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ABSTRACT

The aim of this study is to know the effect of different solid feed and milk intake during suckling on performance around weaning and on caecal content characteristics at weaning. In order to obtain different intakes of milk and solid feed, 13 litters of pregnant females (PF) inseminated the day after delivery and 14 litters of non-pregnant females (NPF) were compared. At birth the litters were equalized at eight pups and during lactation dead pups were replaced by pups of the same age from nursing does. Compared to the PF group, rabbits in the NPF group had a higher milk intake (26.0 *versus* 21.4 g/day; $P < 0.01$) and lower solid feed intake (9.1 *versus* 11.5 g/day; $P < 0.01$) between 20 and 28 days of age. No significant difference was observed between the two groups in weight gain before and post-weaning (28-49 days). At weaning, the rabbits in group PF showed higher values in caecal content (g 26.3 *versus* 22.6; $P < 0.05$) and volatile fatty acids (mmol/l 52.2 *versus* 43.6; $P < 0.01$) and lower values in empty caecal weight (g 7.18 *versus* 7.78; $P < 0.05$), C_3 (6.4 *versus* 9.3%; $P < 0.01$) and C_3/C_4 ratio (0.39 *versus* 0.63; $P < 0.01$) than the group NPF. On the basis of the above results, it may be concluded that the quantity of solid feed and milk intake before weaning influenced the characteristics of the caecal content, but not the performance of rabbits around weaning.

Key words: Rabbits, Weaning, Feed intake, Performance, Caecal fermentation.

RIASSUNTO

INFLUENZA DELLE QUANTITÀ DI LATTE E MANGIME INGERITE PRIMA DELLO SVEZZAMENTO SULLE CARATTERISTICHE DEL CONTENUTO CIECALE E SULLE PERFORMANCE DEI CONIGLIETTI

Con la presente ricerca si è voluto studiare l'influenza di una diversa ingestione di alimento solido durante l'allattamento sulle caratteristiche del contenuto ciecale allo svezzamento e sulle performance produttive intorno allo svezzamento. A tale scopo, sono state messe a confronto 13 nidiate appartenenti a coniglie reinseminate un giorno dopo il parto e rimaste gravide (PF) con altre 14 nidiate di femmine non gravide (NPF). Le nidiate sono state pareggiate a 8 soggetti ed i coniglietti morti durante la prova sono stati sostituiti con altri di pari età. Allo svezzamento, avvenuto a 28 giorni, un coniglietto per nidiata è stato sacrificato per i rilievi sul cieco e sul contenuto ciecale. Altri 84 soggetti per gruppo sono stati alloggiati in 12 gabbie per rilevarne le prestazioni produttive nella prima fase del post-svezzamento (28-49 d). I coniglietti appartenenti al gruppo PF, nel periodo 20-28 giorni di lattazione, hanno avuto a disposizione, rispetto a quelli dell'altro gruppo (NPF), meno latte (g/d 21,4 vs 26,0; $P < 0,01$) e di conseguenza sono stati indotti ad una maggiore

ingestione di mangime (g/d 11,5 vs 9,1; P < 0,01). L'accrescimento medio giornaliero in questa fase non ha presentato differenze significative. Anche le prestazioni produttive registrate nelle 3 settimane successive allo svezzamento non hanno fatto emergere differenze di rilievo. Parecchie differenze, invece, sono emerse a carico del cieco e del contenuto ciecale. In particolare, il peso del cieco vuoto è stato minore nei coniglietti del gruppo PF (g 7,18 vs 7,78; P < 0,05) i quali, invece, hanno fornito maggiore contenuto ciecale (g 26,3 vs 22,6; P < 0,05), peraltro, più ricco di sostanza secca (26,9 vs 25,2%; P < 0,05). Elevata e altamente significativa (P < 0,01) è risultata la differenza osservata nei valori del pH (5,70 e 6,24, rispettivamente per i gruppi PF e NPF). Inoltre, i conigli del gruppo PF hanno fatto registrare una maggiore produzione di AGV totali (mmol/l 52,2 vs 43,6; P < 0,01) con livelli inferiori di C_3 (6,4 vs 9,3%; P < 0,01). Gli altri parametri del contenuto ciecale non sono stati influenzati tranne che per il rapporto C_3/C_4 (0,39 vs 0,63; P < 0,01, rispettivamente per il gruppo PF e per quello NPF). I risultati ottenuti permettono di concludere che la minore disponibilità di latte induce i coniglietti ad una maggiore ingestione di mangime. Tale comportamento, nel nostro caso, ha migliorato l'attività fermentativa del cieco senza influenzare le prestazioni produttive sia prima che dopo lo svezzamento.

