Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v35i4.19101

Effect of nutritional density and season on the performance of young rabbit does before the first mating

Paulo Sérgio dos Santos Teixeira[1], Francisco Stefano Wechsler[2] and Ana Silvia Alves Meira Tavares Moura[2*]

*[1]Biotério Central, Universidade Estadual Paulista 'Júlio de Mesquita Filho', Botucatu, São Paulo, Brazil. [2]Departamento de Produção Animal, Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista 'Júlio de Mesquita Filho', Distrito de Rubião Júnior, s/n, 18618-970, Botucatu, São Paulo, Brazil. *Author for correspondence. E-mail: anamoura@fmvz.unesp.br*

ABSTRACT. The objective was to evaluate the effect of nutritional density and season on the performance of young rabbit does before the first mating. Forty-eight females from the Botucatu Genetic Group were used in each season (warm or cool), starting at the age of 70 days, housed in groups of four per cage up to 119 days, and reared individually from 120 to 140 days of age. The high-density diet was formulated to contain, on a 90% DM basis, 18.4% CP, 16.5% ADF and 2,500 kcal DE kg^{-1}; whereas the low-density diet was formulated to contain 14.7% CP, 24% ADF and 2,000 kcal DE kg^{-1}. The experiment was conducted according to a 2x2 factorial design (two diets x two seasons) with repeated measures (weeks). The high-density diet promoted lower feed intake, higher final weight, and higher daily weight gain, adjusted for constant intake. But these facts alone do not warrant using a high-density diet for growing rabbit does, because it could have a negative impact during the reproductive phase. In the warm season, there was a reduction in feed intake and an improvement in feed efficiency. Along time, however, the mean body weight of does was similar in the two seasons.

Keywords: acid detergent fiber, feed efficiency, feed intake, growth, live weight, nutrition.

Efeito da densidade nutricional e da estação sobre o desempenho de coelhas jovens antes do primeiro acasalamento

RESUMO. O objetivo foi avaliar o efeito da densidade nutricional e da estação sobre o desempenho de coelhas jovens antes do primeiro acasalamento. Foram usadas 48 coelhas do Grupo Genético Botucatu em cada estação (quente ou fresca) que iniciaram aos 70 dias de idade, alojadas em grupos de quatro por gaiola até os 119 dias e individualmente dos 120 aos 140 dias. A dieta de alta densidade foi formulada para conter, com base em 90% de MS, 18,4% PB, 16,5% FDA e 2.500 kcal ED kg^{-1}; enquanto a dieta de baixa densidade foi formulada para conter 14,7% PB, 24% FDA e 2.000 kcal ED kg^{-1}. O experimento seguiu um fatorial 2x2 (duas dietas x duas estações), com medidas repetidas (semanas). A dieta de alta densidade promoveu menor consumo, peso mais elevado e também maior ganho de peso ajustado para consumo constante. Mas estes fatos, isoladamente, não avalizam o uso de uma dieta de alta densidade para coelhas jovens, porque ela pode apresentar impacto negativo durante a fase reprodutiva. Na estação quente, houve redução do consumo de alimento e melhora da eficiência alimentar. Ao longo do tempo, no entanto, o peso médio das coelhas foi semelhante nas duas estações.

Palavras-chave: fibra em detergente ácido, eficiência alimentar, consumo de alimento, crescimento, peso vivo, nutrição.

Introduction

The fiber level required by growing and lactating rabbit does is relatively high, around 34 and 32% neutral detergent fiber (NDF), respectively, on a dry matter content 900 g kg^{-1} (DE BLAS; MATEOS, 2010). Dietary fiber is needed by rabbits to maintain a high rate of passage and avoid digesta retention in the caecum. Otherwise, feed intake would be reduced and growth would be impaired. Fiber also provides an energy-rich substrate for the intestinal microbiota, which supplies the rabbit with additional energy coming from volatile fatty acids and with high-quality microbial protein recycled through caecotrophy (GIDENNE et al., 2010). Fiber type is also important, since the chemical composition and physical structure of plant cell walls vary a great deal among fiber sources (GIDENNE, 2003; NICODEMUS et al., 2006).

