

## EARLY WEANING OF YOUNG RABBITS : A REVIEW

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**ABSTRACT :** In the present work, the main recent literature concerning early weaning of young rabbits was reviewed. Available information about the possible effect of early weaning practice on reproductive females (corporal condition and health status), weaned kits (changes of caecum fermentation and digestive enzymatic activities) and growing rabbits (performance and health status) was revised. Early weaning at 21-25 days seems to be a feasible practice that could have interesting possibilities from a productive point of

view. This practice should decrease the usual reserve mobilization of does during the last days of lactation and could allow a specific and more adequate nutrition of kits around weaning time. However, more information about the positive or negative effects of early weaning on the performance and pathology incidences is need. At this respect, a higher effort on the study of adequate management systems and weaning diets should be required in the future.

**RESUME : Le sevrage précoce des lapereaux : une revue.**

Cette revue prend en compte les principales informations récentes et disponibles dans la littérature concernant le sevrage précoce des lapereaux : effet de sevrage précoce sur les femelles reproductrices (condition corporelle et état de santé), sur lapereaux sevrés (changement dans la fermentation cœcale et l'activité enzymatique digestive) et sur les lapins en croissance (performance et état de santé). Le sevrage précoce à 21-25 jours semble être possible et intéressant quant à la production. Cette pratique doit réduire la

classique mobilisation des réserves des lapines durant les derniers jours de lactation et permettre une alimentation des lapereaux plus spécifique et plus adaptée au moment du sevrage. Cependant plus d'informations sur les effets positifs et négatifs du sevrage précoce sur les performances et la pathologie sont nécessaires. En conséquence, un effort de recherche devra être fait dans le futur pour rechercher les systèmes de production et les aliments de sevrage les mieux appropriés.

### INTRODUCTION

The main research groups in rabbit nutrition and pathology seem to be in agreement that management and nutrition around weaning time are clearly related with the digestive physiology development and maturity of young rabbits during fattening, and consequently, with their susceptibility to suffer different digestive disorders during this period. Lactating kits ingest exclusively milk during the first 18-20 days of life. When they begin to eat solid food, initially as an entertainment, the feed and water intake increases considerably as the milk production of doe decreases. During this period, fermentative activity of caecum begins to be developed (PADILHA *et al.*, 1994; PIATTONI *et al.*, 1995) and some of the enzymatic digestive activities show important changes (MAROUNEK *et al.*, 1995). However, in most of the practical conditions, kits start to eat a diet designed for their mother, making them very liable to suffer digestive disorders.

Some of the disorders registered after weaning seem to be related with the intake of food (quantity and quality), and physiology digestive maturity (SCAPINELLO *et al.*, 1999); perhaps an earlier ingestion of solid food could speed up this maturity (MAERTENS and DE GROOTE, 1990), avoiding digestive troubles during the fattening period. So, in the present work, the effect of early weaning on health and performance of kits and reproductive does has been reviewed.

### REPRODUCTIVE RABBIT DOES AROUND WEANING

Genetic selection on rabbit does have been mainly focused on prolificacy, and artificial insemination development has allowed these does to be inseminated with semen from males selected for a high growth rate. Consequently, requirements of does have greatly changed in last few years. Some work indicates that lactating rabbit does present a clear energy deficit at different times during the reproductive cycle (XICCATO, 1996) that could affect their fertility, performance and even their reproductive life.

So, most nutrition works on reproductively active rabbit does have tried to improve on their performance and corporal condition by changes in the management or in the dietary energy content. PASCUAL *et al.* (2001a), using high energy diets (12.2-12.6 MJ ED kg<sup>-1</sup> DM), showed that the perirenal fat thickness of does was maintained during the first weeks of lactation, but it considerably decreased from 21 to 28 days (weaning), especially in non-pregnant does (Figure 1). This more pronounced negative balance was mainly related to their higher milk production during the 4<sup>th</sup> week of lactation (119 and 192 g/day for intensive and extensive remating intervals, Figure 2). From these results, we could infer that a reduction of lactation requirements during the 4<sup>th</sup> week *post partum* by early weaning or by changes on the doe management, should improve that negative situation of does. In fact, XICCATO *et al.* (2001) observed a significant increase