Parole chiave: *Conigli, Svezzamento, Ingestione alimento, Prestazioni produttive, Fermentazioni ciecali.*

Introduction

The period around weaning (20-40 days of age) is a very critical time for young rabbits as they are more susceptible to digestive disorders. Up to 18-20 days, young rabbits ingest only milk, while from this point onwards they begin to consume solid feed as well, initially in small quantities and subsequently, as their mother's milk yield diminishes, in ever-increasing quantities. During this period, fermentative activity of caecum begins to develop (Padilha *et al.*, 1995; Piattoni *et al.*, 1995) and some of the enzymatic digestive activities show important changes (Marounek *et al.,* 1995). According to some studies (Maertens and De Groote, 1990; Scapinello *et al.*, 1999) an earlier intake of solid feed could accelerate the maturation of digestive enzymes and reduce the risk of digestive disorders.

In recent years, much research has been conducted to study the development of digestive activity around weaning (Padilha *et al.*, 1995; Piattoni *et al.*, 1995; Padilha *et al.*, 1996; Dojana *et al.*, 1998; Debray *et al.*, 2001; Pinheiro *et al.,* 2001), although little is still known about the role played by early intake and quantity of solid feed intake at the pre-weaning phase in caecal fermentation and productive performance immediately after weaning (Scapinello *et al.*, 1999; Fortun-Lamothe *et al.*, 2001; Pascual *et al.*, 2001; Nizza *et al.*, 2001).

The aim of this research was to study the effect of different solid feed intake during lactation on caecal content characteristics at weaning and productive performance of young rabbits around weaning.

Material and methods

Two groups of litters were induced to consume different quantities of solid feed by means of different milk availability. For this purpose, 28 Hyla hybrid rabbit does were inseminated the day after the partum and the litters were equalized at eight pups. Dead pups were replaced during lactation by pups of the same age from nursing does. Abdominal palpation was performed 12 days after insemination to determine whether the females were pregnant. The pregnant females (n. 13) made up group PF, while the 15 remaining non-pregnant females were assigned to group NPF.

At partum, the litters were housed in separate cages and the milk yield of does during lactation and solid feed intake of litters during the last week of lactation were controlled. The litters were administered solid feed *ad libitum* starting from the 18th day. Milk yield was measured by weighing the litters before and after suckling; does were put with their litters to suckle for a short period (about 10 min) once daily in the morning. Until the 18th day of lactation, measurements were made at 4-day intervals; from day 20 measurements were recorded on a daily basis.

Rabbit does were given a feed *ad libitum* with the following characteristics: Neutral Detergent Fibre (NDF) 306 g/kg; Acid Detergent Fibre (ADF) 185 g/kg; Acid Detergent Lignin (ADL) 41 g/kg; Crude Protein (CP) 175 g/kg; Digestible Energy (DE) 10.4 MJ/kg. The feed administered to the litter had the following composition: NDF 322 g/kg; ADF 210 g/kg; ADL 45 g/kg; CP 148 g/kg; DE 9.8

Table 1. Performance of rabbits around weaning (20-49 days)

		Groups		rsd
		PF	NPF	
Before weaning (20-28 days):				
Litters	n.	13	14	
Milk intake	g/d/litter	170.9[B]	207.6[A]	17.21
Feed intake	"	91.8[A]	72.9[B]	10.13
Growth rate	g/d/rabbit	25.5	27.3	6.50
Live weight at 28 d	g/rabbit	531	545	84.30
Mortality	%	1.92	1.80	
After weaning (28-49 days):				
Rabbits	n.	84	84	
Feed intake	g/d/rabbit	83.1	80.2	9.30
Growth rate	"	36.7	37.4	4.55
Food conversion ratio		2.262	2.150	0.23
Mortality	%	4.8	9.5	1.43[*]

A,B = P < 0.01

(*) value of χ^2

MJ/kg. Chemical analysis of diets followed the method of the ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS (1984). Gross energy was determined by adiabatic bomb calorimetric. The digestibility of the diets was previously determined in rabbits between 2 and 2.5 kg of live weight (Perez *et al.*, 1996).