Primiparous does are prone to an intense energy deficit during lactation, because their voluntary feed intake cannot meet the energy requirements due to simultaneous lactation and gestation. This relationship between energy intake and deficit has been demonstrated during the lactation and gestation of does kindling for the first, and especially the second time. A high intake was observed in multiparous does, which suggests that the energy deficit could decrease as parity increases (XICCATO et al., 2004). Feeding young rabbit females, in the pre-mating period, high fiber and low energy diets may increase voluntary feed intake during growth and first pregnancy, partially decreasing the energy deficit at the end of first lactation (XICCATO et al., 1999).

Two main seasons can be distinguished in Southeastern Brazil: a cool and dry season that extends from April to September and a warm and wet season from October to March, which may limit rabbit growth and reproductive performance (MOURA et al., 2001). Depressed voluntary feed intake is the most important consequence of heat exposure in growing rabbits (CERVERA; FERNANDEZ-CARMONA, 2010). In fact, feed intake decreased by 21% and the growth rate by 18% when straightbred and crossbred Botucatu rabbits were maintained at 30°C compared to 18°C, from five to 10 weeks of age (ZEFERINO et al., 2011). Additionally, puberty may be delayed and age at first mating increased under high ambient temperature (MARAI et al., 2002). In the field, when seasons are considered, instead of controlled conditions in environmental chambers, the outcome is less predictable due to the high degree of variation in environmental variables (CERVERA; FERNANDEZ-CARMONA, 2010).

The objective in this study was to evaluate the effect of nutritional density and season on the performance of young does before the first mating.

Material and methods

Animals and facilities

The experiment was conducted during two seasons: from December 14th, 2004 to February 25th, 2005 (warm season); and from May 10th to July 15th, 2005 (cool season). Forty-eight Botucatu does were used in each season. Does were housed in collective cages, in groups of four, from 70 to 119 days of age. From 120 to 140 days they were kept in individual cages. Each cage had a circular feeder and an automatic nipple drinker. Prior to the experiment, all young does had free access to a growing diet, manufactured at the Experimental Farm. Average initial live weights were 2,029 ± 23 g in the warm season and 2,050 ± 21 g in the cool season.

High and low daily air temperatures were recorded at 6:30 am inside the building, at cage level, using a maximum and minimum mercury column thermometer. Complementary outside air temperature data were obtained from the Weather Station of the Faculdade de Ciências Agronômicas (FCA), UNESP, at the Experimental Farm.

Experimental diets

Two pelleted diets were manufactured (Table 1). All ingredients were ground through a 4 mm sieve. The high-density diet (HD) was formulated to attain the following contents: 18.4% crude protein (CP); 16.5% acid detergent fiber (ADF); and 2,500 kcal kg^{-1} of digestible energy (DE), on an as-fed basis (CHEEKE, 1987; ANDRIGUETTO et al., 1990; DE BLAS; MATEOS, 1998). The low-density diet (LD) was formulated to attain 14.7% CP; 24% ADF and 2,000 kcal kg^{-1} of DE. Both diets were balanced to contain approximately 74 mg CP $kcal^{-1}$ DE.

Two diet batches were manufactured during each season. Two samples were taken from each batch, one just as it had come out of the pelleting machine, and another one as the batch was about to be used up. Samples were analyzed for NDF, ADF, lignin, cellulose and silica (GOERING; VAN SOEST, 1970); and for dry matter (DM), CP, ether extract (EE) and ash (SILVA, 1990), at the Feed Analysis Laboratory from Faculdade de Medicina Veterinária e Zootecnia, Botucatu, São Paulo State. Due to differences among batches, a fluctuation was observed in the CP and ADF contents (Table 2), which can be considered normal for rabbit diets.

The regression equation proposed by De Blas et al. (1992) was applied to estimate the DE content, taking into account the EE content. The estimated DE contents were, on a 90% DM basis: 2,778 kcal kg^{-1} for HD and 2,327 kcal kg^{-1} for LD. Thus, according to this criterion, HD ended up having a DE content above the recommendations put forth by De Blas and Mateos (1998) for either breeding does or fattening rabbits (2,653 and 2,510 kcal kg^{-1}, respectively, on a 90% DM basis). The final estimated CP/DE ratios were 69 and 67 mg $kcal^{-1}$, respectively, below the planned value mentioned above.

