ENERGY UTILIZATION AND PARTITION OF NULLIPAROUS RABBIT DOES IN THE LAST THIRD OF PREGNANCY

TOSCHI I.[1], **CESARI V.** [1], **RAPETTI L.** [1], **BAVA L.** [1], **GRILLI G.** [2], **CASTROVILLI C.** [1]

[1] Istituto di Zootecnia Generale. Facoltà di Agraria. Via Celoria, 2. 20133 Milano. Italy.
[2] Dipartimento di Patologia Animale, Igiene e Sanità Pubblica Veterinaria. Facoltà di Medicina Veterinaria. Via Celoria, 10. 20133 Milano. Italy.
ivan.toschi@unimi.it

ABSTRACT

Thirty-two nulliparous rabbit does were mated with artificial insemination to determine the energy metabolism at the beginning of the last third of pregnancy. The animals were divided into two groups each of them fed one of two pelleted diets with different energy concentration (EC1: 11.7 MJ DE/kg DM; EC2: 11.1 MJ DE/kg DM) offered at two levels of intake: restricted (R, 35 g*$LW^{0.75}$) or *ad libitum* (AL). Individual apparent digestibility and metabolizability were determined on 4 days-period with individual metabolic cages; heat production and energy retention were computed by indirect calorimetry on twenty-four rabbit does. The digestibility coefficient and metabolizability of the energy of diet EC1 were higher than those of diet EC2 (63.5 *vs.* 59.6 and 61.2 *vs.* 56.4; P<0.001) while no difference was registered between intake levels. Energy retention resulted lower in restricted animals (-31.4 *vs.* 79.3 kJ/$LW^{0.75}$; P<0.01) and not influenced by the energy concentration of the diet. In the body of rabbit does a significant loss of energy due to the mobilization of fat deposits was observed. Protein balance of the does (maternal plus conceptus tissues) was positively affected by AL intake; fat balances were almost always negative, especially in restricted animals. The relationship between RE and MEI was studied by a simple linear regression for each ingestion level; the ME requirement for maintenance was estimated to be 435 and 486 kJ/$LW^{0.75}$ for AL and R, respectively. The efficiency of utilization of ME for growth was 0.58 in animals fed *ad libitum* but much higher (1.03) for the does fed at the restricted level of intake as a consequence of their higher body fat mobilisation.

Key words: rabbit does, energy utilization, first pregnancy.

INTRODUCTION

The knowledge of energy utilization and body composition is essential for nutritionists to meet nutritional requirements and to support intensive breeding rhythms. Energy requirements and the efficiency of energy utilization for growth in rabbit does in different reproductive states have been investigated, but the results of these studies, reviewed by PARIGI BINI and XICCATO (1998), show very variable values that can be attributed both to the breeds and to the different methodology used (comparative slaughter, direct or indirect calorimetry). Recently, in nulliparous non-pregnant rabbit does using indirect calorimetry, TOSCHI *et al.* (2003) found a higher efficiency of metabolizable energy (ME) for growth and a higher value of ME for maintenance than the average values reported in literature (PARIGI BINI and XICCATO, 1998). In contrast to other animal species, FEKETE *et al.* (2003) have lately observed that the conceptus growth in rabbits is already considerable from the second half of the pregnancy.

The present study aimed to investigate the utilization and partition of energy in rabbit does at the beginning of the last third of first pregnancy using indirect calorimetry.

MATERIAL AND METHODS

Thirty-two hybrid nulliparous pregnant rabbit does (18 weeks of age) were allocated, at 20°C and 16 hours/day of light, to individual metabolic cages to separate faeces and urine. In the first week of pregnancy, the animals were divided into two groups which were fed one of two diets formulated to have different digestible energy (DE) concentration (EC1: 11.7 MJ DE/kg DM; EC2: 11.1 MJ DE/kg DM) and different composition (Table 1). Each diet was offered at two levels of intake (IL): restricted (R, 35 g*$LW^{0,75}$) or *ad libitum* (AL).

Table 1. Ingredients and chemical composition of the diets.

