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STIMULATE FEED INTAKE BEFORE WEANING AND CONTROL INTAKE AFTER WEANING TO OPTIMISE HEALTH AND GROWTH PERFORMANCE

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Abstract: Post-weaning feed restriction is a common practice in rabbit farming to reduce mortality, but results in lower growth performance and slaughter weights. This study aimed to assess the influence of 2 diets both rich in fibre and low in starch, with high or low digestible energy (DE) and digestible protein (DP) contents for a constant DP/DE ratio offered from 18 to 70 d of age, on the growth performance and health parameters of rabbits. Eight hundred rabbit kits were divided in 2 experimental groups differing in the feed offered from 18 to 70 d: a high concentrate diet (HC group; 10.37 MJ DE/kg DM and 102 g DP/kg DM) or low concentrate diet (LC group; 9.63 MJ DE/kg DM and 95 g DP/kg DM). Feed was offered *ad libitum* before weaning (35 d) and from 63 to 70 d, while feed offered from 35 to 63 d was controlled to obtain similar DE intake in both groups. Feed intake, animal weights and health status were recorded weekly. Mortality was recorded daily. Feed intake was similar in both groups before weaning (P=0.204), and consequently the DE intake was higher in the HC group compared to the LC group before weaning (3.91 *vs.* 3.39 MJ, respectively; P=0.017). Feed intake from 63 to 70 d was lower in the HC than in the LC group (229 *vs.* 239 g/d/kit, respectively; P<0.001). Total DE ingested after weaning was similar in both groups (45.44 MJ; P=0.143). Kits were heavier in the HC group throughout the study (P<0.05). A higher average daily gain during the periods of 18-28, 35-42 and 56-63 d was seen in the HC group (+8.1%, +16.8% and +4.5%, respectively; P<0.05). Mortality and morbidity rates were similar between groups throughout the study (P=1.0 and P=0.104, respectively). Our results suggest that when the feed intake after weaning is controlled, i) the feeding strategy before weaning determines the weight at weaning and at slaughter age; and ii) rabbits fed a diet more highly concentrated but rich in fibre increase their growth performance without negative consequences on their digestive health.

Key Words: feeding strategy, health status, pre-weaning, rabbit.

INTRODUCTION

Alternative strategies to antibiotic use, such as feeding strategies or probiotics, are an important topic in livestock production. Post-weaning feed restriction is a commonly used practice in French rabbit breeding systems as a mean to reduce the incidence of post-weaning digestive troubles and improve feed efficiency (Gidenne *et al.,* 2012). Feed intake levels limited to 80% compared to animals fed *ad libitum* have been found to reduce post-weaning mortality and the feed conversion ratio (FCR), yet have a negative impact on growth performance (Di Meo *et al.,* 2007; Gidenne *et al.,* 2012). One strategy to overcome the reduced growth performance could be to increase the digestible energy (DE) level of the feed. The effect of feed energy content on health and performance in young rabbit has previously been studied in animals fed either *ad libitum* (Renouf and Offner, 2007; Montessuy *et al.,* 2009) or restricted (Knudsen *et al.,* 2014), but these studies have focused on the young rabbits after weaning.

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Weaning can be a very stressful period for young rabbits if they undergo both an abrupt change of diet and environment as well as separation from their mother. Digestive troubles frequently arise around weaning, when young rabbits switch from a diet rich in starch and energy, adapted to the needs of reproductive females, to a diet high in fibre and low in starch in order to protect the digestive health of the growing rabbits (Perez *et al.,* 2000). This explains why the most common current feeding strategy in rabbit farms is to distribute energy-rich food during the first 4 wk of lactation to meet the needs of females, then more fibre rich food in the week before weaning to avoid adding the stress of a feed composition change to that of weaning (Combes *et al.,* 2013). With the introduction of separate feeding systems for does and litters (Fortun-Lamothe *et al.,* 2000; Mirabito and Bocquier, 2005), feed changes before weaning would no longer be needed and therefore a reduction of adverse effects could be seen in both the does and kits (Fortun-Lamothe *et al.,* 2005).

The aim of this study was to optimise the growth performance and health status using a high-energy diet distributed at the onset of solid feed ingestion to optimise the growth performance, combined with a feed restriction put in place after weaning to promote the health status of rabbits.