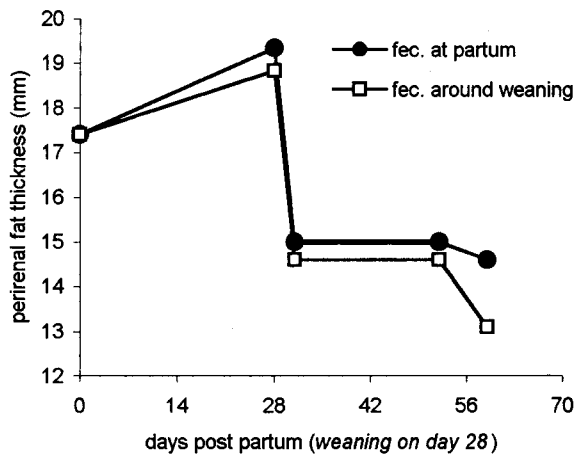


Figure 1 : Effect of remating interval on the evolution of the perirenal fat thickness in primiparous rabbit does given high-energy diets. PASCUAL *et al.* (2001a)

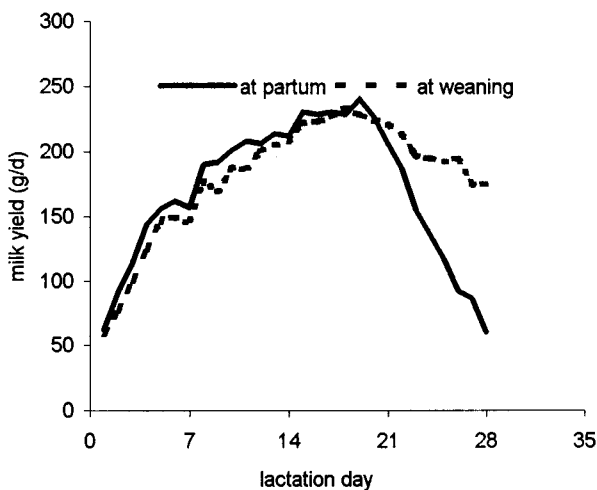


Figure 2 : Effect of remating interval (fecundation at partum or at weaning) on the evolution of milk yield on primiparous rabbit does given high energy diets. PASCUAL *et al.* (2001a)

on body energy losses of reproductive rabbit does when the weaning age of their kits increased (-8%, -14% and -19% for weaning at 21, 26 and 32 days, respectively), although a later restriction program must be advised to avoid excessive fatness of does that could affect their reproductive efficiency.

From a health point of view, we could also hypothesize that early weaning could reduce the transfer of pathogens, as it has been proved by

RIDEAUD and COUDERT (1992) for *Pasteurella multocida*. But no further result has been reported at this respect until now (GIDENNE and FORTUN-LAMOTHE, 2001), and it probably could increase the mammitis problems of does. These points should be more studied in future works.

## NUTRITION AROUND WEANING OF YOUNG RABBITS.

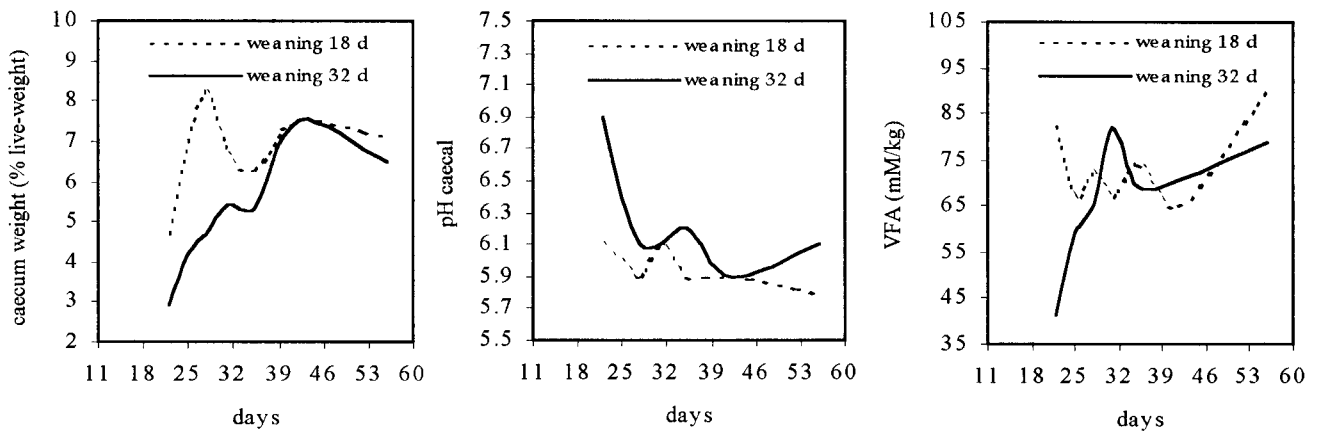
### 1. Evolution of their digestive system.

