NET ENERGY, PROTEIN AND MACROMINERALS REQUIREMENTS FOR 70 TO 120 DAY OLD FEMALE RABBITS[1]

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Abstract - In order to determine the net energy, protein and macrominerals requirements of 70 to 120 day old, 52 female White New Zealand rabbits, weighing 1900g ± 40g were used. At the beginning of the experimental period, 14 of the 52 young does were slaughtered and the 38 remaining animals were kept under two dietary management: "ad libitum" and restricted feeding. Slaughters were performed to determine each nutrient body content. The weight gain nutrient requirements depicted by the quantities of each nutrient stored into the body were obtained by applying the regression equation, which estimate the empty body nutrient content logarithm as a function of the empty body weight logarithm, as described by ARC (1980). By determining the heat production logarithm at the zero level of metabolizable energy intake, the maintenance net energy requirement was estimated to be 45.31 Kcal/day/$Kg^{0.75}$. The mean net energy, protein, calcium, phosphorous, sodium, magnesium and potassium requirements for each gram of weight gain per day were estimated to be, 2.51 Kcal, 0.21g, 0.02g, 0.005g, 0.001g, 0.0004g and 0.002g , respectively.

INTRODUCTION

When compared to the other animal species, the scientific literature related to nutritional requirements of rabbits is very poor. Very often, data available on nutritional requirement are obtained by experiments carried out in temperate countries, so the determination of the nutritional requirements of rabbits reared under tropical conditions is missing, but still essential to reach the best productive and reproductive performance of the animals at our conditions.

The methods for estimating the nutritional requirements of rabbits are usually full of failures, and usually, the resulting data correspond to approaches obtained by performance studies of animals under different levels of one specific nutrient in the diet, to establish the most appropriate utilization level. Recently, more efficient methods have been used to estimate nutrient requirements, which take in account the body nutrient content to formulate predicting nutrient requirement equations.

Considering the lack of information on this subject in our country, this experiment was designed and conducted with the aim of estimating the net energy, protein and macrominerals requirements of 70 to 120 day old female rabbits.

MATERIAL AND METHODS

Fifty two 70 day old White New Zealand does were individually housed in metallic cages and fed on a commercial pelleted ration, with 13 % CP, 18 % CF, 2200 Kcal/Kg EM and 3.7 % EE. They had free access to tap water by automatic drinkers. The experiment was carried out for 50 days. In order to obtain the initial body composition data, 14 of the 52 rabbits were sacrificed when they were 70 days old (reference animals), weighing 1900 g ± 40 g. The other 38 animals were divided into 2 groups, differing on dietary management. The first group, (24 animals) was fed "ad libitum". The second group, (14 young does) received a restrict amount of food, corresponding to 30% of the voluntary mean intake of the "ad libitum" group, estimated by previous daily feed intake control of those animals. The amount of feed offered to the restrict group was enough to reach the daily maintenance metabolizable energy requirement plus 20%. In order to determine the body composition of the animals, from the beginning to the end of the experimental period, the young does of the "ad libitum" group were weekly weighted. As soon as they reached the prestablished slaughter weights (2400, 2800, 3200 g), 6 animals were sacrificed to each weight respectively, and the last 6 rabbits of this group and the 14 belonging to the restricted group, were slaughtered at 120 days old. The slaughter was performed by jugular cut, preceded by stunning. To obtain the empty body weight of each animal, the whole blood was collected into identified plastic bags, into which the distal portions of the anterior and posterior limbs, the head, the fur

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including the distal portion of the tail, the reproductive and digestive tract (free from the content by washing) were placed, too.
The empty bodies were individually ground in a knife mill prototype. Afterwards, the samples were dried for 72 hours at 65°C and ground in a ball mill prototype for laboratorial analysis of crude protein, gross energy, fat, calcium, phosphorous, potassium, sodium and magnesium content. All laboratorial procedures were performed following the methodology described by SILVA (1981).
To determine the maintenance and weight gain net energy requirements, the method suggested by LOFGREEN & GARRET (1968) was adopted. By this procedure, the net energy requirement for maintenance corresponds to the fasting heat production and it is obtained by estimation at the zero level of metabolizable energy intake.
The net energy, protein, and macro-minerals requirements for weight gain, depicted by the quantities of each nutrient stored into the body for an specific weight gain, were obtained by the application of a regression equation of the logarithm of the body nutrient content in the empty body as a function of the body empty weight logarithm, ARC (1980).
The protein requirement for maintenance was not experimentally determined in this experiment, so it was considered to be 0,21g of nitrogen/$Kg^{0.75}$, as suggested by BRUN *et al.* (1987) and quoted by RESENDE (1989).

