

DIFFERENCES IN DIGESTIVE EFFICIENCY BETWEEN RABBIT DOES SELECTED FOR LITTER SIZE AT WEANING AND FOR REPRODUCTIVE LONGEVITY

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ABSTRACT

The main aim of the present work was to assess how selection for reproductive longevity criteria affects the digestive utilisation of reproductive rabbit does in lactation, compared with another common selection criterion, litter size at weaning. A second objective was to analyse and propose correction of the method to improve reliability in the determination of apparent digestibility coefficients of rabbit does in lactation. Fourteen does were used from line V, selected for litter size at weaning, and 13 does from a “longevous” productive line (LP). After standardising the litter size at birth to 10 kits, on day 6 of lactation the does were housed in metabolic cages. In order to determine the apparent digestibility coefficients, after an adaptation period of 7 days, the faeces were collected individually during 4 days (13 to 16 of lactation). To analyse the effect of the intake regularity and/or milk yield of the doe on the reliability of the determination of the apparent digestibility coefficient of dry matter digestibility (dDM), the correlation between the standard deviation of ingestion and milk production was analysed with the individual residues obtained in the dDM determination by a full-cross validation procedure. The standard deviation of the milk production, both in the previous period and during the experimental phase, was not correlated with reliability in the determination of dDM. Nevertheless, a clear and significant correlation was observed between the variability of consumption during the 4 days prior to the experimental phase and this reliability ($r=+0.57$; $P<0.01$). The LP does consumed 22 g DM/d more than the V does ($P>0.10$) and had lower apparent digestibility coefficients for the dry matter, organic matter and gross energy compared with the V does (2.3, 2.5 and 2.1%, respectively; $P<0.05$). In conclusion, it could be hypothesized that the selection for litter size at weaning in reproductive rabbit does may have selected animals more efficient in the use of the nutritional resources.

Key words: Lactating does, Litter size, Longevity, Digestibility, Ingestion regularity.

INTRODUCTION

In recent years, several works have focused on evaluating the effect of selection criteria on the physiology and use of resources in reproductive rabbit does. Quevedo *et al.* (2005) observed how selection for litter size at weaning over 12 generations gave rise to crossbred does with a greater prolificacy (+2 kits born alive) and therefore with greater needs for reproduction. These requirements could be covered to the detriment of other components, such as maintenance needs, which might endanger the survival of the animal, or by an increase of the ability to obtain resources. Some previous works have observed an improvement in the efficacy of use of digestible energy (DE) for foetal growth, and an increase in ingestion and milk yield at the onset of lactation (Quevedo *et al.*, 2005, 2006b) for crossbred does that came from lines selected more for litter size at weaning. These results suggested that selection on reproduction criteria in rabbits could entail an improvement in the capacity to obtain resources, which would not necessarily implicate other components such as the life span. In fact, Theilgaard *et al.* (2006) observed how the selection of does for litter size at weaning did not affect their life span during 6 reproductive cycles, even the relative risk of culling of these does was 26% less. On the other hand, the Institute for Animal Science and Technology at the Polytechnic

University of Valencia recently founded a “longevous” productive line (LP) by selection of animals which produced at least 25 litters with an average size of 7.5 born alive (Sanchez, 2006). When this LP line was compared with another selected from 31 generations for litter size at weaning (line V), the “longevous” does showed a smaller relative risk of culling in later stages of productive life. Theilgaard (2006) proposed that this greater life expectancy of LP does might be related with their larger format (+250 g average live weight) and/or their greater capacity to obtain resources (higher feed consumption, milk production and body condition). In order to confirm this hypothesis, we must assess the capacity to obtain nutritional resources on the basis of selection criteria. The main aim of the present work will therefore be to assess how selection for productive longevity criteria or for litter size at weaning could affect the digestive efficiency of lactating rabbit does. A second objective of this work was methodological and concerned a possible correction method to improve reliability in the determination of apparent digestibility coefficients for rabbit does during lactation.

MATERIALS AND METHODS

Diet

For the digestibility trial a commercial feed for reproductive rabbit does (Cunilactal; NANTA, Nutreco) was used, containing 17.4% crude protein (CP), 21.8% acid detergent fibre (ADF) and 3.7% ether extract (EE), all in a dry base. All the animals received the diet from positive diagnosis of pregnancy.