At weaning, young rabbits change from eating a milk-based diet (rich in animal protein and fat, but poor in carbohydrates) to one based on solid feed (with only plant proteins and rich in carbohydrates). Consequently their digestive system changes from an exclusively endogenous hydrolytic system to one where caecum fermentation also becomes important. We must initially study the possible effect that an early weaning practice could have on the evolution of the different digestive parameters of kits and on their health and performance during the growth period.

#### 1.1. Caecum fermentation.

Under normal weaning conditions, fermentative activity of the caecum and caecotrophy practice starts around 18-20 days of age, reaching its maximum development by the 6<sup>th</sup> week. In fact, the cellulolytic flora of caecum at the end of the 4<sup>th</sup> week has a density similar to that present in the animal at 3 months of age.

Recently, PIATTONI and MAERTENS (1999) have described the evolution (from 22 to 56 days) of the main caecal parameters of early weaned kits (18 days), compared to those weaned at 32 days of age. As shown in Figure 3, as solid intake increased (especially after weaning), caecum weight and volatile fatty acids (VFA) production increased, while caecum pH decreased (from pH 7 to 6). With respect to the effect of early weaning, all these changes start as a consequence of the earlier solid intake of kits. At 22 days of age, caecum has a greater VFA production (82 mM kg<sup>-1</sup>) and lower pH (6.1) in early weaned kits than in others. However, it must be emphasised that early weaning practice had a long-term effect on some of the parameters in this work, which could affect on the incidence of pathology during growth period. Early weaned kits showed a higher caecum activity (lower pH and a higher VFA production) at 56 days that those weaned at 32 days. Until now, although some work suggests that early weaning kits show a better adaptation to solid intake, no significant effect of early weaning on the health of young rabbits during fattening have been recorded (PIATTONI and MAERTENS, 1999; XICCATO *et al.*, 2000; GIDENNE and FORTUN-LAMOTHE, 2001).

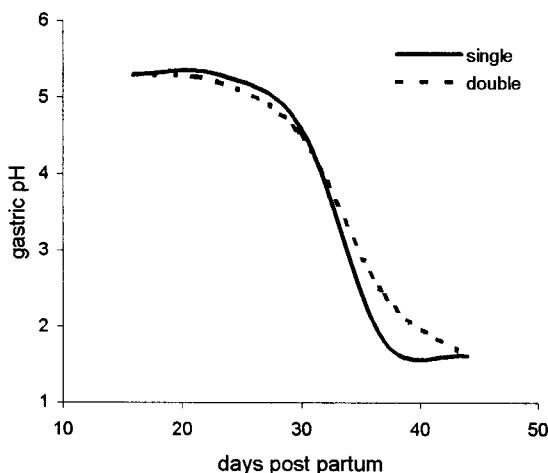


**Figure 3 : Effect of early weaning on the evolution of main caecal parameters (PIATTONI and MAERTENS, 1999)**

GIDENNE and LICOIS (2001) have observed that the type of diet used before weaning (21-29 days) could affect the caecal fermentative activity in the rabbit at 10 weeks of age. Kits receiving a low fibre diet presented a higher butyrate/acetate ratio at 10 weeks (0.26 *v.s.* 0.20) and tended to have a higher sanitary risk index after enteropathogenic *E. coli* infection (58 *vs.* 22%) than those given a standard fibre diet.

### 1.2. Enzymatic activity.

The evolution of main digestive compartments of rabbit during the pre-weaning period has been studied in a number of papers (LEBAS *et al.*, 1971 ; PIATTONI *et al.*, 1995 ; DOJANA *et al.*, 1998). So, in the present review only the effect of early weaning on this evolution has been considered.



