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USE OF THE TOBEC METHOD FOR PREDICTING THE BODY COMPOSITION OF GROWING RABBITS

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ABSTRACT

An EM-SCAN SA-3152 type Small Animal Body Composition Analyser (TOBEC) was used to determine the total conductivity index (E value) of 92 Pannon White growing rabbits. The animals were slaughtered immediately after the measurements had been taken and their bodies were homogenised by grinding twice. In the case of 44 rabbits the content of the gastrointestinal tract was removed before homogenisation and with 48 rabbits it was left in the body. The fat content of the homogenates was subjected to chemical analysis using Soxhlet extraction after hydrochloric acid digestion. The weight of fat-free mass (FFM) was calculated as the difference between the live weight and the weight of fat determined. Using the linear regression model medium accuracy was obtained for predicting the FFM using E value as the only independent variable. Higher accuracy was achieved when the live weight was the only variable in the equation. Prediction of body fat weight and body fat percentage resulted in medium accuracy, using both the E value and live weight as independent variables in the equations. The R^2 values obtained were slightly better in most cases when the content of the gastrointestinal tract was left in the body after slaughter. It was concluded that the precise determination of body fat content in individual animals is not possible by this method, but the method could be useful for following the changes in the same group of animals during different experimental periods. The use of this method seems not to be necessary for predicting the weight of fat-free mass, because it can be predicted from the live weight with the same or higher accuracy.

Introduction

Nowadays different methods are available for determining the body composition at different developmental stages, but in the case of growing rabbits experimental slaughter is the one most frequently used. This technique is very reliable and accurate in the determination of the amount and ratio of body tissues, but it is an obstacle to genetic progress because of the necessity to slaughter the animals. To solve this problem and avoid the slaughter of genetically valuable animals different types of non-invasive methods have been developed (Fekete, 1992), which allow a fairly good estimation of body composition and also faster improvement in the quality of slaughter animals.

One of these methods is the so-termed TOBEC (Total Body Electrical Conductivity) method, which is based on the different electrical conductivity of fatty and non-fatty tissues and is thus suitable for the determination of fat-free mass or fat content on living animals. In previous experiments the use of this method gave close correlations (r=0.88-0.99) between the E value (electrical conductivity of the whole body measured by this method) and lean mass or the weight of total body water of small birds and mammals (Cunningham *et al.*, 1986; Fiorotto *et al.*, 1987; Fekete and Brown, 1993; Staudinger *et al.*, 1995), but only medium accuracy (r=0.59) in the prediction of total body fat percentage (Fekete *et al.*, 1995, Milisits *et al.*, 1999).

Based on these literature data, the aim of this study was to clarify the accuracy of predictions for fat-free body mass, body fat weight and body fat percentage and to develop prediction equations for the *in vivo* determination of the total body fat content of growing rabbits.

Material and methods

Animals and experimental procedure

The experiment was carried out with 92 growing Pannon White rabbits, weaned at the age of 6 weeks and housed in a closed building, in groups of 5 or 6 per cage (800x500mm). The animals were kept under artificial lighting conditions (16 hours per day) and at a room temperature of 15-20°C prior to the TOBEC measurement and slaughter procedure. For the *ad libitum* feeding of the young a commercial pelleted diet (DE 10.30 MJ/kg, crude protein 17.5%, crude fat 3.6%, crude fibre 12.4%) was used. Drinking water was available continuously from self-drinkers.

TOBEC measurements

The TOBEC measurements were carried out with an EM-SCAN SA-3152 type Small Animal Body Composition Analyser (EM-SCAN Inc., Springfield, Illinois, USA), which allows rapid, non-invasive measurement of the total conductivity index (E value) of small animals. This method is useful for detecting energy absorption in the presence of a radio-frequency electromagnetic field, which is created when a 10 MHz frequency is passed through a copper wire wound around a plexi-glass tube. In this system more energy is absorbed by conductive materials such as normally hydrated lean tissue than by resistant materials such as body fat (Funk, 1991). The net energy absorption detected by TOBEC is compared to the chemical determination of body composition as reference. With this method the fat-free body mass could be measured directly and the fat content calculated from it.

Because the length and also the mobility of the animals have a significant effect on the E values measured (EM-SCAN Model SA-3000 Operation Manual, 1996; Milisits *et al.*, 1999), the rabbits were fixed with belts to a standard length (400mm) in a lying position during the whole measuring procedure. In this study the E value of the rabbits was determined three times and the mean was used for the calculation of prediction equations. Intra-animal variability (CV) of the E value was lower than 2% for each animal.

Slaughter and analytical procedures

After the TOBEC measurements the rabbits were immediately slaughtered. The content of the gastrointestinal tract was removed in the case of 44 rabbits and left in the body of the other 48. For the chemical analysis of the body composition the empty or the whole bodies were cut into pieces and homogenized by grinding them twice. A 100g sample was taken from each of the homogenates and stored at -20°C until use. The crude fat content (CF) of the samples was measured with Soxhlet extraction after hydrochloric acid digestion. The fat-free body mass (FFM) was calculated as the difference between the live weight and the weight of fat determined by chemical analysis.

Statistical procedures

For the *in vivo* estimation of fat-free mass, body fat weight and body fat percentage prediction equations were created by linear regression using the SPSS statistics software package (SPSS 8.0 for Windows, 1997).

RESULTS AND DISCUSSION

The basic data for the experimental animals are presented in *Table 1*.