The following dependent variables were analyzed: feed intake, live weight, and daily weight gain adjusted for the weekly feed intake, which is a measure of feed efficiency.

Statistical procedures

The experiment followed a 2 x 2 factorial (two diets x two seasons), in a completely randomized design with repeated measures. For the first phase (70 to 119 days), each collective cage was considered as an experimental unit; for the second phase (120 to 140 days), each doe became an experimental unit. Therefore, separate analyses were carried out for each phase. Weeks were considered as repeated measures.

The statistical analyses were run through the MIXED procedure of SAS (2001). For the analysis of feed intake and live weight, the model included season, diet and week and their interactions as fixed effects, and cage within season vs. diet (or doe within season vs. diet) and the residual as random effects. A first-order autoregressive covariance structure was used for the repeated measures (KAPS; LAMBERSON, 2004).

Weekly weight gain adjusted for feed intake was analyzed according to the model above, but the weekly feed intake was included as a covariate.

Table 1. Ingredients and planned chemical composition of experimental diets, on an as-fed basis (g kg^{-1}).

Ingredient	High-density diet	Low-density diet
Soybean meal	286.2	166.1
Corn grain	150.0	116.2
Wheat bran	100.0	100.0
Citrus pulp	126.8	210.6
Black oat hay	252.7	516.2
Limestone	1.6	11.4
Dibasic calcium phosphate	24.6	25.2
L-threonine	0.2	1.4
Vitamin and mineral premix[1]	5.0	5.0
Kaolin	20.0	10.0
Soybean oil	27.3	22.4
Salt	5.0	5.0
Nutrient (calculated)[2]		
Crude protein (%)	18.4	14.7
Digestible energy (kcal kg^{-1})	2,500	2,000
Acid detergent fiber (%)	16.5	24.0
Starch (%)	12.6	10.0
Calcium (%)	1.2	1.2
Phosphorus	0.6	0.6
Methionine	0.3	0.2
Sulfur-containing amino acids (%)	0.6	0.4
Lysine (%)	1.0	0.8
Threonine (%)	0.7	0.7
Tryptophan (%)	1.8	1.1

[1]'Supervit Coelho' 5:1. in order to reach the following additional levels (per kg of diet): vit. A – 7.000 UI; vit D_3 – 1.250 UI; vit. E – 35 mg; vit K_3 - 2 mg; vit. B_1 - 3 mg; vit. B_2 – 5 mg; vit B_6 – 2 mg Vit. B_{12} – 12.5 mcg; calcium pantothenate – 10 mg; niacin – 30 mg; folic acid – 1 mg; antioxidant – 200 mg; anticoccidial agent – 33mg; choline - 125 mg; selenium – 0.2 mg; manganese – 60 mg; iron – 80 mg; copper – 12 mg; iodine – 1 mg; zinc – 50 mg .
[2]According to Cheeke (1987), Andriguetto et al. (1990) and De Blas and Mateos (1998).

Table 2. Chemical composition of the diets, based on a 90% dry matter content.

Diet	Chemical components (%)							
	CP	EE	Ash	NDF	ADF	Lignin	Cellulose	Silica
Warm season								
High-density	19.3	5.1	7.1	28.7	16.0	2.7	12.5	0.6
Low-density	15.7	3.3	8.3	38.1	22.3	3.8	17.4	1.0
Cool season								
High-density	20.1	5.2	8.2	27.0	16.8	3.0	12.5	1.2
Low-density	15.6	4.2	7.8	39.8	23.0	4.3	17.5	0.9

[1]CP = crude protein; EE = ether extract; NDF = neutral detergent fiber; ADF = acid detergent fiber.

Results and discussion

During the warm season, average minimum and maximum daily temperatures inside the building were 20.5 and 28.0°C, respectively, from 70 to 119 days of age; and 19.0 and 26.0°C, respectively, from 120 to 140 days. Outside, maximum air temperature exceeded 25°C in 89% of days and 30°C in 30% of days in this period. During the cool season, the average low and high temperatures inside the building were: 15.5 and 27.8°C, respectively, from 70 to 119 days; and 13.0 and 25.5°C, respectively, from 120 to 140 days. Outside, minimum air temperature was below 15°C in 39% of days and below 10°C in 3% of days in this period.