Animals

In the experiment, a total of 27 does were used; 14 does came from line V selected for litter size at weaning from r 32 generations, and 13 from a “longevous” productive line (LP) recently constituted with animals having a minimum of 25 litters and with an average number of 7.5 kits born alive (Sanchez, 2006). The experiment was carried out with 2 experimental batches, the first of them take place January 2007 and included 12 does (6 from each line), and a second batch in March 2007, with 15 does (7 and 8 from the LP and V lines, respectively).

Experimental procedure

The apparent digestibility coefficients of the dry matter (DM), organic matter (OM), CP, crude fibre (CF), neutral detergent fibre (NDF), ADF, EE and gross energy (GE) were determined for both genetic lines using multiparous does. Litters were standardised post partum to 10 kits per doe in order to maximise milk production. On day 6 of lactation, the does were housed in metabolic cages with free access to the feed and water. After a 7 day adaptation period, the faeces were collected individually for 4 days (13 to 16 d of lactation) following the recommendations of Perez *et al.* (1995). From the moment the doe rabbits were placed in metabolic cages, both feed intake and milk yield were daily monitored. Faeces were analysed individually for DM, OM, CP, NFD, ADF and GE, while EE was determined from a pool including animals from the same line and batch.

Analytical methods

The chemical analysis of feed and faeces was performed using the methods of the AOAC (1991) for DM, ash, EE, CP and CF, following the recommendations of Van Soest *et al.* (1991) for the fibrous fractions (NDF, ADF and ADL), with a thermostable amylase pre-treatment. The GE was determined by means of an adiabatic calorimetric bomb (EGRAN, 2001).

Statistical analysis

To determine the effect of intake regularity and milk yield, during the pre-experimental and faeces collecting phases, on the reliability of the determination of the DM digestibility coefficient (dDM), this coefficient was determined individually (dDM_i) and subsequently, by means of a full-cross validation procedure, a dDM reference value (cdMS_r) was obtained for each animal on the basis of the individual DM digestibility values of all the animals from the same genetic line and batch, except that of this individual itself. The difference between both values gave a residue, which in absolute value can be an indicator of the suitability in the determination of each dDM value. The correlation between the standard deviations of feed intake (SDI) and milk yield (SDM) with the absolute values of the residues (|dDM_r-dDM_i|) was done using the CORR procedure of SAS (1996).

Data from digestibility trial were analysed statistically by means of a GLM procedure from SAS (1996). The analysis was performed by means of a completely random design following a model in which they were included as fixed effects of the genetic line and the experimental batch, as well as their interaction. Due to its correlation with the reliability in determination of dDM, the SDI of the does in the 4 days prior to the experimental phase (SDI4d_i) was used to improve reliability in the determination of the different digestibility coefficients. This was done by means of the introduction as weight variable of the relative percentage of this standard deviation (PSD_i), calculated as:

$$\text{PSD}_i (\%) = \frac{\text{SDI4d}_{\max} - \text{SDI4d}_i}{\text{SDI4d}_{\max}} \times 100$$

where SDI4d_{max} was the maximum SDI4d_i observed in this experiment.

RESULTS AND DISCUSSION

Regularity of ingestion and reliability of dDM

Digestibility assays in rabbits, are usually carried out using animals of 42 days of life (Pérez *et al.*, 1995). These results are usually extrapolated to reproductive does. However, as several authors have observed (Maertens and de Groote, 1982; Pérez *et al.*, 1996), when we compare the digestibility coefficients obtained from fattening rabbits and lactating does, greater digestibility values for all the dietary components in favour of young rabbits (+1.7% for dDM, dOM, dGE; +2.9% for dCP; and +4.3% for dCF). In an experiment where the aim is to study the effect of genetic selection on two such different criteria as litter size and longevity, the use of reproductive doe rabbits in lactation phase is necessary, since it is at this stage that the greatest productive challenge takes place which may differentiate both lines. However, the milk yield and lactation day of the does could affect the regularity of feed intake, one of the main determining factors of reliability in obtaining the apparent digestibility coefficients. To analyse the effect of the regularity of the doe's feed consumption and/or milk yield on the reliability of the determination of the dDM, the correlation existing between the SDI and SDM was analysed with the individual residues obtained in the dDM determination by a full-cross validation procedure. As shown in Table 1, the SDM, both in the prior period and during the experimental phase, was not correlated with reliability in the determination of dDM (residues). Nevertheless, this result was to be expected, since the litter size (and therefore the productive effort to which the does were submitted) was standardised and kept constant during the experiment.