MATERIALS AND METHODS

The experiment was designed and carried out according to the European Union recommendations on the protection of animals used for scientific purposes (European Union, 2010) at the PECTOUL Experimental Unit (INRA, Toulouse, France), and was approved by the French government (n°0873.01).

Animals, diet and experimental design

A total of 800 rabbits of both sexes from 91 litters were used for this trial. Animals were issued from 65 rabbit does, which were selected for prolificacy (INRA 1067) and inseminated with semen from males selected for growth rate (Hypharm, France) for 2 successive reproductive cycles. The litters were equalised at 10 kits 3 days (d) after birth (d 0) by cross-fostering or culling. Does and litters were housed in specific wire cages (61×68×35 cm, width×length×height) containing a nest box for kits (39×27×35 cm, width×length ×height), and maintained in a ventilated breeding unit with a 16 h light schedule (06:00 to 22:00 h). Cages were equipped to feed the kits independently from their mother without inhibiting the mother-young interactions (Fortun-Lamothe *et al.*, 2000), where the kits were prevented from eating from the mothers' feeder by the use of a weighted grill system and the doe was excluded from the area containing the kits feeder. The separate feeding system was put in place at 18 d of age. Kits had access to the mothers' area in order to suckle. Weaning took place at 35 d of age, where litters were split into cages of 5 kits/cage according to the weight ranking of each kit within its litter. The kits of ranks 2, 4, 6, 7 and 9 were kept in the experiment, the others were left out of the experiment.

Two experimental diets were used in the experiment: a low concentrated diet (LC), lower in starch (72 g/kg DM) and protein (147 g CP/kg), and a high concentrated diet (HC), richer in starch (115 g/kg) and protein (153 CP/kg DM; Table 1). The 2 diets were formulated to have similar DP/DE ratios and both diets were prepared to meet the nutrient needs of young rabbits while limiting digestive disorders without the use of antibiotics and thus have moderate starch levels (<120 g/kg), a high level of neutral detergent fibre (NDF; >350 g/kg), acid detergent fibre (ADF; >200 g/kg) and acid detergent lignin (ADL; >5.5 g/kg). The hardness of the pellets was measured with a Kahl apparatus (n=20 samples), which determines the pressure required to crush a pellet (4.99 and 4.94 kg for feeds LC and HC, respectively; P=0.873). Length and diameter of the pellets were also measured using a calliper and were similar for the 2 diets (13.7 mm, P=0.24 and 4.0 mm, P=0.31, respectively).

Animals were distributed at birth into one of 2 experimental groups depending on the does' weight (4597±455 g; P=0.95) and parity (5.4±3.3; P=0.54), as well as litter size at birth (11±3 kits; P=0.97). Milk production between birth and 21 d of lactation was calculated for does of the 2 groups according to Fortun-Lamothe and Sabater (2003). All reproductive females were fed the same non medicated diet *ad libitum* throughout the study (10.57 MJ DE/kg, 128 g DP/kg, 199 g DF/kg). Kits received either diet LC or HC from 18 to 70 d.

Suckling rabbits received assigned diet *ad libitum* before weaning. From weaning to 63 d, a restriction at 80% was targeted, taking into consideration the energy content of the feed, in order to ensure that both groups ingested the same amount of energy. Feed was then offered *ad libitum* from 63 until 70 d.

Digestibility trial

A digestibility trial was carried out to determine the DE and DP content of the diets on 16 growing rabbits (8 animals per diet) at 42 d using the European standardised method (Perez *et al.,* 1995). The chemical analyses were performed on diets and faeces according to ISO methods and the recommendations of the European Group on Rabbit Nutrition (EGRAN, 2001): dry matter (DM; 24 h at 103°C; method 6496.1999), organic matter (OM), crude protein (CP; N×6.25, Dumas method, method 16634.2004), and crude energy (IKA C5000, Staufen, Germany). Measurements of fibrous fractions (NDF, ADF, ADL) in the diets were carried out according to the sequential method of Van Soest *et al.* (1991) with an amylolytic pre-treatment (AFNOR, 1997; method 16472.2007; method 13906.2008). Nitrogen levels were determined in feeds and faeces according to the Dumas combustion method using the Elementar auto-analyser (model Vario El cube, Elementar, Hanau, Germany) and converted to crude protein (N×6.25).