One doe died from enteritis in the first season, when still in a collective cage. Another doe died suddenly in the second season, also when still in a collective cage.

Performance from 70 to 119 days (in collective cages)

No diet vs. season interaction effects were detected on feed intake ($p = 0.8148$) or mean weight ($p = 0.9207$).

The LD-fed does showed higher mean intake (Table 3), probably in an attempt to meet energy requirements. Rabbits are able to regulate intake to meet their energy requirements, as long as the fiber content is not excessively high (CHEEKE, 1987; DE BLAS; MATEOS, 1998; ROMMERS et al., 1999).

The mean intake was lower in the warm season than in the cool season (Table 3), because temperatures were, in general, higher. According to Cheeke (1987) the thermoneutral zone for rabbits ranges from 21 to 25°C, but a recent review of several studies (CERVERA; FERNANDEZ-CARMONA, 2010), revealed no consensus among authors and pointed out to a wider range of values, between 15 and 25°C. But anyway, when ambient temperature exceeds 25°C, heat stress sets in and feed intake is depressed. An age effect ($p < 0.0001$) was also observed on intake, since it increased over weeks (Figure 1).

The does fed HD showed higher mean weight than those fed LD (Table 3). As expected, an age effect ($p < 0.0001$) on weight was observed (Figure 2); the mean weight was 2,042 g at the beginning of the first week and 3,189 g at the end of the seventh week.

A diet vs. week interaction ($p < 0.0001$) was observed on the mean weight, as weight gain was higher in the HD-fed animals (Figure 2). This difference can be attributed to the higher nutrient intake in the HD-fed does, which ingested approximately 411 kcal DE and 28.5 g CP day^{-1}, as compared to 370 kcal DE and 25.0 g CP day^{-1} for the LD-fed does. The DE and CP intakes for the HD-fed animals were, respectively, 9 and 19% above the recommended values for growing rabbits (377 kcal day^{-1} and 24 g day^{-1}), as indicated by De Blas and Mateos (1998). In comparison, the DE and CP intakes for the LD animals were, respectively, 2% below and 4% above the recommended values. These comparisons should be taken with caution, because the requirements for growing rabbits may be different from rearing does. Also, the origin of the ingested protein was different between the two regimens, which would probably result in different essential amino acids digestibility and availability. According to Nizza et al. (1997), Rommers et al. (1999) and Xiccato and Trocino (2010), diets for growing does should be rich in fiber (17.5% ADF) and have a moderate DE content (2,510 kcal kg^{-1}) and an adequate CP content (15.9%) (all values on a 90% DM basis). This would result in a future increase in ingestion capacity when the does reach the reproductive phase, which is a beneficial effect, because it has the potential of limiting the mobilization of body reserves and the energy deficit during the first lactation (FORTUN-LAMOTHE, 2006).

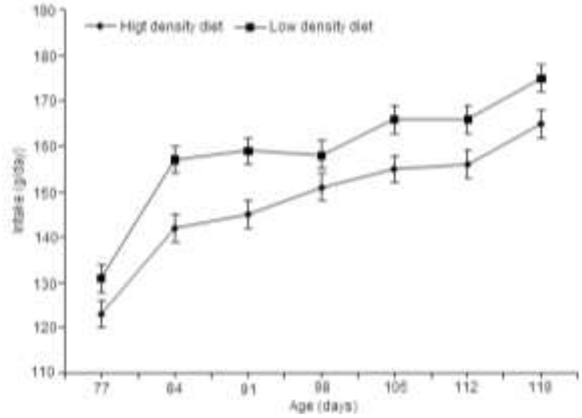

Figure 1. Least-squares means and respective standard errors for weekly feed intake from 70 to 119 days of age, according to the diet.

The adjusted daily gain was higher during the warm season (Table 3), as the animals would have used more energy for thermoregulation in the cool season, impairing feed efficiency.

An age effect ($p < 0.0001$) was observed on adjusted daily weight gain, since it became progressively smaller. The mean gain during the first week of the experiment was 33 g day^{-1}, whereas the mean gain during the final week was only 10 g day^{-1}. These results were expected, because feed efficiency decreases progressively with the advancement of age.

