

EFFECT OF TWO DIETS WITH VARIED STARCH AND FIBRE LEVELS ON THE PERFORMANCES OF 4-7 WEEKS OLD RABBITS

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SUMMARY : 1200 weaned crossbred rabbits, individually controlled, were fed *ad libitum* on Diet A (16.4 % starch, 15.3 % CF) or Diet B (24.8 % starch, 11.6 % CF) from 28 to 49 days of age. Live weight gain was not affected by diet (37.7 g/day). Feed intake and feed conversion were higher with Diet A (95.5 vs 84.5 g/day and 2.55 vs 2.27 g/g, $P < 0.001$). Mortality was however lower with this diet (4.7 vs 8.0 %, $P < 0.05$). Another group of 60 rabbits was slaughtered at 38

or 49 days of age, the starch content of their digesta at the distal ileum and caecum was determined. Starch content of ileal digesta and its difference with that of caecal digesta varied with diet (higher in Diet B, $P < 0.001$) and age (higher at 38 days, $P < 0.001$); interaction between diet and age was also detected ($P < 0.05$), since the difference between diets was larger at the earlier age.

RÉSUMÉ : Effet de deux régimes à taux d'amidon et de fibres différents sur les performances de lapins âgés de 4 à 7 semaines.

1200 lapins hybrides sevrés, individuellement contrôlés, ont été nourris *ad libitum* avec un aliment A (16,4 % d'amidon, 15,3 % de fibres brutes) ou B (24,8 % d'amidon et 11,6 % de fibres brutes) de 28 à 49 jours d'âge. Le gain de poids vif n'a pas été affecté par l'aliment (37,7 g/jour). La consommation et l'indice de consommation étaient plus élevés avec l'aliment A (95,5 vs 84,5 g/jour et 2,55 vs 2,27 g/g, $P < 0.001$). En outre

la mortalité était plus faible avec cet aliment A (4,7 vs 8,0 %, $P < 0.05$). Un autre groupe de 60 lapins fut abattu à 38 ou 49 jours d'âge, l'amidon du contenu de l'iléon distal et du caecum ont été analysés. La teneur en amidon du contenu iléal et sa différence avec la teneur du contenu caecal varient en fonction de l'aliment (plus élevé pour l'aliment B, $P < 0.001$) et de l'âge (plus élevé à 38 jours, $P < 0.001$); l'interaction entre l'aliment et l'âge est significative ($P < 0.05$), la différence entre les aliments étant plus importante pour les lapins les plus jeunes.

INTRODUCTION

The role of low starch-high fibre diets in the reduction of mortality of rabbits during the post weaning period was originally supported by the hypothesis that an overload of starch in the hind gut could produce some undesirable microbial growth (CHEEKE and PATTON, 1980). Later, BLAS (1986) found a higher starch content in digesta from distal ileum of 4-6 weeks-old rabbits fed on a high starch diet, when compared to either a low starch diet or to older rabbits; this could be explained by the fact that the secretion of pancreatic amylase is not well established at an early age (CORRING *et al.*, 1972; BLAS, 1986).

In order to prevent digestive disorders, special diets for rearing rabbits until 6-7 weeks of age become popular over the last few years (DE BLAS, 1990; MAERTENS, 1992). These are characterised by their

starch or fibre levels, at lower or higher than those normally included in standard fattening diets.

However, there are only two substantial works which used normal levels of starch and fibre on large groups of animals under practical conditions and which confirm the reduction of mortality rate (LEBAS and MAITRE, 1989; MAITRE *et al.*, 1990).

The present work aims to verify this effect and to relate it to the amount of starch reaching the caecum.

MATERIALS AND METHODS

Diets

Two diets were formulated. Diet A was lower in starch and higher in fibre than Diet B. In both diets, maize and alfalfa hay were the main sources of starch and fibre. Amino acids, minerals and vitamins were

Table 1 : Composition of experimental diets.

	Diet A	Diet B
<i>Ingredients</i>		
Maize	20	40
Wheat bran	20	-
Soya bean meal, 44 % CP	9	18
Alfalfa hay, 14 % CP	50	40
Calcium carbonate	0.2	0.4
Dibasic calcium phosphate	0.2	1.0
Salt	0.4	0.4
Trace minerals/vitamins	0.2	0.2
<i>Analysis</i>		
Dry matter	90.8	90.3
Crude fibre	15.3	11.6
A D F	21.4	16.2
N D F	30.2	21.6
Starch	16.4	24.8
Crude protein	16.2	17.0
Calculated DE *, MJ/kg	9.7	10.9

* according to DE BLAS and VILLAMIDE (1989) and MAERTENS *et al.* (1990).

adjusted according to LEBAS (1989) and robenidine was added as coccidiostatic (60 ppm). Both diets were pelleted in September 1992 and September 1993, different batches of the raw materials being used each time. The ingredients and analysis of the diets are shown in Table 1

Growth trial

Three-way crossbred rabbits were housed in individual cages from weaning at 28 days, each litter was divided between the two diets. Rabbits were fed *ad libitum* for 21 days. Feed intake, live weight gain and mortality were recorded. The experiment was carried out during two eight-month periods (October–May) for two consecutive years, the monthly averages of daily minimum and maximum indoor temperatures ranged from 12 to 20°C and from 16 to 24°C. A total of 1200 animals were controlled (600 rabbits per diet).