**Figure 4 : Effect of double suckling on the gastric pH evolution of kits around weaning (ZOMBORSKY-KOVÁCS *et al.*, 2000)**

**Gastric pH.** The gastric pH of kits is usually high (around 6) and relatively constant during the first 21 days of lactation, decreasing as their solid feed intake increases (BROOKS, 1978; ZOMBORSKY-KOVÁCS *et al.*, 2000). There are no references in the literature about the possible effect of early weaning on the gastric pH evolution, but it is reasonable to believe that it could be different. In fact, ZOMBORSKY-KOVÁCS *et al.* (2000) showed that the gastric pH decrease on double suckled kits was slower than for single suckled kits (Figure 4). Taking into account that stomach pH is their first defensive barrier against pathogens, early weaning of kits (18-23 days) could increase the incidence of post-weaning diarrheas because kits should still show a high gastric pH.

**Carbohydrate digestion.** Starch digestion mainly happens at the intestine level (pancreatic amylase), but salivary amylase and microbial amylase of caecal origin may also be active. Salivary (BLAS, 1986) and caecal amylases (BLAS, 1986; MAROUNEK *et al.*, 1995) showed a similar activity at the 4<sup>th</sup> week of age than to those present in adult rabbits, but pancreatic amylase don't reach the maximum activity until the 6-8<sup>th</sup> week of age (Figure 5). As it should be expected (Table 1), kits weaned at 21 days increased their pancreatic amylase activity a little bit faster than those weaned at 30 days (CORRING *et al.*, 1972). However, amylase activity at 21 days (19.4 U pancreatic amylase/g protein) is much lower than that present at 30 days in kits weaned at 21 or 30 days (158 or 120 U pancreatic amylase/g protein), casting doubts if starch digestion would be complete, avoiding the possible problems associated with incomplete intestinal starch digestion.

Consequently, in diets designed for weaning we must take into account the type and level of the different carbohydrates (starch, fibre, ...). With

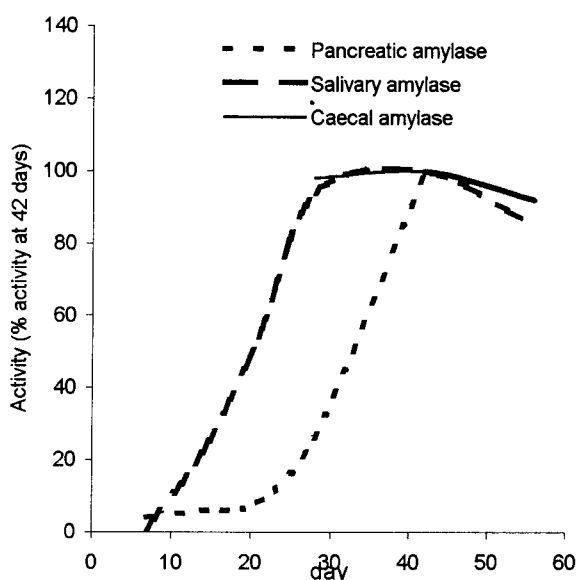


Figure 5.: Effect of age on digestive amylase activity (BLAS, 1986)

respect to the most adequate starch/fibre ratio, the literature results are contradictory or different with respect of the weaning system used. GUTIERREZ *et al.* (2001a) observed that a high starch/NDF post-weaning diet (19.5/30) had a higher nutrient digestibility in kits weaned at 25 days, improving their growth (+2 g/day) and survival index (+8%) during the growth period in contrast to a diet with a low starch/NDF ratio (15/36). However, FORTUN-LAMOTHE *et al.* (2001) found that kits given a high starch/NDF diet (18.5/27.9) from 18 days to weaning (32 days) presented a lower pre-weaning feed intake and a higher sanitary risk index during the growth period than those given a diet with a lower starch/NDF ratio (16.9/28.2). DE BLAS *et al.* (1999) proposed that a portion of the starch could arrive in the caecum depending on its level and type (maize, barley, peas, ...). In fact, GUTIERREZ *et al.* (2000a) observed a lower mortality from 25 to 39 days (3.5 vs. 8% of mortality) on early weaned kits (25 days) given high starch diets (18.2 to 21.6%) when some commercial enzymes ( $\alpha$ -amylase,  $\beta$ -glucanase, xylanase and pectinase) were added to the diet.