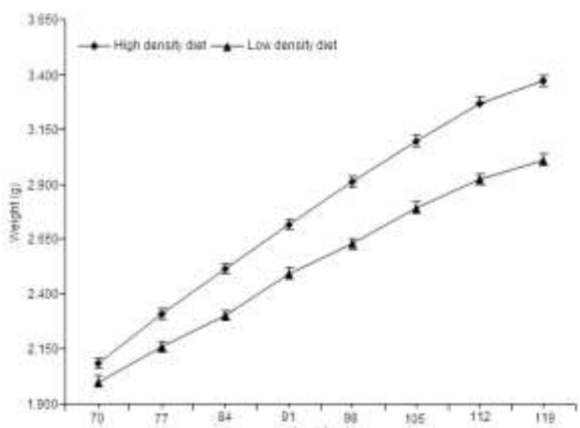

Figure 2. Least-squares means and respective standard errors for live weight from 70 to 119 days of age, according to the diet.

Performance from 120 to 140 days (in individual cages)

No diet vs. season interaction effects were detected on feed intake ($p = 0.9291$), mean weight ($p = 0.9100$), or adjusted average daily gain ($p = 0.4964$).

The mean intake was lower for HD-fed does and also in the warm season (Table 3), probably for the same reasons explained above. As during the previous phase, an age effect ($p < 0.0001$) on intake was also detected: here, however, the overall trend was in the opposite direction, there was a decrease in intake with the advancement of age (Figure 3).

As during the previous phase, the HD-fed does showed higher mean weights (Table 3). Nevertheless, in contrast with the previous phase, no diet vs. week interaction ($p = 0.1594$) was detected, as both diets showed similar weekly weight gains (Figure 4).

No effect of season was detected on mean weight (Table 3), but an age effect ($p < 0.0001$) was observed: body weight was 3,188 g at the end of the first week, and 3,579 g at the end of the last week.

Table 3. Least-squares means (standard errors) for feed intake, live weight and daily weight gain adjusted for intake, according to diet and season.

Trait	Diet			Season		
	High-density	Low-density	P-value	Warm	Cool	P-value
	70 to 119 days of age (in collective cages)					
Intake(g day^{-1})	148.0 (2.1)	159.1 (2.1)	0.0012	145.1 (2.2)	161.9 (2.0)	< 0.0001
Weight (g)	2,782 (20)	2,538 (20)	< 0.0001	2,632 (21)	2,688 (20)	0.0649
Adj. daily gain (g day^{-1})[1]	27.59 (0.52)	19.90 (0.50)	< 0.0001	25.54 (0.59)	21.96 (0.52)	0.0005
	120 to 140 days of age (in individual cages)					
Intake (g day^{-1})	164.2 (2.7)	180.1 (2.8)	0.0001	163.2 (2.8)	181.1 (2.8)	< 0.0001
Weight (g)	3,574 (27)	3,215 (27)	< 0.0001	3,428 (27)	3,361 (27)	0.0859
Adj. daily gain (g day^{-1})[1]	19.88 (0.71)	17.34 (0.73)	0.0175	23.32 (0.72)	13.90 (0.72)	< 0.0001

[1]Average daily gain adjusted for feed intake.

Thus season, by itself, does not seem to have a potential effect on age at puberty and first mating.

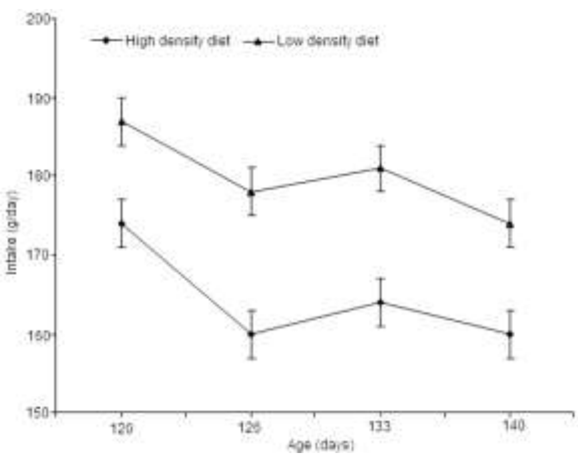

Figure 3. Least-squares means and respective standard errors for weekly feed intake from 120 to 140 days of age, according to the diet.