Sampling of ileal and caecal digesta

Another 60 animals were handled as previously described but these were slaughtered at 38 or 49 days (15 rabbits per diet and age). Killing was performed between 20 and 21 hours, when the daily period of high intake was going on. The digestive tract was removed and samples of digesta were obtained from ileum (the whole content of the last ten centimetres) and caecum (2–3 grams of content was taken from its central part). Digesta samples were freeze-dried and their starch content determined.

Chemical analysis

Dry matter, crude protein and crude fibre were analysed according to AOAC (1984). Detergent fibres were determined following the methods of VAN SOEST and WINE (1967) and VAN SOEST (1963), adapted by GIGER *et al.* (1979), with treatment by thermostable amylase (Novo) before the extraction with neutral detergent solution. Starch was hydrolysed according to a two-step enzymatic procedure (Tecator, application note 85/86), again using thermostable amylase followed by amyloglucosidase (Merck); resultant glucose was measured by the hexokinase/glucose-6-phosphate dehydrogenase/NADP system (Boehringer).

Statistical analysis

Feed intake, live weight gain and feed conversion were analyzed by one-way analysis of variance to compare diets. The relationship between mortality and diet was analysed by a Chi-square test. Starch content of ileal and caecal digesta and their difference were analysed by two-way analysis of variance to examine the effects of diet and age; when interaction resulted significant ($P < 0.05$), means were compared with Duncan's multiple range test.

RESULTS

Growth performances

Feed intake, live weight gain, feed conversion and mortality during the growth trial are summarized

Table 2 : Performances during the growth trial (28-49 days) depending on the diet.

	Diet A	Diet B	SEM*	Significance P
Initial live weight, g	565	569	3.0	0.490
Feed intake, g/day	95.5	84.5	0.47	<0.001
Live weight gain, g/day	37.7	37.7	0.21	0.972
Feed conversion, g/g	2.55	2.27	0.008	<0.001
Mortality, %	4.7	8.0	-	0.018

* Standard error of mean.

Table 3 : Starch content of digesta (% D M basis) depending on the diet and the age.

	Diet A		Diet B		SEM*	Significance P		
	38 days	49 days	38 days	49 days		Diet	Age	Diet/Age
Ileal digesta (1)	6.8 ^b	3.9 ^c	12.9 ^a	6.3 ^b	0.34	<0.001	<0.001	0.010
Caecal digesta (2)	5.2	3.8	6.4	4.3	0.22	0.061	<0.001	0.442
(1) - (2)	1.6 ^b	0.1 ^c	6.5 ^a	2.0 ^b	0.24	<0.001	<0.001	0.012

* Standard error of mean; a,b,c means within a line with different superscripts differ significantly (P<0.05).

in Table 2. Only live weight gain was not affected by diet, both diets showing an identical value. Feed intake and feed conversion were higher with Diet A. However, mortality was lower with this diet.

Starch content in ileal and caecal digesta

Results are shown in Table 3 and Figure 1. Starch content in ileal digesta varied with diet (higher in Diet B) and age (higher at 38 days); interaction between diet and age was also detected, the difference between diets was greater at the earlier age. Starch content in caecal digesta was lower than in ileal digesta and similarly varied with diet (near significant P level) and age, but no interaction between these factors was observed. Finally, the difference of starch content between ileal and caecal digesta fitted the pattern described for starch content in ileal digesta.

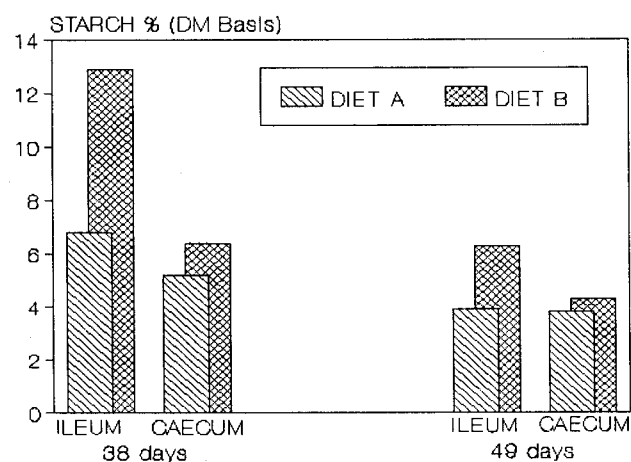


Figure 1 : Starch content of digesta

DISCUSSION

Results of the growth trial were closely related to the energy value of the diets. It is well established

that growing rabbits fed *ad libitum* modify their food intake level according to the dietary energy content in order to achieve constant energy intake and growth rate. This compensatory response is successful when the energy content of diet is above 9.5 MJ DE/kg (FRAGA, 1989) or the fibrous level is below 15-19 % CF or 21-26 % ADF (DAVIDSON and SPREADBURY, 1975; PARIGI-BINI and CHERICATO, 1980; DE BLAS *et al.*, 1986). In our experiment, the DE intake and growth rate were very similar for both diets (924 kJ and 37.7 g per day).

