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S. Schiavon, C. Ceolin, F. Tagliapietra, L. Bailoni & A. Piva

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S. Schiavon[1], C. Ceolin[2], F. Tagliapietra[1], L. Bailoni[1], A. Piva[3]

[1] Dipartimento di Scienze Animali. Università di Padova, Italy

[2] Istituto Zooprofilattico delle Venezie. Padova, Italy

[3] Dipartimento di Morfofisiologia Veterinaria e Produzioni Animali. Università di Bologna, Italy

Corresponding author: Stefano Schiavon. Dipartimento di Scienze Animali. Facoltà di Agraria, Università di Padova. Viale dell'Università 16, 35020 Legnaro (PD), Italy - Tel. +39 49 8272644 - Fax: +39 49 8272633 - Email: stefano.schiavon@unipd.it

ABSTRACT: The hypothesis that a single allometric relationship relating carcass lean protein (CLP) to whole body protein (WBP) can allow accurate estimates of CLP on pigs of different populations, sex and nutritional history, was tested. Three datasets of different origins were used. Data were representative of 548 pigs, castrated males and females, of 8 pig populations, serially slaughtered over ample empty body weight (EBW) ranges (from 22 to 217 kg). WBP and CLP ranged, respectively, from 2 to 28 and from 1 to 16 kg. The pooled data were run and the following relationship was found: $CLP=0.497*WBP^{1.021}$ (CV=0.062; rsd=0.501 kg). The residuals were subjected to ANOVA to test the effects due to dataset, pig population within dataset and sex; significant differences between datasets mean residuals (+0.095, SE=0.041; -0.258, SE=0.094; -0.116, SE=0.055 kg, P<0.001) were observed. No differences due to sex and pig populations were found. The average residuals were low and only in few cases they differed from zero. Conclusions: CLP can be accurately predicted from WBP; the coefficients of this function are mainly influenced by the procedures of slaughtering, dissection, sampling and analysis.

Key words: Growing pig, Whole-body protein, Carcass lean protein.

INTRODUCTION – Mechanistic pig growth models usually predict body composition, defined in terms of body chemicals contents. However, for the practice of pig production, it is not the chemical but the physical body composition (e.g. carcass and lean mass) that is of importance (Rook *et al.*, 1987; de Greef, 1995). Carcass lean protein (CLP) is usually fitted to nonlinear functions of empty body weight (EBW) (Wagner *et al.*, 1999), but the parameters of these functions are markedly affected by a number of factors (e.g., pig population, sex, nutritional history, range of EBW, slaughter procedures and so on), so that different equations for different situations are required. Susenbeth and Keitel (1988), analyzing data of different origins, concluded that the percentage of CLP related to whole body protein (WBP) was rather independent of the percentage of lean mass and from differences caused by breed effects. The hypothesis that a single allometric relationship ($CLP=a*WBP^b$) can allow accurate estimates of CLP on pigs of different populations, sex and nutritional history was investigated in this work.

MATERIAL AND METHODS – Three serial slaughter datasets, providing information about EBW, WBP and CLP over ample ranges of BW were used. Datasets represented different pig populations, sex and nutritional history. Details are given in the legend of Table 1. The data of the 3 datasets were pooled and the following log-linear models were used to evaluate the growth of CLP relative to EBW: $\hat{y}_1 = a*x_1^b$ and relative to WBP: $\hat{y}_2 = a*x_2^b$; where $\hat{y}_{(1 \text{ or } 2)}$ is CLP estimated from EBW (x_1) or from WBP (x_2), a is the value of $\hat{y}$ when x = 1, and b is relative growth coefficient. Each set of residuals ($\hat{y}_1 - y$) and ($\hat{y}_2 - y$) resulting from the two models were analysed with the model: $(\hat{y} - y)_{ijkl} = \mu + dataset_i + population(dataset)_{ij} + sex_k + e_{ijkl}$; where μ is the mean and e_{ijkl} is the residual. Contrasts were run to evaluate significant differences of the average residuals between the levels of each source of variation. To test differences across populations dataset was taken as line of error.

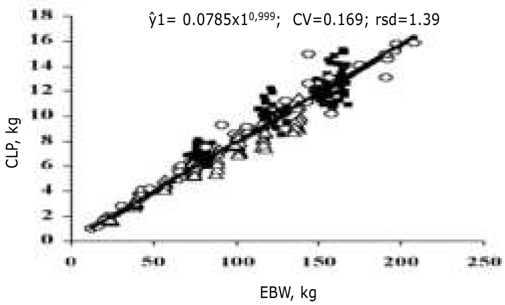
Table 1. Main characteristics of three 3 datasets used in this work.

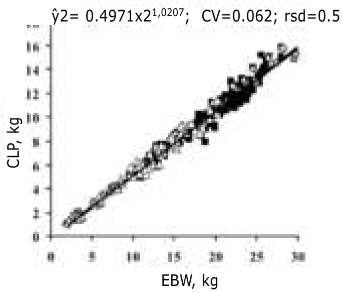
Dataset[1]	Obs.[2]	Pig population[3]	Feeding and feeds			BW[6] range	WBP[7] range	CLP[8] range
			Regime	ME[4]	CP[5]	kg	kg	kg
1	144	1,2	Restricted	11.8	13 or 11	75 to 176	11 to 28	5 to 15
2	28	3	*Ad libitum*	13.7	23	22 to 217	2 to 28	1 to 16
3	80	4,5,6,7,8	"	13,8	19 to 15	25 to 152	3 to 20	1 to 12

[1]Data: 1= Prandini et al., unpublished; 2= Tullis (1981); 3= Wagner et al. (1999). [2]Each observation of Tullis (1981) was a mean of 3 pigs and for Wagner et al. (1999) it was a mean of 4 pigs. [3] Pig population: 1=Duroc [D] x (Large White [LW] x Landrace [L]); 2=L x (LWxL); 3=LW x (LW x L); 4=synthetic hybrid; 5 and 6 commercial terminal crosses from two sources; 7=L x (LW x D); 8=Hampshire-Duroc [HD] x [L x (LW x D)]. Pig population 4, 5, 6, 7, and 8 were selected based on previously estimated differences in body composition (Wagner et al., 1999). Each data set was equally represented by castrated males and gilts. [4]Metabolizable energy, MJ/kg. [5]Dietary crude protein, % as fed. [6]BW = Body weight. [7]WBP = whole-body protein. [8]CLP= carcass lean protein.