At weaning, one rabbit per litter was slaughtered to obtain data regarding caecal content. Caecal contents, after measurement of the pH, were frozen at 18°C until ammonia was determined (Boehringer UV urea/ammonia kit method) as well as volatile fatty acids (VFA) (Perkin Elmer 841 Gaschromatograph with column 80/120 Carbopack B-DA/4% Carbowax 20M-2m 2mm id). Eighty-four other rabbits per group were raised for 3 weeks to ascertain post-weaning performance and health. Then the animals were housed in cages with seven places, kept in an experimental room with artificial ventilation and a 12h light - 12h dark schedule. The rabbits were given the same feed *ad libitum* before weaning. Individually conducted weight controls and feed consumption per cage were recorded weekly.

Data were analysed by ANOVA, using the general linear procedure (GLM; Statistical Analysis Systems Institute, SAS, 1989). Parameters of mortality were analysed with the χ^2 method.

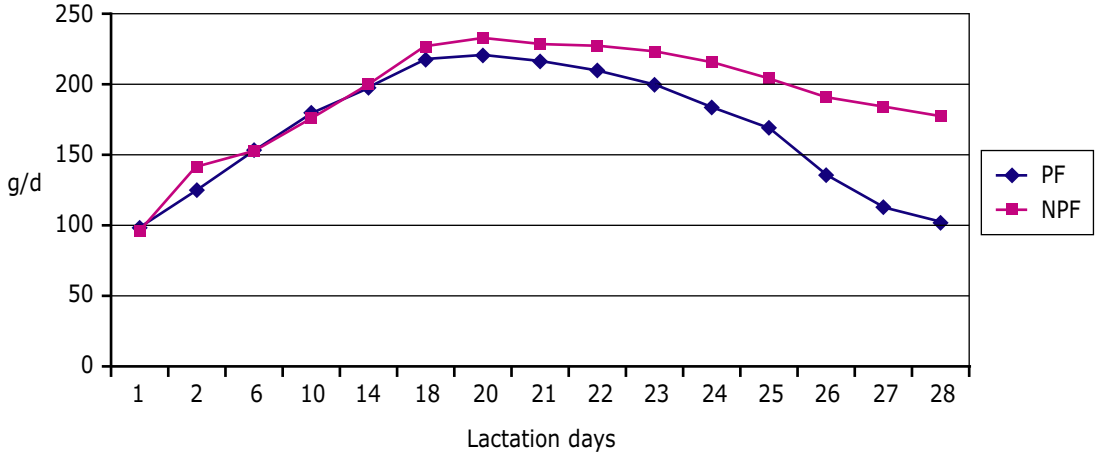
Results and discussion

During the experiment one litter in the NPF group was eliminated as the doe suffered an enteric disorder.

The productive performance of young rabbits around weaning is reported in table 1. In the period between 20 and 28 days milk consumption of litters was significantly ($P < 0.01$) higher in group NPF (207.6 g/d) than in group PF (170.9 g/d).

As might be expected, in does belonging to the latter group, already in an advanced state of pregnancy, milk yield began to decline appreciably from the 24th day of lactation (figure 1). For the first 18 days, however, milk yield was similar in the two groups. These results confirm the findings of other studies (Xiccato *et al.*, 1989; Parigi-Bini and Xiccato, 1993) with regard to the lowering effect of pregnancy on milk yield. Xiccato *et al.* (1989) report, for non-pregnant does and for pregnant does inseminated within two days of partum, very similar milk yield from day 10 to day 20 of lactation (220.2 and 216.5 g, respectively) and sig-

Figure 1. Milk yield of pregnant (PF) and non pregnant (NPF) rabbit does



nificantly different production (P< 0.01) in the third decade (174.2 and 120.2 g for non-pregnant and pregnant groups respectively).

