to be more accurate than those determining their content. However, the equation estimating the bone content of carcass appeared to be more accurate than that estimating the bone weight. Earlier studies by Stanford *et al*. [1995] and Delfa *et al*. [1996b] also indicated the possible improvement in accuracy of the estimation of the tissue composition in the goat carcasses on the basis of ultrasound measurements using multiple regression equations.

The regression equations presented here may be used for the *in vivo* assessment of the slaughter value of male meat-type kids. The results of such assessment may aid selection towards e.g. a decreased bone content of carcass.

**REFERENCES**


1. DELFA R., GONZALEZ C., TEIXEIRA A., VIJIL E., 1996a – Ultrasonic measurements in live goats. Prediction of weight of carcass joints. The 47th Annual Meeting of the EAAP, Book of Abstracts, PS5.13.
2. DELFA R., TEIXEIRA A., GONZALEZ C., VIJIL E., 1996b – Ultrasonic measurements for predicting carcass quality in live goats. The 47th Annual Meeting of the EAAP, Book of Abstracts, PS5.12.
3. EDWARDS J.W., CANNELL R.C., GARRETT P.R., SAVELL J.W., CROSS H.R., LONGNECKER M.T., 1989 – Using ultrasound, linear measurements and live fat thickness measurements to determine the carcass composition of market lambs. ***Journal of Animal Science*** 67, 3322-3330.
4. GRUSZECKI T., SZYMANOWSKA A., LIPECKA C., JUNKUSZEW A., 1999 – Wykorzystanie techniki ultrasonograficznej w ocenie wartości rzeźnej koźląt (The application of ultrasound method in the assessment of slaughter value of kids). In Polish, summary in English. ***Zeszyty Naukowe Przeglądu Hodowlanego*** 46, 71-76.
5. HOUGHTON P.L., TURLINGTON L.M., 1992 – Application of ultrasound for feeding and finishing animals: A reviev. ***Journal of Animal Science*** 70, 930-941.
6. KUHLERS D.L., NADARAJAH K., JUNGST S.B., ANDERSON B.L., 2001 – Genetic selection for real-time ultrasound loin eye area in a closed line of Landrace pigs. ***Livestock Production Science*** 72, 225-231.
7. MULTISCAN 2001 – MultiScan Base v. 12.07. Computer Scanning Systems Ltd. Warsaw.
8. NAWARA W., OSIKOWSKI M., KLUZ J., MODELSKA M., 1963 – Wycena tryków na podstawie badania wartości potomstwa w stacjach oceny tryków Instytutu Zootechniki za rok 1962 (Appraisal of rams on the basis of merit of offspring in progeny testing stations of the National Research Institute of Animal Production for the year 1962]. In Polish. Wydawnictwo własne Instytutu Zootechniki w Krakowie, 45–58 (in Polish).
9. PERKINS T.L., GREEN D.R., HAMLIN K.E., 1992 – Evaluation of ultrasonic estimates of carcass fat thickness and longissimus muscle area in beef cattle. ***Journal of Animal Science*** 70, 1002-1010.
10. SAS/STAT 1989 – User's Guide, version 6.12, 4$^{th}$ Edition, vol. 2, Cary, NC:SAS Institute Inc., 846.
11. STANFORD K., MC ALLISTER T.A., MAC DOUGALL M., BAILEY D.R.C., 1995 – Use of ultrasound for the prediction of carcass characteristics in Alpine goats. ***Small Ruminant Research*** 15, 195-201.

12. STANFORD K., JONES S.D.M., PRICE M.A., 1998 – Methods of predicting lamb carcass composition: A review. ***Small Ruminant Research*** 29, 241-254.
13. SZABO CS., BABINSZKY L., VERSTEGEN M.W.A., VANGEN O., JANSMAN A.J.M., KANIS E., 1999 – The application of digital imaging techniques in the in vivo estimation of the body composition of pigs: a review. ***Livestock Production Science*** 60, 1-11.

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## Zastosowanie przyżyciowych pomiarów ultrasonograficznych do szacowania wartości rzeźnej koźląt typu mięsnego

S t r e s z c z e n i e

Badano możliwość wykorzystania techniki USG do przyżyciowej oceny wartości rzeźnej koziołków $F_1$ (matki rasy białej uszlachetnionej × kozły rasy boer). W wyniku zbadania 38 koziołków mieszańcowych stwierdzono przydatność pomiarów USG do szacowania masy mięśni, tłuszczu i kości oraz udziału (%) tłuszczu i kości w masie tuszy. Użycie zaproponowanych równań regresji wielokrotnej zwiększa dokładność szacowania składu tkankowego tuszy koźląt.