On the other hand, taking into account that lactose is the main milk carbohydrate, its inclusion in weaning diets has been tested (GUTIERREZ *et al.*, 2000b). However, the results were not favorable because the inclusion 12% lactose decreased the digestibility of DM (-3%), starch (-1%) and CP (-5%), affecting, in contrast to a diet without lactose, the growth (-2 g/day) and survival (mortality 2.8 times higher) of kits during the growing period.

Table 1 : Effect of early weaning on the evolution of the pancreatic amylase activity (CORRING *et al.*, 1972)

Day	U pancreatic amylase/g protein	
	Weaning at 21 d	Weaning at 30 d
7		12,9
16		18,2
21		19,4
24	32,2	25,8
28	94,4	75,9
30	157,8	120,0
32	145,1	130,4
36	184,6	166,9
43	278,0	271,6

*Protein and fat digestion.* Protein digestion occurs in the rabbit's stomach (gastric pepsin) and at the level of the intestine (trypsin and chymotrypsin). DE BLAS *et al.* (1999) described that pepsin activity decreased until weaning and then increased as feed intake increased and the gastric pH decreased. Pancreatic proteases decreased also from 7-8 days of age. Independently from weaning age, pancreatic trypsin increased from day 21 and chymotrypsin from day 32, with a maximum at 6 weeks of age. (LEBAS *et al.*, 1971; MAROUNEK *et al.*, 1995; DOJANA *et al.*, 1998). The importance of this increase is partly related to the ingestion of solid feed for chymotrypsin, but more in response to an ontogenetic factor for trypsin (DEBRAY *et al.*, 2001).

The protein content of rabbit milk is high (12-13%) and consequently suckling kits have a high proteolytic activity. In fact, the faecal digestibility values for the protein in the weaning diets at 25-30 days obtained by GUTIERREZ *et al.* (2001a, 2000b) are even higher (approx. 78%) than those usually obtained during the growth period at 42 days (approx. 72%). However weaning happens at the same time when proteolytic capacity is lowest, therefore the protein source (digestibility, anti-nutritive factors, ...) for weaning diets must be carefully selected.

The fat of rabbit milk is usually high (15-25%), especially at the beginning and at the end of lactation, and inversely correlated with the milk yield (PASCUAL *et al.*, 1999). It's reasonable that kits showed a significant lipasic activity at gastric and intestinal level at the beginning of lactation (DOJANA *et al.*, 1998), and then a decrease as the milk is changed by the addition of solid feed. These diets don't present a high fat content (max. 5-6%), and some limitation on dietary fat digestion should be expected when kits were early weaned.

The milk fat and protein that suckling kits received during their first few days of life are very digestible. Therefore, we must be careful of protein and fat sources to be used for the weaning diets formulation. XICCATO *et*

**Table 2 : Effect of solid food intake before weaning (21-28 days) on the performance of growing rabbits (PASCUAL *et al.*, 2001b).**

	Solid food intake before weaning			SE	Prob.
	Low	Medium	High		
No of kits	210	200	180		
<b>Before weaning (21-28 days)</b>					
Solid food intake (g day <sup>-1</sup> LW <sup>0.75</sup> )	130 <sup>a</sup>	150 <sup>b</sup>	170 <sup>c</sup>	1.7	0.001
Milk intake (g day <sup>-1</sup> kit <sup>-1</sup> )	20 <sup>b</sup>	15 <sup>a</sup>	14 <sup>a</sup>	1.0	0.001
Live weight at 28 days (g kit <sup>-1</sup> )	458 <sup>b</sup>	435 <sup>a</sup>	409 <sup>a</sup>	21.7	0.031
<b>Growing period (28-63 days)</b>					
Food intake (g day <sup>-1</sup> kit <sup>-1</sup> )	81.6 <sup>a</sup>	89.1 <sup>a</sup>	97.1 <sup>b</sup>	2.2	0.023
Live weight at 63 days (g kit <sup>-1</sup> )	1704	1622	1692	47.0	0.634
Mortality (%): 28-35 days	1.4	1.0	2.2	1.07	0.758
35-63 days	17.6	12.5	7.7	6.75	0.071

<sup>ab</sup> Means with a different superscript differ at  $p < 0.05$ .

*al.* (2000) designed a starter diet for early weaned kits based on the substitution of barley by animal fat (2%) and skimmed milk (2%) as energy and protein substitutes, improving the individual live weight of kits at 32 days (+3.2 %).