	EC1	EC2
Ingredients (%)		
Alfalfa meal	35.0	55.0
Maize meal	30.0	-
Soybean meal, 44% CP	18.0	11.0
Beet pulp	8.40	9.00
Wheat bran middlings	5.00	21.4
Minerals & vitamins	3.60	3.60
Chemical composition (% of DM)		
Crude protein	18.5	19.5
Ether extract	2.99	3.29
Ash	9.32	10.7
NDF	28.9	34.9
ADF	13.1	18.6
ADL	3.33	3.75
NFC[1]	40.3	31.6
Crude fibre	11.0	12.3

[1]Non fibrous carbohydrate = 100 – (ASH+CP+EE+NDF).

The DE and ME contents of the diets and the digestibility of the other nutrients were determined on 4 days-period from individual digestibility trials from the 20th to the 24th day of pregnancy; individual body weight was registered at the beginning and at the end of each period.

Chemical analysis of diets and faeces was performed following the recommendations of the Italian Scientific Association for Animal Production (ASPA, 1980). Neutral detergent fibre, acid detergent fibre, and acid detergent lignin were determined according to the sequential procedure of Van Soest *et al*. (1991).

Total heat production (HP) was determined by indirect calorimetry using the equation of Brouwer (1965):

$$HP\ (kJ) = 16.18*VO_2\ (l) + 5.02*VCO_2\ (l) - 5.99*N\ (g) - 2.17*VCH_4\ (l)$$

where N is urinary nitrogen excretion. Oxygen consumption (VO_2) and carbon dioxide production (VCO_2) were individually recorded by means of four respiratory chambers on twenty-four animals for three cycles of 24 hours during each period of digestibility; methane production (VCH_4) was not considered.

Energy retention (ER) was calculated from nitrogen and carbon balances using BROUWER'S (1965) formula:

$$ER\ (kJ) = 51.83\ (kJ/g)*C\ retained\ (g) – 19.38\ (kJ/g)*N\ retained\ (g).$$

Data were analysed by the General Lineal Model (GLM) procedure of SAS (2000) accounting for the fixed effects of the energy concentration, intake level and their interaction. A simple linear regression model was applied to determinate the ME for maintenance (ME_m) and the efficiency of utilization of the ME for growth (k_g).

RESULTS AND DISCUSSION

One animal for each group was eliminated from the data set for adaptation problems during digestible and respiratory periods. Therefore, for digestible and respiratory trials 28 and 20 animals were considered, respectively. Statistical analysis revealed no significant interaction between the energy concentration of the diets and the intake level; consequently, the discussion of the results concerns only the two main effects.

The data reported in Table 2 show a higher digestibility and metabolizability (P<0.001) of diet EC1 as compared to diet EC2; this can be explained by the higher content of non-fibrous carbohydrates and the lower level of NDF in diet EC1. The feeding level did not influence energy digestibility and metabolizability as reported by PARIGI BINI *et al.* (1992) in rabbit does concurrently pregnant and lactating; the effect of the intake level could have been masked by the not high dry matter intake of *ad libitum* fed animals. In fact, in nulliparous rabbit does, TOSCHI *et al*. (2003) found that high intake level decreased energy utilization significantly. Energy concentration of the experimental diets, in terms of DE and ME (MJ/kg DM), resulted to be higher in EC1 in comparison with those of EC2 (11.7 and 11.3 *vs.* 11.1 and 10.5 respectively, P<0.001).

Energy retention values (ER) of the animals fed *ad libitum* were statistically different from those of does restricted (P<0.01). Energy concentration of the diets did not affect the ER values significantly, due to the high variability of energy balance data, obtained with different levels of intake. During the trial, body of rabbit does showed a significant loss of energy due to mobilization of fat deposits (confirmed by the low values of respiratory quotient); the protein balance resulted positive since the transfer of protein from maternal body to the foetuses was not determined. Fat balances were almost always negative, especially in restricted animals (P<0.01); the deposition of protein was statistically different only for level of intake.