Measurements

Animal weight was recorded weekly from 18 to 70 d of age. Feed intake of young rabbits before weaning was measured at day of distribution (18 d), at 28 d and at 35 d. Feed intake was then measured weekly from 35 d until 70 d. Health status of the rabbits was checked at weighing. A rabbit with digestive disorders, such as mild or severe diarrhoea or bloating, was considered morbid. Animals found to be abnormally lean were also recognised as morbid animals. Mortality of kits was recorded daily from 18 to 70 d. In the case of mortality, the remaining feed for the affected cage was weighed. Dead animals were considered not to have consumed any feed for the two days preceding its death, so feed consumed per animal was recalculated accordingly.

Table 1 Ingredients, chemical composition and physical properties of experimental diets.

Item	LC	HC
Ingredients (g/kg)		
Wheat	0	100
Barley	30	34
Bran	204	111
Wheat middling	60	39
Rapeseed meal	0	56
Sunflower meal	230	230
Molasses	20	20
Apple pomace	21	30
Fruit pulp	100	57
Beet pulp	250	262
Alfalfa	60	30
Rapeseed oil	0	5
Minerals[1]	1.6	2.3
Amino acids[2]	1.9	2.9
Vitamin premix[3]	22	22
Chemical composition (g/kg)		
Crude Protein	147	153
Ash	90	85
Starch	70	112
Fat	25	29
Digestible fibre[4]	260	240
Acid detergent fibre (ADF)	222	200
Neutral detergent fibre (NDF)	386	350
Acid detergent lignin (ADL)	70	60
Crude cellulose	179	164
Starch/ADF ratio	3.3	5.8
Lysine	7.1	7.9
Methionine + Cysteine	5.3	6.0
Threonine	5.4	6.0
Physical properties of pellets		
Diameter (mm)	4.0	4.0
Length (mm)	13.8	13.5
Hardness (Kahl index; kg)	4.99	4.94

LC: Low concentrate diet. HC: High concentrate diet.

[1]Salt.

[2]Feed LC: Methionine: 0.3, Lysine: 1.6; Feed HC: Methionine: 0.4; Lysine: 2.2, Threonine: 0.3.

[3]Vitamins: A, D3, B1, E; Oligo elements: Cu2+, Fe2+, Zn2+, Mn2+; Sepiolite.

[4]Calculated as the sum of (NDF-ADF) and water insoluble pectins according to tables of ingredients (Maertens *et al.,* 2002).

Statistical analysis

All statistical analyses were carried out using R version 3.0.3 (R Development Core Team, 2013). The model used to analyse growth performance, average daily gain and FCR of rabbit kits was a linear mixed model (package nlme, R), which took into consideration the variation between animals. The experimental group was a fixed effect, the doe was a random effect and the live weight of the kits upon equalisation of the litters was a co-variable. Mortality and morbidity of kits was analysed using a chi-squared test.

RESULTS

Feed Digestibility

The apparent faecal digestibility of DM, OM, CP and gross energy was higher in the HC diet than the LC diet (+4.9, +5.1, +5.2 and +4.8 units of percentage, respectively; $P<0.01$, Table 2). The digestibility trial of the 2 experimental feeds determined a difference of 0.74 MJ DE/kg between the LC and HC diets ($P<0.001$). The digestibility coefficients found for CP was higher in the HC diet than the LC diet ($P<0.01$). Therefore, the DP content was +7 g/kg higher in the HC diet than in the LC diet. As expected, the DP/DE ratio was similar between the 2 feeds.