Table 1 Basic data for the growing rabbits

Traits	Rabbits with full (n=48) gastrointestinal tract		Rabbits with empty (n=44) gastrointestinal tract	
	Mean	S. E.	Mean	S. E.
Live weight (g)	2560	12	2566	13
E value	1636	20	1662	21
FFM (g)	2307	12	2111	10
Crude fat (g)	251	4.7	250	5.9
Crude fat (%)	9.8	0.18	10.6	0.22

As the first step of the evaluation the correlation between E value and fat-free mass was examined in the case of the rabbits with empty gastrointestinal tract. It was found that the E value in itself is not sufficient for the estimation of the fat-free body mass of growing rabbits, due to the medium (r=0.61) correlation obtained (*Eq. 1*):

Eq. 1. $\mathbf{FFM_{(g)i} = 1632 + 0.288 \times E_i}$ $\mathbf{(R^2=0.37,\ p<0.001)}$

($FFM_{(g)i}$ = the weight of fat-free mass of the i^{th} animal, E_i = the E value of the i^{th} animal)

The live weight as the only independent variable in the equation resulted in significantly higher accuracy in this case (*Eq. 2*):

Eq. 2. $\mathbf{FFM_{(g)i} = 565 + 0.602 \times BW_{(g)i}}$ $\mathbf{(R^2=0.61,\ p<0.001)}$

($FFM_{(g)i}$ = the weight of fat-free mass of the i^{th} animal, $BW_{(g)i}$ = the body weight of the i^{th} animal)

The inclusion of the E value in this equation did not improve the accuracy of prediction (*Eq. 3*):

Eq. 3. $\mathbf{FFM_{(g)i} = 625 + 0.551 \times BW_{(g)i} + 0.0443 \times E_i}$ $\mathbf{(R^2=0.61)}$
$\mathbf{(p<0.01)\quad (p<0.001)\quad (p=0.512)}$

Worse results were obtained in the case of body fat weight, where the first prediction resulted in zero accuracy using E value as the only independent variable (*Eq. 4*):

Eq. 4. $\mathbf{CF_{(g)i} = 255 - 0.0027 \times E_i}$ $\mathbf{(R^2=0.00,\ p=0.949)}$

The weight of the rabbits gave a slightly better result for prediction of the body fat weight (*Eq. 5*), but it proved not to be as good a predictor as the above for fat-free body weight:

Eq. 5. $\mathbf{CF_{(g)i} = -328 + 0.225 \times BW_{(g)i}}$ $\mathbf{(R^2=0.25,\ p=0.001)}$

The inclusion of the E value in this equation resulted in a significant increase in the accuracy of prediction (*Eq. 6*):

$$Eq.\ 6.\quad \mathbf{CF_{(g)i} = -615 + 0.475 \times BW_{(g)i} - 0.213 \times E_i} \quad (R^2=0.54)$$
$$(p<0.001)\quad (p<0.001)\quad (p<0.001)$$

In the case of body fat percentage the E value in itself gave a similarly bad result as above in the case of body fat weight (*Eq. 7*):

$$Eq.\ 7.\quad \mathbf{CF_{(\%)i} = 13.0 - 0.0015 \times E_i} \quad (R^2=0.02,\ p=0.364)$$

Combined with the body weight, it resulted in medium accuracy of prediction (*Eq. 8*):

$$Eq.\ 8.\quad \mathbf{CF_{(\%)i} = -15.5 + 0.0156 \times BW_{(g)i} - 0.0084 \times E_i} \quad (R^2=0.43)$$
$$(p<0.01)\quad (p<0.001)\quad (p<0.001)$$

In the case of rabbits with full gastrointestinal tract similar tendencies were observed, but mostly slightly better results were obtained (*Table 2*).

Table 2. Linear regression equations for predicting different body parts of growing rabbits with full gastrointestinal tract

Estimated traits	Constant	Regression coefficient of		R^2	Significance of the model
		body weight	E value		
FFM (g)	1476	-	0.507	0.70	<0.001
FFM (g)	-102	0.941	-	0.84	<0.001
FFM (g)	228	0.690	0.190	0.88	<0.001
Crude fat (g)	325	-	-0.0452	0.04	=0.193
Crude fat (g)	78	0.0677	-	0.03	=0.251
Crude fat (g)	-258	0.322	-0.193	0.29	<0.001
Crude fat (%)	15.6	-	-0.0036	0.15	<0.01
Crude fat (%)	0.0080	0.0086	-0.0075	0.28	<0.01

From these results it can be established that the accuracy of prediction for FFM is in agreement with the results of Scott *et al*. (1991) and Lyons and Haig (1995), who obtained very similar R^2 values (0.35-0.93) in the case of some species of birds.

The accuracy of prediction for body fat percentage is also very similar to the result of Fekete *et al*. (1995), who obtained nearly the same result with dwarf and normal rabbits.

In the case of body fat weight much more better result was obtained by Fortun-Lamothe *et al*. (1999), who obtained a very high accuracy (R^2=0.91) with lactating and weaned rabbit does.

CONCLUSIONS

As a conclusion from this work it can be established that the TOBEC method is useful for the determination of body fat content with only medium accuracy. This means that the precise determination of body fat content is not possible by this method, but the method could be useful for following the changes in the same group of animals during different experimental periods and with different treatments. The use of this method seems not to be necessary for predicting the weight of fat-free mass, because it can be predicted from the live weight with the same or higher accuracy.

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