The HD-fed does showed higher adjusted weight gain (Table 3) from 120 to 140 days of age, as during the previous phase.

The adjusted weight gain from 120 to 140 days was, on average, higher in the warm season, the difference between the two seasons being much higher (68 vs. 16%) than in the previous phase (Figure 3). It was noticed that the average low temperature in the cool season was lower from 120 to 140 days (13.0°C) than from 70 to 119 days (15.5°C), which could, at least partially, explain this difference (CERVERA, FERNÁNDEZ-CARMONA, 2010). An age effect ($p = 0.0014$) was observed, as the adjusted weight gain showed a progressive fall: 21 g day^{-1} during the first week and 17 g day^{-1} during the third week.

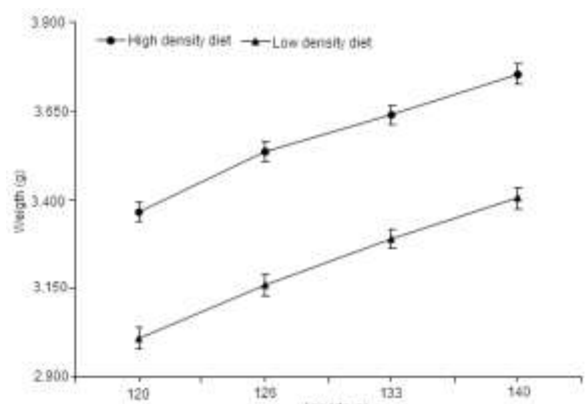

Figure 4. Least-squares means and respective standard errors for live weight from 120 to 140 days of age, according to the diet

Conclusion

Feeding a high-density diet resulted in higher weight gain, higher weight gain adjusted for a constant intake, lower feed intake and higher nutrient intake. But these facts alone do not ensure the use of a high-density diet for growing rabbit does, because it could have a negative impact during the reproductive phase, or it could interact with the diet density used during the reproductive phase. In the warm season, feed intake was reduced, but feed efficiency was improved compared to the cool season. The net effect was that the final body weight of does was not affected by season.

Acknowledgements

The authors wish to thank all the personnel working at the Rabbit Production Facility, Feed Analysis Lab, Ration Plant, Office of Graduate Studies, and Animal Production Department of FMVZ, Botucatu Campus, for their help during this experiment. They also wish to express their gratitude to Professors Antônio Cláudio Furlan, Cláudio Scapinello, Denise Rangel da Silva Sartori and José Roberto Sartori for review and suggestions. Ana Silvia A. M. T. Moura receives a productivity scholarship from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

References

ANDRIGUETTO, J. M.; PERLY, L.; MINARDI, I.; FLEMMING, S. J.; VAN DER VINNE, U. J.; FLEMMING, R.; SOUZA, A. G.; ANDRIGUETTO, L. J.; DUTRA, J. M.; FILHO, B. A. **Normas e padrões de nutrição e alimentação animal**. Revisão 89/90. Curitiba: Nutrição e Editora e Publicitária, 1990.

CERVERA, C.; FERNÁNDEZ-CARMONA, J. Nutrition and the climatic environment. In: DE BLAS, C.; WISEMAN, J. (Ed.). **The nutrition of the rabbit**. 2nd ed. Madrid: CABI Publishing, 2010. p. 267-289.

CHEEKE, P. R. **Rabbit feeding and nutrition**. Oregon: Academic Press, 1987.

DE BLAS, C.; MATEOS, G. G. Feed formulation. In: DE BLAS, C.; WISEMAN, J. (Ed.). **The nutrition of the rabbit**. 2nd ed. Madrid: CABI Publishing, 2010. p. 222-232.

DE BLAS, C.; MATEOS, G. G. Feed formulation. In: DE BLAS, C.; WISEMAN, J. (Ed.). **The nutrition of the rabbit**. Madrid: CABI Publishing, 1998. p. 241-253.