RESULTS AND CONCLUSIONS – The pooled log-linear relationships relating CLP to EBW and to WBP are given in Figure 1a and 1b. As expected the first relationship showed very high residual standard deviation (rsd=1.39 kg) and coefficient of variation (CV =0.169 kg/kg). The rsd and the CV of the equation relating CLP to WBP were markedly lower with respect to those of the first relationship. In this case the values of rsd and CV were only 0.5 kg and 0.062 kg/kg, respectively.

Figure 1. Carcass lean protein (CLP, $\hat{y}_1$ or $\hat{y}_2$) related to: a) Empty body weight (EBW, x_1) or b) whole-body protein (WBP, x_2) using data from Prandini *et al.*, (unpublished), n; Tullis (1981), o; and Wagner *et al.* (1999), Δ.





The analysis of the residuals is given in Table 2. When CLP was related to EBW significant differences between datasets, pig population and sex were observed, high values of residuals and SE were observed. Almost in all situations the mean values of the residuals differed significantly from zero. When CLP was related to WBP the mean values of the residuals were very low and they did not differ from zero, with some exception. Significant differences due to the dataset were observed but no differences due to pig population and sex were detected. Across pig populations the mean residuals ranged from -0.291 to +0.104 kg, with respect to the corresponding observed mean CLP values, these values corresponded to systematic errors ranging from -4.7 to +1.82 %. In conclusion CLP and WBP are closely related and this relationship is well described by a log-linear function. The coefficients of this relationship seems to be weakly affected by the sex and the genetic origin of the pigs, at least for the pig populations considered in this work. Although energy intake can influence the partitioning of body protein between carcass and viscera (Bikker *et al.*, 1996; Weis *et al.* 2004), these results support the hypothesis that the main sources of variation of these coefficients are likely due to different procedures of slaughtering, dissection, sampling and analysis.

Table 2. Analysis of residuals: expected minus observed values ($\hat{y}_1$-y) and ($\hat{y}_2$-y) of carcass lean protein masses (kg), effects of dataset, pig population and sex.

	CLP	CLP related to EBW			CLP related to WBP		
	Observed mean (y)	Residuals ($\hat{y}_1$-y)	SE of residuals	P	Residuals ($\hat{y}_2$-y)	SE of residuals	P
Dataset:							
1	9.7	-0.241^B	0.078	**	$+0.095^A$	0.041	*
2	7.4	-0.041^B	0.177		-0.258^B	0.094	**
3	5.9	$+1.743^A$	0.104	**	-0.116^B	0.055	
Pig population:							
1	9.9	-0.498^C	0.111	**	+0.091	0.059	
2	9.5	$+0.017^B$	0.177		+0.098	0.059	
3	7.4	-0.041^B	0.234		-0.258	0.094	**
4	4.7	$+1.994^A$	0.234	**	-0.111	0.125	
5	6.2	$+1.516^A$	0.234	**	-0.291	0.125	*
6	5.9	$+1.700^A$	0.234	**	-0.212	0.125	
7	5.7	$+1.900^A$	0.234	**	+0.104	0.125	
8	6.0	$+1.600^A$	0.234	**	-0.069	0.125	
Sex:							
Castrated males	8.0	$+0.711^A$	0.094	**	-0.045	0.050	
Gilts	8.4	$+0.263^B$	0.094	**	-0.140	0.050	**

^{A,B}= P<0.01; * = P<0.05; ** = P<0.01; In the Table P indicates the probability that the mean residual estimated for each level of the various sources of variation differed from zero.

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REFERENCES – **Bikker,** P., Verstegen, M.W.A., Kemp, B.,. Bosch, M.W., 1996. Performance and body composition of finishing gilts (45 to 85 kg) as affected by energy intake and nutrition in earlier life: 1. Growth of the body and body components. J. Anim. Sci. 74:806–816. **de Greef,** K.H., 1995. Prediction of growth and carcass parameters. In: P.J. Moughan, M.W.A. Verstegen, M.I. Visser-Reyneveld (Eds) Modelling growth in the pig, EAAP Publication No.78, pp. 151-163. **Rook,** A.J., Ellis, M., Whittemore, C.T., Phillips, P., 1987. Relationships between whole body chemical composition, physically dissected carcass parts and backfat measurements in pigs. Anim. Prod. 44:263-273. **Susenbeth,** S., Keitel, K., 1988. Partition of whole body protein in different body fractions and some constants in body composition in pigs. Livest. Prod. Sci. 20:37-52. **Tullis,** J.B., 1981. Protein growth in pigs. PhD thesis. University of Edinburgh, Edinburgh, UK. **Wagner,** J.R., Schinckel, A.P., Chen, W., Forrest, J.C., Coe, B.L., 1999. Analysis of body composition changes of swine during growth and development. J. Anim. Sci. 77:1442-1466. **Weis**, R.N., Birkett, S.H., Morel, P.C.H., de Lange, C.F.M., 2004. Effects of energy intake and body weight on physical and chemical body composition in growing entire male pigs. J. Anim. Sci. 82:109–121.