As protein substitute, animal protein (plasma) has been evaluated successfully (GUTIERREZ *et al.*, 2000c) but, because its a product of animal origin, its possible utilisation is now in doubt from a legal point of view. However, the type of vegetal protein source used in the formulation of weaning diets must be taken into account. GUTIERREZ *et al.* (2001), comparing different vegetal protein sources (soybean meal, concentrate of soybean protein, sunflower meal and concentrate of potato protein) observed that when soybean or potato were used, the mortality during the growth period increased (26 and 44%, respectively) as compared to the use of sunflower (20%). The authors supposed that some antigenic factors (glicinine and  $\beta$ -conglicine), oligosaccharides or glyco-alkaloids present on soybean grain and or the potato could damage the intestinal mucous in young rabbits increasing the incidence of diarrhea, as have been just observed for piglets and also for young rabbits (SCHEELE and BOLDER, 1987).

There is not information available about the most adequate fat source, in spite of many weaning diets in the literature having been formulated with a high fat content (6-7%). We can only indicate that litters given a diet rich in vegetal oil during the last week of lactation showed a higher growth (250 g/day) than those given a diet rich in starch or animal fat (210 g/days in both cases) for a similar milk and solid food intake (PASCUAL *et al.*, 2001b).

## 2. Weaning age.

The experiments where the weaning was carried out at 14 days (ultra-early weaning) showed a series of troubles related to training and adaptation of kits to eat the replacement milk or pelleted diets, obtaining contradictory results. PRUD'HON and BEL (1968), comparing animals weaned at 14 and 32 days, observed

that early weaning kits adapted well to solid intake, arriving at 8-9 weeks with a similar live weight as those weaned at 32 days with no differences in total mortality. However, MCNITT and MOODY (1992) and FERGUSON *et al.* (1997) observed that kits weaned at 14 days showed a low ingestion, and consequently, lower growth and higher mortality than those weaned at 28 days.

Early weaning was less problematic when young kits showed a slight solid feed intake (18-21 days). PIATTONI *et al.* (1999) found that the kits weaned at 18 days don't eat any solid feed for 1 or 2 days, but they showed an earlier

adaptation to the solid food intake than those weaned at 32 days, affecting their growth slightly, but not their mortality. XICCATO *et al.* (2000) and TROCINO *et al.* (2001), comparing kits weaned at different ages (21, 25, 28 and 32), observed that early weaned kits (21 and 25 days) showed a lower weight at 32 days (678 and 679 g, respectively) that those weaned at 28 and 32 days (704 and 719 g, respectively), but the 4 groups presented a similar weight at 56 days (approx. 1850 g), with no difference in mortality. Similar results have been recently obtained by GIDENNE and FORTUN-LAMOTHE (2001), although a higher mortality during the late weaning period (32-45 days) was registered for early weaning kits in spite of the use of an specific weaning diet (17.2 and 9.2 % mortality for rabbits weaned at 23 and 32 days, respectively).

Finally, there seems to be a relationship between a high and early adaptation to solid food intake with the total food intake and digestive troubles susceptibility registered during the growth period (MAERTENS and DE GROOTE, 1990; FORTUN-LAMOTHE *et al.*, 2001). Frequently, animals showing earlier high solid food intake (Table 2), usually as a consequence of a low milk intake, present a higher food intake and growth during the fattening, and show a tendency to suffer a lower number of "digestive troubles" (PASCUAL *et al.*, 2001b). Therefore, independently of early weaning practice, it seems interesting to study different ways to promote the solid intake of kits during the last weeks of lactation.

## CONCLUSIONS

1. Early weaning between 21-25 days seems to be a feasible practice that could have interesting possibilities from a productive point of view: improving the corporal condition of does and allowing a specific nutrition of kits around weaning time.

2. However, more information about its effect on the incidences of pathology registered during the growth

period is needed. Actually, only incidences on the adaptation period (21-32 days) have been reported, but no long-term effect could be clearly deduced.

3. The only factor that seems to be related with the predisposition to suffer digestive disorders during fattening is the earlier adaptation to solid food intake. More information about this topic (feeding management systems, weaning diets, weaning age,...) is required in the future.

4. Finally, for weaning diets, formulation has to be considered that: a) the kits do not have a great capacity for carbohydrate digestion, b) the type of protein and fat used could affect their following performance and, c) a high solid food intake should be promoted to improve the maturity of their digestive system.