Table 2. Daily energy utilization and partition (R=restricted; AL=*ad libitum*).

		EC1		EC2			Prob.	
		R	AL	R	AL	SE	EC	IL
Live Weight $^{0.75}$		2.59	2.62	2.61	2.62	0.03		
[1] Dry Matter Intake	(g)	110	130	110	138	9.19		**
[1] Energy Intake	($kJ/LW^{0.75}$)	783	915	784	984	62.5		**
[1] Faecal Energy	($kJ/LW^{0.75}$)	284	336	317	399	25.5	*	**
	(%IE)	36.2	36.8	40.4	40.5	0.63	***	
[1] Digestible Energy	($kJ/LW^{0.75}$)	499	579	467	584	38.4		*
	(%IE)	63.8	63.2	59.6	59.5	0.63	***	
[1] Urinary Energy	($kJ/LW^{0.75}$)	18.4	19.5	27.4	27.2	3.25	*	
	(%IE)	2.35	2.22	3.51	2.77	0.39	*	
[1] Metabolizable Energy	($kJ/LW^{0.75}$)	481	559	440	557	37.7		*
	(%IE)	61.4	61.0	56.1	56.8	0.78	***	
[2] Heat Production	($kJ/LW^{0.75}$)	482	499	491	490	25.9		
	(%IE)	62.9	52.8	64.9	51.3	4.50		*
	(%ME)	103	85.9	115	88.2	7.74		**
[2] Respiratory Quotient †		0.94	0.96	0.88	0.94	0.03		
[2] Retained Energy	($kJ/LW^{0.75}$)	-8.73	95.2	-54.1	64.9	35.9		**
	(%IE)	-1.73	8.66	-8.29	6.76	4.57		**
	(%ME)	-0.03	0.14	-0.15	0.12	0.08		**
[2] Fat Balance	($g/LW^{0.75}$)	-1.92	0.22	-2.76	-0.78	0.75		**
	($kJ/LW^{0.75}$)	-76.5	8.92	-110	-31.2	29.8		**
[2] Protein Balance	($g/LW^{0.75}$)	2.36	3.54	1.88	3.23	0.54		*
	($kJ/LW^{0.75}$)	56.1	84.2	44.8	77.0	13.0		*

***: P<0.001; **: P<0.01; *:P<0.05.
[1]: values determined on 28 animals; [2]: values determined on 20 animals.
†: Carbon dioxide production / Oxygen consumption.

The restricted intake level has determined almost always negative energy balance; consequently, the relationship between RE and ME intake was studied with a simple linear regression for each level of ingestion (Figure 1). The value of metabolizable energy for maintenance (ME_m) in pregnant rabbit doe includes a components which relates to the weight of the foetuses and hypertrophied uterus and assumes values higher than that determined in non-pregnant rabbit doe. Assuming RE=0, ME_m resulted to be 435 and 486 $kJ/LW^{0.75}$ in animals fed *ad libitum* and restricted, respectively. The first value is similar to those obtained in pregnant rabbit does with the comparative slaughter technique by FRAGA *et al.* (1989) and XICCATO (1996) (429 and 409 $kJ/LW^{0.75}$, respectively) and higher than that determined by ERIKSSON (1952) in non-pregnant rabbit does using indirect calorimetry (385 $kJ/LW^{0.75}$). With the same technique, TOSCHI *et al.* (2003) found in non-pregnant rabbit does a greater value (417 $kJ/LW^{0.75}$) of ME_m. The high value obtained in animals restricted is probably related to a high physical activity observed, as suggested by the high HP determined.