Feed Intake

Feed intake between 18 and 28 d, and 28 to 35 d of age was similar for both groups (Table 3; 112±35 g/kit from 1-28 d and 252±100 g/kit from 28-35 d, respectively; $P>0.1$). A large variation in feed intake levels between litters within a group was seen before weaning (18-28 d: coefficient of variation 23.9% and 34.3% for the group LC and HC, respectively; 28- 35 d: CV 38% for the 2 groups, respectively). Such variability is not explained through different availability of milk, as the milk production between birth and day 21 of lactation was similar in both groups (4250±72 g; $P=0.133$). Similar feed intake in the 2 groups before weaning led to higher DE and DP ingested in the HC group compared to the LC group (3.91 *vs.* 3.39 MJ DE/kit, $P=0.017$ and 38.6 *vs.* 33.1 g DP/kit, $P=0.019$ in the HC and LC groups, respectively, from 18-35 d of age).

During the feed restriction period, from 35 to 63 d, no remaining feed was found in the feeder, therefore feed intake corresponded to feed offered. When animals were once again fed *ad libitum*, between 63-70 d, the intake level was higher for the rabbits in the LC group compared to the HC group rabbits ($P<0.001$; Table 3). Feed intake levels varied less during the period 63-70 d (CV=4.7%) than before weaning.

Similar energy intake in the LC and HC groups from 63 to 70 d (16.43 MJ DE/rabbit/period; $P>0.1$) resulted in a similar total DE ingested from weaning to 70 d in both groups (45.29 *vs.* 45.59 MJ DE/rabbit/period for the groups LC and HC, respectively; $P>0.1$). Total DP intake after weaning was similar between the two groups (447 g DP/rabbit/period; $P>0.1$; Table 3).

Growth performance

At the beginning of the experiment (18 d) when kits began to have access to solid feed, the live weights of the kits were similar between the groups (320±54; $P=0.1$; Table 4). At 28 d, the LC group kits were significantly lighter than the kits in the HC group (–7.2%; $P=0.002$). The difference in weight was maintained throughout the study, where the

Table 2: Feed intake, apparent faecal digestibility and nutritive value of experimental diets in rabbits.

	LC	HC	s.e.m.	*P*-value
Feed intake (g DM/d)	153	142	4.18	
Apparent faecal digestibility (%)				
Dry Matter	56.8	61.7	0.9	<0.001
Organic Matter	58.8	63.9	0.9	<0.01
Crude protein	62.4	67.6	1.0	<0.01
Energy	57.9	62.7	0.8	<0.001
Nutritive value				
Digestible energy (MJ/kg DM)	9.63	10.37	0.1	0.001
Digestible protein (g/kg DM)	95	102	1.4	0.01
DP/DE (g/MJ)	9.86	9.83	0.07	0.565

LC: Low concentrate diet. HC: High concentrate diet. s.e.m: pooled standard error of means. DE: digestible energy. DP: digestible protein. DM: dry matter.

Table 3: Daily feed, digestive energy (DE) and digestive protein (DP) intake of growing rabbits before and after weaning.

Groups	LC	HC	s.e.m.	*P*-value
Feed intake (g/rabbit d)				
18-28 d	11	12	0.5	0.520
28-35 d	35	37	2.2	0.204
35-42 d	78	73	NC[4]	NC
42-49 d	106	97	NC	NC
49-56 d	118	108	NC	NC
56-63 d	130	120	NC	NC
63-70 d	240	229	1.0	<0.001
Digestible energy intake (MJ/rabbit d)				
18-28 d	0.10	0.12	0.01	0.019
28-35 d	0.34	0.38	0.02	0.137
35-42 d	0.75	0.75	NC	NC
42-49 d	1.02	1.01	NC	NC
49-56 d	1.14	1.12	NC	NC
56-63 d	1.25	1.24	NC	NC
63-70 d	2.31	2.38	0.01	0.143
Digestible protein intake (g/rabbit d)				
18-28 d	1.05	1.22	0.05	0.015
28-35 d	3.33	3.77	0.20	0.075
35-42 d	7.41	7.44	NC	NC
42-49 d	10.07	9.90	NC	NC
49-56 d	11.21	11.13	NC	NC
56-63 d	12.36	12.24	NC	NC
63-70 d	22.77	23.36	0.15	0.002

LC: Low concentrate diet. HC: High concentrate diet. s.e.m: pooled standard error of means. NC: not calculable as the variance of the feed intake for restricted groups is null.

LC group kits were –5.0% (P=0.049) and –4.4% (P<0.001) lighter than the kits in the HC group at 35 and 70 d of age, respectively. The largest weight differences between the 2 groups were seen at 28 and 42 d of age (7.2% and 7.1%, respectively).

