PREDICTION OF RABBIT BODY FAT DEPOSITS FROM PERIRENAL FAT MEASUREMENTS OBTAINED WITH REAL-TIME ULTRASONOGRAPHY

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ABSTRACT

This study aimed to predict fat depots in rabbit does using perirenal fat measurements obtained with real-time ultrasonography (RTU). From RTU images, the depth and area measurements of perirenal fat were determined to have the kidney as an anatomical reference. Forty-two New Zealand × Californian rabbit does with a live weight of 4.5 ± 0.57 kg were studied. Body weight (BW), body condition score (BCS) and RTU measurements were determined in vivo, whereas the fat depots (scapular, perirenal, inguinal fat, carcass and body fat depots) were determined post mortem. For RTU measurements an Aloka 500V equipped with a linear probe of 7.5 MHz was used. The results show that the most significant correlations were observed between body fat and BW, BCS and RTU measurements (r between 0.517 to 0.923; P<0.01). It was also observed that all other fat depots, with the exception of inguinal fat, showed significant correlations with BW, BCS and RTU measurements (r between 0.472 to 0.867; P<0.01). In conclusion, the results of the present work indicate that the perirenal fat measurements obtained by RTU can be taken into account to predict fat depots of rabbits does.

Key words: rabbit does, body condition, fat depots, ultrasound.

INTRODUCTION

Rabbit production is characterized by an intense program of reproduction and as a result, the rabbit does are always either in gestation or lactation, which are very demanding processes in terms of energy (Cardinali *et al*., 2008; Garcia *et al*., 2019). As a result, a negative energy balance with substantial fluctuations in body fat reserves can be observed (Fortun-Lamothe, 2006; Garcia et al., 2019). On the other hand, it is well established that body fat reserves are related to reproductive and welfare aspects (Castellini *et al*., 2010). Over the years, various methodologies have been developed and applied to evaluate and monitor the body fat reserves of rabbit does: computed tomography (Romvari *et al*., 1996; Szendro *et al*., 2008), the nuclear magnetic resonance (Köver *et al*., 1998), measurement of body conductivity - TOBEC (Fortun-Lamothe *et al*., 2002) and real-time ultrasound (RTU). This last technique has been considered and demonstrated feasible to estimate body fat reserves from measurements at various anatomical points of the rabbits in several works (Pascual *et al*., 2000; Dal Bosco *et al*., 2003), particularly those related with the perirenal fat deposit. However, inaccuracy resulting from changes in the position of the perennial fat with the weight of animals (Pascual *et al*., 1999) and the fact that this deposit is scattered in a very variable form (Pascual *et al*., 2000), opens the possibility to new approaches.

As such, the present work aims to estimate the body fat reserves of rabbits does in different body condition using in vivo RTU measurements of perirenal fat having the kidney as an anatomical reference.

MATERIALS AND METHODS

Animals and housing

The trial was carried out at the Rabbit Research Unit of the Department of Animal Science of the Universidade de Trás-os-Montes and Alto Douro, at Vila Real, Portugal. The animals were handled according to animal welfare principles, according to Portuguese legislation (Portaria nº 1005/92, 214/08, 635/09). Forty-two New Zealand × Californian rabbit does with a live weight of 4.5 ± 0.57 kg have been studied. Females were housed in individual cages under a constant photoperiod of 16 h light and 8 h darkness and the environment with controlled ventilation throughout the experiment.

Body weight, body condition and RTU measurements

Live weight (LW) was determined in the morning using a digital scale (Precise 32000D, 32000 ± 0.01 g). The body condition score (BCS) was evaluated in the lumbar and rump regions following the methodology proposed by Cardinali *et al*. (2008). The perirenal fat measurements were obtained after analysis of images captured using an Aloka SSD 500V RTU apparatus equipped with a 7.5 MHz linear probe (UST-5512U-7.5). The images were captured with a video camera (Sony DCR-HC96E). To capture RTU images the fur between the 1st lumbar vertebra and the 7th lumbar vertebra was shaved. A gel was placed to ensure acoustic contact between the probe and the skin. The probe was placed on the right side of the animal in a position perpendicular to the dorsal midline and displaced to fit the kidney and the perennial fat. All session was continuously recorded with the video camera and the videos were analyzed, and the images that best presented the kidney and the surrounding fat were chosen. Using the selected images (Figure 1A), the perirenal fat depth (Figure 1B) and the perirenal fat area (Figure 1C) were obtained. All images were analyzed using Fiji software (ImageJ 1.49u, http://rsb.info.nih.gov/ij/).