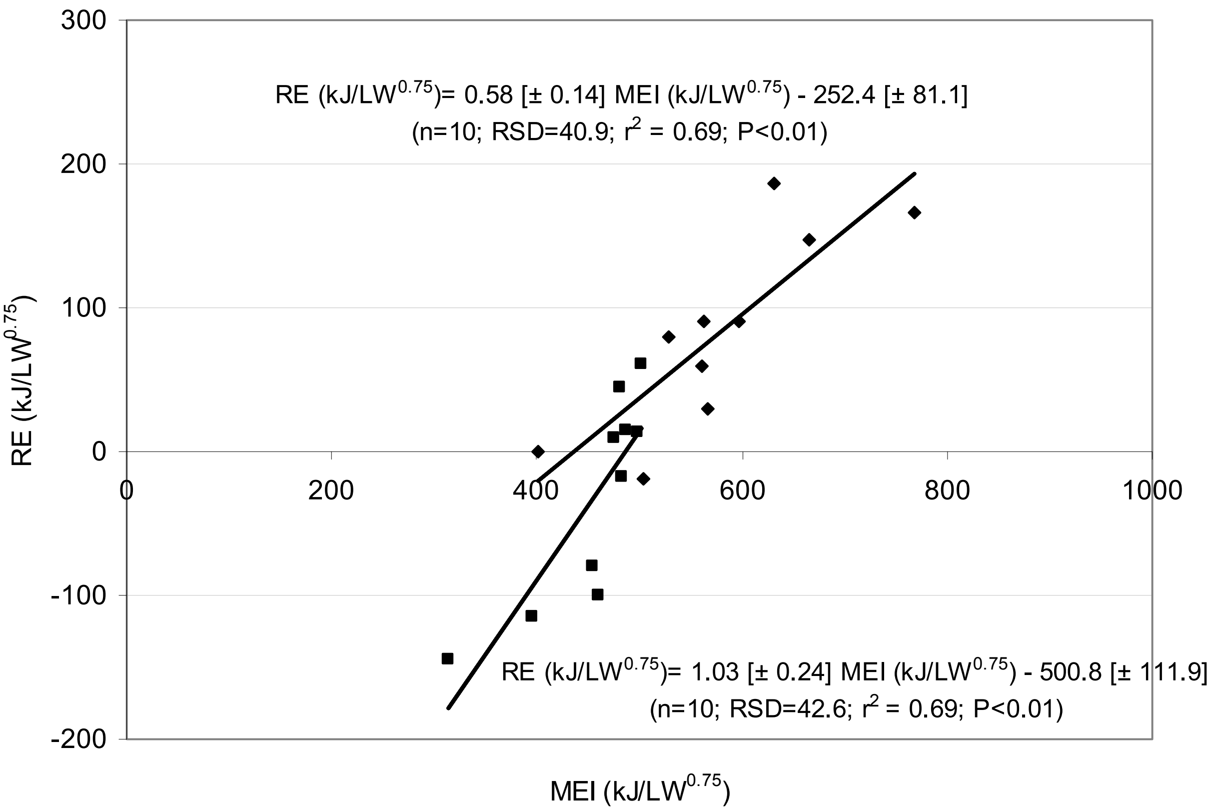

Figure 1. Relationship between the metabolizable energy intake and the retained energy.

In this trial, also the efficiency of metabolizable energy for growth (k_g) has to be interpreted since it represents both the rate of energy gain by conceptuses and by the maternal body. The k_g determined (0.58) is higher than the value (0.49) reported by PARIGI BINI *et al.* (1991) for maternal tissue accretion; however, Partridge *et al.* (1986), in pregnant and non-pregnant rabbit does by direct calorimetry, and TOSCHI *et al.* (2003) by indirect calorimetry in nulliparous non-pregnant rabbit does found a high efficiency of metabolizable energy for growth (0.67 and 0.77, respectively). The k_g value resulted to be 1.03 for the does fed at restricted levels of intake as a consequence of their considerably high body fat mobilisation.

CONCLUSIONS

The data obtained in our work confirmed the value of ME_m determined in previous research with different methodologies. As expected, energy requirement for maintenance during pregnancy results to be higher than that indicated for non-pregnant rabbit does.

To explain the different values of energy utilization efficiency for growth obtained with different methodology, further studies should investigate the relationship between the diet and energy utilization in the rabbit.

Ad libitum level of ingestion and high energy concentration of the diet can moderately reduce the occurrence of the tissue mobilization and body energy losses.

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