Formulas used to estimate the nutritional requirements:

$$\textbf{Mean Metabolic Net Weight} = ((iNW - fNW) / 2)^{0.75}$$

(g)

iNW = initial Net Weight
fNW = final Net Weight

$$\textbf{Retained Energy / day / Metabolic Net Weight} = (fNWE - iNWE) / (days * MMNW)$$

(Kcal / day /$Kg^{0.75}$)

fNWE = final Net Weight Energy
iNWE = initial Net Weight Energy
MMNW = Mean Metabolic Net Weight

$$\textbf{Metabolizable Energy Intake / day / } Kg^{0.75} = MEI / (days * MMNW)$$

(Kcal / day / $Kg^{0.75}$)

MEI = Metabolizable Energy Intake
MMNW = Mean Metabolic Net Weight

$$\textbf{Heat Production / day / } Kg^{0.75} = MEI / day / MMNW - RE / day / MMNW$$

(Kcal / day / $Kg^{0.75}$)

RE = Retained Energy

The statistical analysis was conducted using the Genetics and Statistics Analysis System - SAEG, EUCLYDES (1982).

RESULTS

Table 1 : Weight and empty body composition means of the experimental groups

	Reference animals	"ad libitum" Group				Restricted Group
		2400 (g)	2800 (g)	3200 (g)	final	
Live Weight (g)	1992	2403	2802	3195	2988	1887
Empty body Weight (g)	1743	2127	2448	2867	2658	1610
Dry Matter (%)	30.72	32.49	34.07	37.25	34.88	28.27
Protein (% DM)	61.21	58.48	57.56	57.83	57.82	78.28
Fat (% DM)	29.31	32.52	33.36	39.21	33.49	11.73
Energy (Mcal DM)	5.84	6.03	5.64	6.07	5.95	5.12
Calcium (% DM)	4.74	4.47	4.75	4.42	4.22	5.28
Phosphorous (% DM)	1.64	1.58	1.55	1.36	1.42	1.77
Magnesium (% DM)	0.11	0.10	0.10	0.09	0.10	0.12
Sodium (% DM)	0.50	0.45	0.44	0.41	0.43	0.51
Potassium (% DM)	0.76	0.70	0.72	0.61	0.66	0.84

Table 2 : Regression equations for estimating the empty body weight (g) (EBW), as a function of the live weight (g) (LW), and for empty body nutrient contents (g) of the animals fed "ad libitum"

EMPTY BODY WEIGHT	EBW = - 88.48 + 0.9183 LW	99.29
PROTEIN	Log Pt = - 1.2997 + 1.1765 Log EBW	90.40
FAT	Log G = - 3.6909 + 1.8145 Log EBW	88.33
ENERGY	Log E = - 0.9336 + 1.3659 Log EBW	88.59
CALCIUM	Log Ca = - 2.4498 + 1.1882 Log EBW	92.46
PHOSPHOROUS	Log P = - 2.3266 + 1.0094 Log EBW	87.75
SODIUM	Log Na = - 2.8025 + 0.9921 Log EBW	83.24
MAGNESIUM	Log Mg = - 3.7291 + 1.0799 Log EBW	81.69
POTASSIUM	Log K = - 2.6236 + 1.0094 Log EBW	84.22

To estimate the maintenance net energy requirement of young female rabbits weighing from 2000 to 3500 g, the following regression equation was used.

Log Heat Production = 1.6562 + 0.00275 Log Metabolizable Energy Intake
$R^2 = 94.00\ \%$

This equation, which determine the heat production logarithm as a function of the metabolizable energy intake logarithm, estimates the net maintenance energy requirement, which corresponds to the heat production at the zero level of metabolizable energy intake, was estimated to be 45.31 Kcal/day/$Kg^{0.75}$. To determine the animals net energy requirement for each live weight range, the empty body weight was estimated by the regression equation presented in Table 2. The data obtained were converted into Kg of metabolic body weight. When multiplied by the net energy requirement at the zero level of metabolizable energy intake (45,31 Kcal), it gives us the data presented at Table 3. To calculate the maintenance net energy requirement as a function of the empty body weight, we just need to convert the empty body weight into metabolic weight, and then, multiply the last one for 45.31.

Table 3 : Estimates of net energy requirements for maintenance as a function of the empty body weight and live weight of young female rabbits weighing from 2000 to 3500 g (kcal/animal/day)

	Live weight (g)			
	2000	2500	3000	3500
Empty body weight	76.18	90.06	103.26	15.92
Live weight	68.87	82.03	94.52	106.49

The protein and macrominerals requirements estimates for weight gain were performed using the equations presented in Table 2. For this, each prestablished live weight added as well as subtracted of 50 g, resulted in two live weight values, corresponding to 100g of live weight gain (i.e.: for 2000 g of live weight, 1950g as well as 2050g were used). By using the first equation presented in Table 2, each fictitious live weight was then converted into the respective empty body weight. The resulting values, applied to the appropriate equation of the Table 2, will determine the logarithm of each nutrient as a function of the empty body weight logarithm. By subtracting, the amount of an specific nutrient stored into the empty body (g), for each 100g of live weight gain is obtained. This procedure make possible to estimate the nutrient requirements for live weight gain to any live weight range, as presented at Tables 4, 5, 6, 7, 8, 9 and 10.