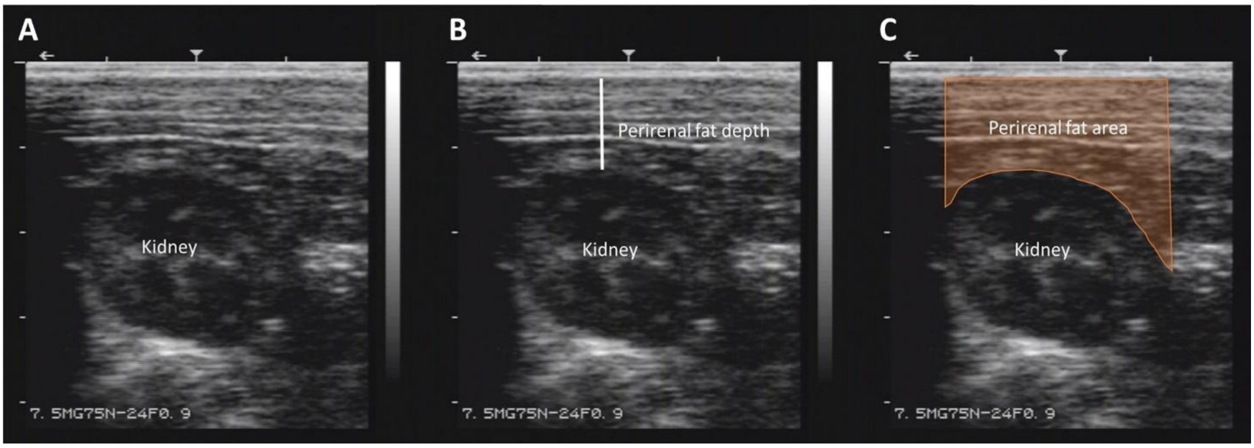

Figure 1 - Example of RTU image that presents the kidney and the surrounding fat (A); RTU image showing the perirenal fat depth (B) and RTU image showing the perirenal fat area (C).

After RTU image acquisition the animals were sacrificed and the carcasses were obtained. After 24 hours in refrigeration, the weight of the scapular, perirenal and inguinal fat depots were determined. The carcasses were dissected for determination of the subcutaneous fat and intermuscular fat depots, which is considered as the carcass fat. The body fat was determined as the sum of all the fat depots.

Statistical Analysis

A descriptive analysis of the data was performed. A correlation analysis between the LW, BCS and RTU measurements with fat depots was determined. All statistical analyzes were done with JMP-SAS (version 14, SAS Institute Inc. Cary, NC, USA).

RESULTS AND DISCUSSION

A descriptive analysis of the data is shown in Table 1. As expected, taking into account the BCS range, the fat depots show a considerable variation (43 to 102%). Inguinal fat is the depot that shows the larger variation (CV = 102%). This result is not relevant since this depot represents only 2.5% of the body fat. Similar variations were observed for RTU measurements (40%) and accounted for about half of that observed for the perirenal fat depot (40 vs 83%), whereas CV values for carcass fat (43%) and body fat (54%) show to be closer to those observed for RTU measurements.

Table 1. Mean, standard deviation, minimum and maximum for live weight, body condition, fat deposits and thickness of perirenal fat obtained by UTR.

Trait	Mean	Sd	Minimum	Maximum	CV (%)
BW (g)	4501	575	2857	5491	12.8
BCS loin+rump (1 to 5)	3.13	0.65	1.00	4.00	20.6
RTU measurements					
Perirenal fat depth (mm)	7.20	2.90	2.10	13.30	40.3
Perirenal fat area (cm2)	1.78	0.70	0.49	3.47	39.5
Fat depots (g)					
Scapular fat	31.4	23.0	3.7	126.8	73.1
Perirenal fat	129.9	107.9	7.6	493.2	83.0
Inguinal fat	9.20	9.38	0.20	49.2	102.0
Carcass fat	198.2	85.8	40.6	469.4	43.3
Body fat	368.8	197.9	66.6	873.3	53.7

The correlation analysis between in vivo measurements (BW, BCS and RTU) and the fat depots is presented in Table 2. The inguinal fat has shown to be poorly correlated (P> 0.05) with BW, BCS and RTU measurements. On the other hand, the most significant correlations were observed between body fat and BW, BCS and RTU measurements (r between 0.517 to 0.923; P<0.01).

Table 2. Correlation coefficients (r) between body weight (BW), body condition (BCS) and RTU measurements with fat depots (n=42).

	Scapular fat	Perirenal fat	Inguinal fat	Carcass fat	Body fat
BW	0.478	0.472	-0.091 ns	0.481	0.517
BCS loin+rump	0.525	0.675	0.053 ns	0.647	0.712
RTU measurements					
Perirenal fat depth	0.725	0.830	0.179 ns	0.841	0.910
Perirenal fat area	0.669	0.848	0.161 ns	0.867	0.923

ns- P > 0.05; Correlation values equal to or greater than 0.393 are significant - P <0.01.

Significant correlations values were also observed for scapular fat, perirenal fat and carcass fat depots (r between 0.472 to 0.867; P<0.01). These correlation coefficients were similar to those found by different reports. In fact, Pascual *et al*. (1999) found a correlation ranging from 0.79 to 0.95 for the prediction of perirenal fat and from 0.76 to 0.93 in the case of body fat. It should also be noted that the correlation values obtained between BW and the fat depots are systematically lower than those observed for BCS and RTU measurements. This result is also in line with what was observed by Pascual *et al*. (2000).

CONCLUSIONS

In conclusion, the results of the present work indicate that the perirenal fat measurements obtained by RTU and having the kidney as a reference, can be considered to predict fat depots of rabbits does and in particular body fat. In future work it would be interesting to validate the methodology of the present work with computed tomography technique. Finally, it is necessary to deepen this methodology mainly in the RTU images capture procedure, finding an alternative to the cutting the fur of the measuring zone, which represents an important drawback for a practical application.

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