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## REFERENCES

- BLAS E., 1986. El almidón en la nutrición del conejo: utilización digestiva e implicaciones prácticas, *Doctoral Thesis, Universidad de Zaragoza*, 227 pp.
- BROOKS D.L. 1978. Endemic diarrhea of domestic rabbits in California. *Doctoral Thesis, California University*.
- CORRING T., LEBAS F., COURTOT D., 1972. Contrôle de l'évolution de l'équipement enzymatique du pancréas exocrine du lapin de la naissance a 6 semaines. *Ann. Biol. Anim. Bioch. Biophys.*, **12**, 221-231.
- DEBRAY L., GIDENNE T., FORTUN-LAMOTHE L., 2001. Evolution of intestinal enzymatic digestive capacity of rabbit around weaning. *2<sup>nd</sup> Meeting of workgroup 3 and 4. COST Action 848. Gödöllő. Hungary*.
- DE BLAS C., GUTIERREZ I., CARABAÑO R., 1999. Destete precoz en gazapos. Situación actual y perspectivas. *XV Curso de Especialización FEDNA, Madrid*, 67-81.
- DOJANA N., COSTACHE M., DINISCHIU A., 1998. The activity of some digestive enzymes in domestic rabbits before and after weaning. *Anim. Sci.*, **66**, 501-507.
- FERGUSON F.A., LUKEFAHR S.D., McNITT J.I., 1997. A technical note on artificial milk feeding of rabbit kits weaned at 14 days. *World Rabbit Sci.*, **5**, 65-70.
- FORTUN-LAMOTHE L., GIDENNE T., DEBRAY L., CHALAYE F., 2001. Intake regulation, performances and health status according to feeding strategy around weaning. *2<sup>nd</sup> Meeting of workgroup 3 and 4. COST Action 848. Gödöllő. Hungary*.
- GIDENNE T., LICOIS D., 2001. Interaction between nutritional status and digestive pathology of the growing rabbits: resistance to an enteropathogenic strain of *Escherichia coli* according to dietary fibre level and consequences on caecal fermentative activity. *2<sup>nd</sup> Meeting of workgroup 3 and 4. COST Action 848. Gödöllő. Hungary*.
- GIDENNE T., FORTUN-LAMOTHE L., 2001. Early weaning: effect on performance and health. *2<sup>nd</sup> Meeting of workgroup 3 and 4. COST Action 848. Gödöllő. Hungary*.
- GUTIERREZ I., ESPINOSA A., GARCIA J., CARABAÑO R., DE BLAS J.C., 2000a. Efecto de la sustitución de fibra por almidón en piensos de gazapos destetados precozmente. *Expoaviga 2000, Barcelona (Spain)*.
- GUTIERREZ I., ESPINOSA A., GARCIA J., CARABAÑO R., DE BLAS J.C., 2000b. Efecto de la sustitución de almidón por lactosa en piensos de gazapos destetados precozmente. *Expoaviga 2000, Barcelona (Spain)*.
- GUTIERREZ I., CACHALDORA P., CARABAÑO R., DE BLAS J.C., 2000c. Effect of supplementation with animal plasma and antibiotics of starter diets for rabbits. *World Rabbit Sci.*, **8**, 269-275.
- GUTIERREZ I., ESPINOSA A., CARABAÑO R., DE BLAS J.C., 2001a. Alimentación de gazapos destetados precozmente I. *XXVI Symposium Cunicultura, Aveiro, Portugal*, 98-108.
- GUTIERREZ I., ESPINOSA A., CARABAÑO R., DE BLAS J.C., 2001b. Alimentación de gazapos destetados precozmente II. *XXVI Symposium Cunicultura, Aveiro, Portugal*, 110-116.
- LEBAS F., CORRING T., COURTOT D., 1971. Equipement enzymatique du pancréas exocrine chez le lapin, mise en place et évolution de la naissance au sevrage. relation avec la composition du régime alimentaire. *Ann. Biol. Anim. Bioch. Biophys.*, **11**, 399-413.
- MAERTENS L., DE GROOTE G., 1990. Feed intake of rabbit kits before weaning and attempts to increase it. *J. Appl. Rabbit Res.*, **13**, 151-158.