Because of its influence on the production of rabbit farms, the effect of diet on mortality must be emphasized. Our results closely agree with those reported by LEBAS and MAITRE (1989) in an experiment which involved a considerable number of animals (around 1700 rabbits per diet) : mortality from 28 until 45 days was higher with a 25 % starch and 13.5 % CF diet than with a 15 % starch and 15 % CF diet (9.8 % vs 4.6 %, respectively), the former diet being low in protein and giving low live weight gain. Similarly, MAITRE *et al.* (1990) reported a decreasing mortality (from 8.75 % to 3.75 %) when comparing four diets gradually varying from 21 % starch and 15 % ADF to 17 % starch and 21 % ADF, with 380 rabbits per diet controlled from 28 days to 49 days. Other works have also shown this trend (GROBNER *et al.*, 1983; DE BLAS *et al.*, 1986; ROBINSON *et al.*, 1988), but their experimental conditions were not so similar to ours (very few controlled animals, longer rearing period, greater dietary variations).

Our results on the starch content of ileal digesta agree with those of BLAS (1986). He found higher starch content at terminal ileum taken from rabbits of 28 or 42 days fed on a high starch barley-based diet compared to a low starch wheat bran-based diet, the difference being also more evident in younger animals. In the present work, starch content of ileal digesta was much higher than any previously reported, probably because maize starch is less digestible than other starches (BLAS *et al.*, 1990; GIDENNE *et al.*, 1990). In adult rabbits, the starch content of ileal digesta was

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also higher with a maize-based diet than with a barley-based diet (GIDENNE and PEREZ, 1993).

Our diets caused different starch intake (15.7 vs 21.0 g per day, with Diet A and Diet B respectively). This fact, together with the age related development of the secretion of pancreatic amylase (CORRING *et al.*, 1972; BLAS, 1986), could affect the digestion of starch. Thus, in the absence of direct measurements, results on starch contents of digesta would suggest some consideration about starch ileal flow and its degradation in the caecum. These figures could be higher in Diet B and they should become specially significant at earlier age. In this case, starch content of ileal digesta and its difference with that of caecal digesta seem much too high to be compensated by lower DM intake, more extensive DM digestion in small intestine and less DM disappearance in caecum (to be expected with a more concentrated diet). This hypothesis appears to be supported by data on ileal and overall organic matter digestibilities from adult rabbits fed on diets differing more substantially than ours in their starch and fibre levels (GIDENNE, 1992; BLAS *et al.*, 1994).

Therefore, increased mortality on Diet B could be related to starch overload in the hind gut and the subsequent undesirable fermentation and growth of caecal microflora, as CHEEKE and PATTON (1980) suggested. *Clostridium spiroforme* and its glucose-dependent production of iota-toxin is involved in digestive disorders of growing rabbits (BORRIELLO and CARMAN, 1983; CARMAN and BORRIELLO, 1984; PEETERS *et al.*, 1986). Recently, PEETERS *et al.* (1993) reported that the experimental infection with *Clostridium spiroforme* caused clinical signs of iota-enterotoxemia in weaned rabbits fed on a 26 % starch and 13 % CF diet but not when fed on a 13 % starch and 15 % CF diet.

The proportion and intake of fibre also varied between our diets, this must also be considered as important in maintaining a well balanced caecal microbial ecosystem. Fibre promotes the turnover rate of hind gut contents and the cell wall degradation in adult rabbits fed *ad libitum* (GIDENNE, 1992). This latter effect has been observed in young animals (BLAS *et al.*, 1990).

Our results support the need for lower starch levels and higher fibre levels in diets for rabbits in the first three weeks after weaning, this is in line with current recommendations (DE BLAS, 1990; MAERTENS, 1992). These authors advise diets with 13.5–18 % starch as a maximum and 15.5–16 % CF as a minimum, provided energy to be at least 9.4–9.6 MJ DE/kg. Recent works involving 11–12 % starch and 16.5–17 % CF diets compared to 13.5–15.5 % starch and 15–15.5 % CF diets reported no consistent

effects on mortality rate (DUPERRAY, 1993; MOUSSET *et al.*, 1993).

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