The lower milk availability induced group PF young rabbits to increase their daily solid feed intake (11.5 *vs* 9.1 g; P< 0.01). Similar results are reported by Scapinello *et al.* (1999) who found that at weaning the solid feed intake was 62 % higher in the group that had consumed 23% less milk. Also Pascual *et al.* (2001) observed higher solid feed intake in rabbit groups that consumed less milk, noting, as expected, a negative correlation (-0.57; P<0.001) between solid feed intake and milk ingestion. The milk and solid feed intake values which we observed from the 20th to 28th day also proved significantly and negatively correlated (r -0.90; P < 0.01).

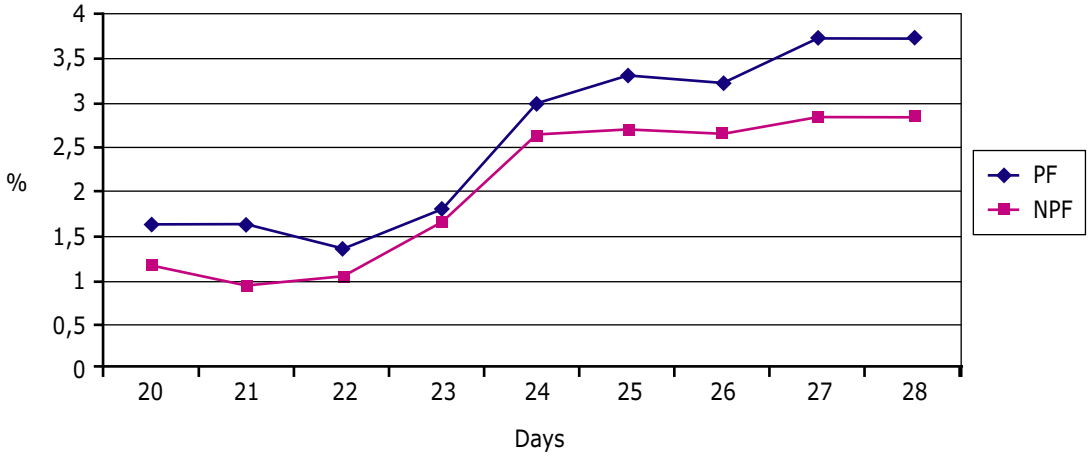
Solid feed intake (figure 2) remained low between the 20th and 22nd day, then undergoing a considerable increase between the 23rd and 24th day. From this moment onward, the difference between the groups became increasingly evident as group PF recorded a greater increase in solid feed intake than group NPF.

Live weight at 28 days (531 and 545 g respectively for group PF and NPF) and growth rate in the 20-28 day period (25.5 and 27.3 g, respectively for group PF and NPF) show no significant differences between the groups. By contrast, Pascual *et al.* (2001) observed a significantly lower weight at weaning (P< 0.05) in rabbits that, despite consuming more solid feed, had ingested less milk.

Table 2 reports the parameters observed in the rabbits slaughtered at weaning. Caecal content was higher in group PF than in group NPF (26.3 vs. 22.6 g; P < 0.05). The proportion of caecal content to body weight was thus higher in group PF than in group NPF (4.78% *vs.* 4.09%; P < 0.01). In practice, rabbits that consume more solid feed have a higher caecal content. The same results were obtained in a previous study (Nizza *et al.*, 2001) where rabbits that received rationed solid feed had a lower caecal content than those fed *ad libitum*. In the above test the proportion of caecal content was on average lower than 4%. However, considering that, besides diet, other factors (age, sampling time, etc.) may affect this parameter, the values that we observed may be considered normal. In this respect, Gidenne (1996), in agreement with the findings of several studies (Lebas and Laplace, 1972; Candau *et al.*, 1978; Padilha *et al.*, 1995), reports caecal content values in % of live weight ranging from 2 to 6 for 25-60 day-old rabbits.