- MAROUNEK M., VOVK S.J., SKRIVANOVA V., 1995. Distribution of activity of hydrolytic enzymes in the digestive tract of rabbits. *British J. Nutr.*, **73**: 463-469.
- McNITT J.I., MOODY G.L., 1992. A method for weaning rabbit kits at 14 days. *J. Appl. Rabbit Res.*, **15**, 661-665.
- PADILHA T.S.M., LICOIS D., GIDENNE T., CARRE B., FONTY G., 1994. Evolution de la microflore et de l'activité fermentaire caecale chez le lapereau pendant la période peri-sevrage: premier résultats. *Vèmes Journées de la Recherche Cunicole, La Rochelle, vol 2*, 341-346.
- PASCUAL J.J., CERVERA C., BLAS E., FERNANDEZ-CARMONA J., 1999. Effect of high fat diets on the performance, milk yield and milk composition of multiparous rabbit does. *Anim. Sci.*, **6**: 151-162.
- PASCUAL J.J., QUEVEDO F., FERNANDEZ-CARMONA J., CERVERA C., 2001a. Utilización de piensos energéticos en conejas primíparas. II.- Condición corporal. *XXVI Symposium Nacional de Cunicultura, Aveiro, Portugal*, 136-144.
- PASCUAL J.J., CERVERA C., FERNANDEZ-CARMONA J., 2001b. Effect of solid food intake before weaning on the performance of growing rabbits. *2<sup>nd</sup> Meeting of workgroup 3 and 4. COST Action 848. Gödöllő. Hungary*.
- PIATTONI F., MAERTENS L., 1999. Effect of weaning age and solid feed distribution before weaning on the caecal fermentation pattern of young rabbits. *11. Arbeitstagung über Haltung und Krankheiten der Kaninchen, Pelztiere und Heimtiere, Celle, Ed. Deutsche Vet. Med. Gesellschaft e. V., Giessen*, 97-105.
- PIATTONI F., MAERTENS L., DEMEYER D., 1995. Age dependent variation of caecal contents composition of young rabbits. *Arch. Anim. Nutr.*, **48**, 347-355.
- PRUD'HON M., BEL L., 1968. Le sevrage précoce des lapereaux et la reproduction des lapines. *Ann. Zootech.*, **17**: 23-30.
- RIDEAUD P., COUDERT P., 1992. Pasteurella epidemiology. Effect of age of weanling rabbits. *J. Appl. Rabbit Res.*, **15**, 1411-1414.
- SCHEELE C.W., BOLDER N.M., 1987. In: *Rabbit Production Systems including Welfare*. Ed. E.C. Bruxelles, 115-125.
- SCAPINELLO C., GIDENNE T., FORTUN-LAMOTHE L., 1999. Digestive capacity of the rabbit during the post-weaning period according to the milk/solid feed intake pattern before weaning. *Reprod., Nutr. Devel.*, **39**, 423-432.
- TROCINO A., XICCATO G., SARTORI A., QUEAQUE P.I., 2001. Effect of starter diet and weaning age on growth, caecal fermentation and body composition of young rabbits. *2<sup>nd</sup> Meeting of workgroup 3 and 4. COST Action 848. Gödöllő. Hungary*.
- XICCATO G., 1996. Nutrition of lactating does. In: *Proc. 6<sup>th</sup> World Rabbit Congress. Toulouse, vol. 1*, 29-47.
- XICCATO G., TROCINO A., SARTORI A., QUEAQUE P.I., 2000. Early weaning of rabbits: effect of age and diet on weaning and post-weaning performance. In: *Proc. 7<sup>th</sup> World Rabbit Congress, Valencia, Vol. C*, 483-490.
- XICCATO G., TROCINO A., QUEAQUE P.I., SARTORI A., 2001. Effect of weaning age and parity order on reproductive performance and body balance of rabbit does. *2<sup>nd</sup> Meeting of workgroup 3 and 4. COST Action 848. Gödöllő. Hungary*.
- ZOMBORSKY-KÓVAS M., GYARMATI T., PÁRIZS T., SZENDRŐ Zs., KAMETLER L., TÓTH Á., 2000. Some physiological properties of the digestive tract in traditionally reared and exclusively milk-fed young rabbits. In: *Proc. 7<sup>th</sup> World Rabbit Congress, Valencia, Vol. C*, 499-506.