However, although the regularity in ingestion during the experimental phase was not closely correlated with the reliability in the determination of dDM ($r=+0.20$; $P=0.33$), a clear and significant correlation was observed between the variability of consumption in the 4 days preceding the experimental phase and this reliability ($r=+0.57$; $P<0.01$). These results illustrate the relevance of maintaining a regular consumption during the stage prior to the experimental phase in order to increase the reliability in the determination of the digestibility coefficients, and the possible interest of the use of this value as a

variable of correction for the statistical analyses used in the calculation of these coefficients. So, the digestibility coefficients shown below were calculated using PDS_i as weight variable.

Table 1: Simple correlation coefficients between the standard deviation of the dry matter intake (SDI) and milk yield (SDM) with the individual absolute residues obtained in the determination of the apparent digestibility coefficient of dry matter (dDM)

Phase ¹	SDI			SDM		
	Total	Prior	Experimental	Total	Prior	Experimental
dDM residues	0.090	0.517	0.201	0.037	0.081	0.061
P value	0.622	0.008	0.326	0.859	0.694	0.766

¹Phase: Total, from 4 days before the experimental phase to the final day of faeces collection; Prior, from 4 days before to the experimental phase and the first day of faeces collection; Experimental: 4 day faeces collection process

Selection criterion and digestive utilisation

Table 2 shows the effect of the genetic selection for litter size at weaning or productive longevity on the apparent digestibility coefficients in lactating does. The average values obtained for these coefficients (58, 58 and 71% for dDM, dGE and dCP, respectively) were similar to those obtained by Pérez *et al.* (1996) using lactating does that received a diet similar to the one used in the present work (56, 55 and 66 %, respectively). Only the dCF values were higher (22%) than that obtained by Pérez *et al.* (1996; 10%), but this could be partially due to the different fibrous source of the feed ingredients.

Table 2: Effect of genetic line on the apparent digestibility coefficients of feed in lactating does

Apparent digestibility coefficients (%):	LP	V	P value
dDM	57.35 ± 0.69	59.67 ± 0.61	0.018
dOM	57.41 ± 0.71	59.91 ± 0.62	0.014
dCP	70.90 ± 0.72	71.77 ± 0.63	0.373
GE	56.83 ± 0.68	58.96 ± 0.60	0.027
dNDF	26.59 ± 1.76	29.59 ± 1.56	0.216
dADF	22.13 ± 1.84	25.86 ± 1.63	0.144
dCF	20.12 ± 1.53	23.42 ± 1.43	0.128
dEE	74.43	76.09	
Intake in experimental phase:			
DM (g/d)	395.1 ± 12.8	373.0 ± 10.8	0.200
DE (kJ/d)	4057 ± 134.2	3973 ± 112.7	0.638
DP (g/d)	48.89 ± 1.6	46.65 ± 1.35	0.945

DE: Digestible energy; DP: Digestible protein.

Theilgaard (2006) observed a greater and significant feed intake for secondiparous LP does compared with the V does (326 and 308 g DM/d, respectively; $P < 0.05$). Likewise, in the present work LP does consumed 22 g DM/d more than V line does. This difference was not significant owing to a lower number of animals and a shorter duration of the period of measurement. The greater feed consumption in LP does could partly explain the lower apparent digestibility coefficients for the DM, OM and GE obtained for LP does compared with the V does, (2.3, 2.5 and 2.1%, respectively; $P < 0.05$). However, a 6% of change in the ingestion cannot completely explain this effect on the apparent digestibility coefficients, especially if we consider that the feed intake per kilogram of metabolic weight was the same for both lines (131 g DM/kg^{0.75}/day). Quevedo *et al.* (2006a) reported how selection on litter size at weaning over 12 generations led to crossbreed animals more efficient during gestation, so achieving DE utilisation efficiencies for foetal growth of 0.29 and 0.33 for the more and less selected, respectively. In another work, these authors (Quevedo *et al.*, 2006b) observed that V line does with a greater selection on litters size showed a greater ingestion capacity at the beginning of lactation which led to an increase in milk yield and litter survival during this period.

CONCLUSIONS

taking into account previous results and those found in the present work, the hypothesis may be raised that selection for litter size at weaning in reproductive rabbit does may have led to obtaining animals more effective in the use of the resources available, achieving greater reproduction-linked results (foetal growth and milk yield) from the same resources (feed) through, in particular, the improvement in the efficiency of digestive utilisation.

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