Weight of the caecal wall (CW) and percentage of the weight of the caecal wall compared to the body weight (CW/BW) had the opposite behaviour to that of caecal content. Indeed, these two parameters had lower values in group PF rabbits (7.18

Figure 2. Solid feed intake in young rabbits as percentage of live litter weight



vs. 7.78 g and 1.31% versus 1.41% respectively for CW and CW/BW). Very similar CW/BW values to those observed in this test are reported by Nizza *et al.* (2001) in 30-day-old rabbits (1.35%) and by Padilha *et al* (1996) in 29-day-old rabbits fed only milk (1.29%).

Considerable differences were also observed in the characteristics of the caecal content. In particular, group PF animals had higher dry matter caecal content (26.9% and 25.2%, $P < 0.05$) and lower pH values (5.70 and 6.24, $P < 0.01$) than those in group NPF. The same results had been obtained by Nizza *et al.* (2001) in rabbits weaned at 35 days and subjected to a different solid feed intake by

Table 2. Characteristics of caecum and caecal content at weaning (28 days)

Groups		PF	NPF	rsd
Rabbits	n.	13	14	
Body weight (BW)	g	550.0	549.4	85.76
Caecal content weight	"	26.3^{a}	22.6^{b}	4.52
Caecal content	% BW	4.78^{a}	4.09^{b}	0.55
Empty caecal weight	g	7.18^{b}	7.78^{a}	1.16
Empty caecal	% BW	1.31^{B}	1.41^{A}	0.05
Dry matter caecal content	%	26.9^{a}	25.2^{b}	1.79
pH		5.70^{B}	6.24^{A}	0.19
Ammonia	mmol/l	9.1	9.7	2.0
Total VFA	"	52.2^{A}	43.6^{B}	5.8
C_2	molar %	76.3	75.0	6.3
C_3	"	6.4^{B}	9.3^{A}	1.7
C_4	"	16.3	14.8	2.5
C_3/ C_4		0.39^{B}	0.63^{A}	0.17

A,B = P < 0.01; a,b = P < 0.05

means of rationing. The rationed animals had a lower dry matter of caecal content (25.7% *vs.* 27.3%) and higher pH (6.40 *vs.* 5.67). Compared with those fed ad libitum, such findings suggest that it is the quantity of solid feed rather than that of milk intake which plays a greater role in these parameters.

The rabbits of group PF recorded a greater production of total VFA than those in group NPF (52.2 and 43.6 mmol/l; $P < 0.01$), accompanied by lower levels of C_3 (6.4 and 9.3 mmol/100 mol; $P < 0.01$). An increase in VFA production is usually encountered as a consequence of early weaning or earlier solid intake of young rabbits and is associated with better caecal fermentative activity (Pascual, 2001). The other volatile fatty acids and ammonia showed no significant differences. However, the C_3/C_4 ratio was lower in group PF animals (0.39 and 0.63; $P < 0.01$). Nevertheless, the values observed in both groups are close to those reported in the literature (Gidenne *et al.*, 1991; Gidenne, 1995) for adult rabbits and may be the result of well-established caecal fermentation with the use of solid feed.

The different treatment adopted before weaning had no effect on post-weaning performance. The rabbits of group PF consumed slightly higher quantities of feed (83.1 *vs.* 80.2 g/days) and had a higher feed conversion ratio (2.262 *versus* 2.150) than group NPF rabbits. The differences between the groups, however, were never statistically significant. Nor was mortality (4.8% and 9.5%, respectively for groups PF and NPF) statistically different between the groups.

Conclusions

The results obtained in this survey, though derived from a limited number of cases, show that the lower availability of milk induces higher solid feed intake in young rabbits. This behaviour affects caecum weight and many caecal content parameters, thus proving greater fibrolytic fermentation. In this respect, it should be emphasised that an extensive rhythm (a.i. after weaning), promoting a higher milk yield, could delay the development of digestive activity in young rabbits. By contrast, the quantity of pre-weaning solid feed and milk intake does not appear to affect the performance of rabbits around weaning.

Finally, these results suggest anticipating the age of weaning in order to improve the corporal condition of reproductive rabbit does. However, further studies are necessary to acquire more information about this topic.

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