Table 4 : Net energy requirements estimates for maintenance and live weight gain of young female rabbits weighing from 2000 to 3500 g (Kcal/animal/day)

Live weight (g)	Maintenance	Daily live weight gain (g)			
		20	30	40	50
2000	68.87	44.89	67.33	89.78	112.22
2500	82.03	48.94	73.41	97.88	122.35
3000	94.52	52.39	78.58	104.78	130.97
3500	106.49	55.53	83.29	111.05	138.81

Table 5 : Net protein requirements estimates for maintenance and live weight gain of young female rabbits weighing from 2000 to 3500 g (g/animal/day)

Live weight (g)	Maintenance	Daily live weight gain (g)			
		20	30	40	50
2000	2.20	4.05	6.07	8.09	10.11
2500	2.61	4.22	6.33	8.44	10.55
3000	2.99	4.36	6.54	8.72	10.90
3500	3.36	4.48	6.73	8.97	11.21

Table 6 : Net calcium requirements estimates for maintenance and live weight gain of young female rabbits weighing from 2000 to 3500 g (g/animal/day)

Live weight (g)	Maintenance	Daily live weight gain (g)			
		20	30	40	50
2000	0.002	0.314	0.471	0.628	0.785
2500	0.003	0.330	0.495	0.660	0.825
3000	0.003	0.342	0.513	0.684	0.855
3500	0.005	0.352	0.528	0.704	0.880

Table 7 : Net phosphorus requirements estimates for maintenance and live weight gain of young female rabbits weighing from 2000 to 3500 g (g/animal/day)

Live weight (g)	Maintenance	Daily live weight gain (g)			
		20	30	40	50
2000	0.0282	0.094	0.141	0.188	0.235
2500	0.0334	0.094	0.141	0.188	0.235
3000	0.0383	0.094	0.141	0.188	0.235
3500	0.0430	0.094	0.141	0.188	0.235

Table 8 : Net sodium requirements estimates for maintenance and live weight gain of young female rabbits weighing from 2000 to 3500 g (g/animal/day)

Live weight (g)	Maintenance	Daily live weight gain (g)			
		20	30	40	50
2000	0.176	0.028	0.042	0.056	0.070
2500	0.209	0.028	0.042	0.056	0.070
3000	0.239	0.028	0.042	0.056	0.070
3500	0.269	0.028	0.042	0.056	0.070

Table 9 : Net magnesium requirements estimates for maintenance and live weight gain of young female rabbits weighing from 2000 to 3500 g (g/animal/day)

Live weight (g)	Maintenance	Daily live weight gain (g)			
		20	30	40	50
2000	0.024	0.008	0.012	0.016	0.020
2500	0.029	0.008	0.012	0.016	0.020
3000	0.033	0.006	0.009	0.012	0.015
3500	0.037	0.008	0.012	0.016	0.020

Table 10 : Net potassium requirements estimates for maintenance and live weight gain of young female rabbits weighing from 2000 to 3500 g (g/animal/day)

Live weight (g)	Maintenance	Daily live weight gain (g)			
		20	30	40	50
2000	0.479	0.042	0.063	0.084	0.105
2500	0.567	0.042	0.063	0.084	0.105
3000	0.650	0.042	0.063	0.084	0.105
3500	0.730	0.042	0.063	0.084	0.105

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Exigencias netas en energía, proteína y macrominerales de conejas con 70 hasta 120 días de edad - Para estimar los requerimientos netos de energía, proteína y macro-minerales, 52 conejas de la raza New Zealand White, con pesos de 1900 g ± 40g y edad de 70 hasta 120 días fueron matenidas bajo 2 sistemas alimentares: pienso *ad libitum* y restricto. Durante la investigación, las conejas fueron sacrificadas en los momentos adecuados (a los 70 días de edad, 2400g, 2800g, 3200g de peso vivo, así como, a los 120 días de edad) para permitir la determinación de la cantidad de cada nutriente investigado en el cuerpo del animal. Los requerimientos en nutrientes para ganancia en peso referentes a las cantidades de cada nutriente depositadas en el cuerpo del animal fueron obtenidos por medio de ecuaciones de regresión, las cuales estimaron el logarítmo de la concentración de nutriente en el cuerpo vazio en función del logarítmo del peso del cuerpo vazio, de acuerdo con ARC (1980). Por la determinación del logarítmo de la produción de calor a nivel zero de ingestión de energía metabolizable, el requerimiento neto en energía para mantención fue estimada en 45,31 Kcal/dia/$Kg^{0,75}$. Los requerimientos netos medios para los nutrientes investigados fueron: 2,51 Kcal de energía, 0,21g de proteína, 0,02g de cálcio, 0,005g de fósforo, 0,001g de sódio, 0,0004g de magnésio y 0,002g de potásio para cada g de peso vivo obtenido por día.