DE BLAS, J. C.; WISEMAN, J.; FRAGA, M. J.; VILLAMIDE, J. M. Prediction of digestible energy and digestibility of gross energy of feeds for rabbits. 2. Mixed diets. **Animal Feed Science Technology**, v. 39, n. 1-2, p. 39-59, 1992.

FORTUN-LAMOTHE, L. Energy balance and reproductive performance in rabbit does. **Animal Reproduction Science**, v. 93, n. 1-2, p. 1-15, 2006.

GIDENNE, T. Fibres in rabbit feeding for digestive troubles prevention: respective role of low-digested and digestible fibre. **Livestock Production Science**, v. 81, n. 2-3, p. 105-117, 2003.

GIDENNE, T.; CARABAÑO, R.; GARCIA, J.; DE BLAS, C. Fibre digestion. In: DE BLAS, C.; WISEMAN, J. (Ed.). **The nutrition of the rabbit**. 2nd. ed. Madrid: CABI Publishing, 2010. p. 66-82.

GOERING, H. K.; VAN SOEST, P. J. **Forage fiber analyses**. Beltsville: USDA, 1970. (Agriculture Handbook, n. 379).

KAPS, M.; LAMBERSON, W. R. Repeated measures. In: KAPS, M.; LAMBERSON, W. R. (Ed.). **Biostatistics for animal science**. Wallingford: CABI Publishing, 2004. p. 365-383.

MARAI, I. F. M.; HABEEB, A. A. M.; GAD, A. E. Rabbits' productive, reproductive and physiological performance traits as affected by heat stress: a review. **Livestock Production Science**, v. 78, n. 2, p. 71-90, 2002.

MOURA, A. S. A. M. T.; COSTA, A. R. C.; POLASTRE, R. Variance components and response to selection for reproductive, litter and growth traits through a multi-purpose index. **World Rabbit Science**, v. 9, n. 2, p. 77-86, 2001.

NICODEMUS, N.; GARCIA, J.; CARABAÑO, R.; DE BLAS, C. J. Effect of a reduction of dietary particle size by substituting a mixture of fibrous by products for lucerne hay on performance and digestion of growing rabbits and lactating does. **Livestock Science**, v. 100, n. 2-3, p. 242-250, 2006.

NIZZA, A.; DI MEO, C.; ESPOSITO, L. Influence of the diet used before and after the first mating on reproductive performance of rabbit does. **World Rabbit Science**, v. 5, n. 3, p. 107-110, 1997.

ROMMERS, J. M.; KEMP, B.; MEIJERHOF, R.; NOORDHUIZEN, J. P. T. M. Rearing management of rabbit does: a review. **World Rabbit Science**, v. 7, n. 3, p. 125-138, 1999.

SAS-Statistical Analysis System. **System for Microsoft Windows**: release 8.2. Cary: SAS Institute, 2001. 1CD-ROM.

SILVA, D. J. **Análise de alimentos (métodos químicos e biológicos)**. Viçosa: Imprensa Universitária. 1990.

XICCATO, G.; TROCINO, A. Energy and protein metabolism and requirements. In: DE BLAS, C.; WISEMAN, J. (Ed.). **The nutrition of the rabbit**. 2nd ed. Madrid: CABI Publishing, 2010. p. 83-118.

XICCATO, G.; BERNARDINI, C.; CASTELINI, C.; DALLE ZOTTE, A.; QUEAQUE, I. P.; TROCINO, A. Effect of postweaning feeding on the performance and energy balance of female rabbits at different physiological states. **Journal of Animal Science**, v. 77, n. 2, p. 416-426, 1999.

XICCATO, G.; TROCINO, A.; SARTORI, A.; QUEAQUE, I. P. Effect of parity and litter weaning age on the performance and body energy balance of rabbit does. **Livestock Production Science**, v. 85, n. 2-3, p. 239-251, 2004.

ZEFERINO, C. P.; MOURA, A. S. A. M. T.; FERNANDES, S.; KANAYAMA, J. S.; SCAPINELLO, C.; SARTORI, J. R. Genetic group x ambient temperature interaction effects on physiological responses and growth performance of rabbits. **Livestock Science**, v. 140, n. 1-3, p. 177-183, 2011.

Received on November 9, 2012.

Accepted on February 6, 2013.