Kits in the HC group had the highest average daily gain (ADG) during the periods of 18-28, 35-42 and 56-63 d (+8.1%, +16.8% and +4.5%, respectively, compared to the LC group kits; Table 4). The overall ADG from 35 to 70 d was found to be higher in the HC group compared to the LC group (49.6 *vs.* 47.5 g/d, respectively; P<0.001). When the animals were fed *ad libitum* again, the ADG increased drastically in both groups (87 g/d; P>0.1). The FCR was found to be lower in the HC group during the periods 35-42, 49-56, 56-63 and 63-70 d ($P < 0.001$ for all periods). After the restricted feeding period, the FCR was found to decrease by 0.96 and 0.68 points for the groups LC and HC, respectively.

Health Status

Kit mortality was low and similar in both groups throughout the study (1.49% from 18 to 70 d; P=1.0; Table 5). No difference in mortality rate or morbidity was found before or after weaning between the two groups.

DISCUSSION

The trade-off between animal performance and health is a delicate balancing act for rabbit farmers. The aim of this study was to determine the interest of combining the use of a concentrated diet, high in energy and protein but meeting fibre recommendations for growing rabbits, distributed at the onset of solid feed ingestion, to optimise

Table 4: Effect of feeding strategy on growth performance.

Groups	LC[1]	HC[2]	s.e.m.[3]	*P*-value
Weight of rabbit kits (g)				
18 d	312	333	1.9	0.099
28 d	573	617	3.2	0.002
35 d	858	903	4.4	0.049
42 d	1036	1115	4.2	<0.001
49 d	1364	1436	4.8	<0.001
56 d	1666	1750	5.3	<0.001
63 d	1919	2016	5.8	<0.001
70 d	2522	2639	6.9	<0.001
Average daily gain (g/d)				
18-28 d	26.1	28.4	0.2	<0.001
28-35 d	40.9	40.8	0.5	0.781
35-42 d	25.3	30.4	0.3	<0.001
42-49 d	46.8	45.9	0.2	0.084
49-56 d	43.2	44.6	0.2	0.117
56-63 d	36.2	37.9	0.3	0.034
63-70 d	86.1	89.0	0.4	0.154
Feed conversion ratio				
18-28 d	0.44	0.49	0.03	0.642
28-35 d	1.10	1.20	0.05	0.748
35-42 d	3.51	2.66	0.07	<0.001
42-49 d	2.33	2.32	0.07	0.773
49-56 d	2.81	2.47	0.02	<0.001
56-63 d	3.78	3.28	0.03	<0.001
63-70 d	2.82	2.60	0.01	<0.001

LC: low concentrate diet. HC: high concentrate diet. s.e.m: pooled standard error of means.

the growth performance, with a feed restriction put in place after weaning to promote rabbit health status. Through the control of feed intake, this study observed that: i) the preparation of animals before weaning has an impact on later growth performance; and ii) that a higher concentrated diet has positive effects on growth performance with no negative effects on animal health in good sanitary conditions.

In several animals, feed intake is influenced by nutrient content of the diet but also by its technological characteristics such as hardness, length or size of the pellets (rabbits: Gidenne *et al.,* 2003; Travel *et al.,* 2009; poultry: Roper and Marples, 1997 ; Bouvarel *et al.*, 2009). In our study, hardness, length and size of the pellets are similar for the 2 experimental diets. Thus, difference in feed intake should be mainly related to difference in nutritional composition.

Table 5: Health status and mortality of rabbit kits.

Groups	LC[1]	HC[2]	*P*-value
Number of kits	394	393	
Morbidity (%)			
Period 18-35 d	8.27	6.51	0.468
Period 35-70 d	10.15	6.66	0.139
Period 18-70 d	18.42	13.18	0.104
Mortality (%)			
Period 18-35 d	1.24	0.74	0.722
Period 35-70 d	0.25	0.76	0.618
Period 18-70 d	1.49	1.48	1.000

LC: Low concentrate diet. HC: High concentrate diet.

Few studies have focused on the impact of pre-weaning feeding in young rabbits on performance after weaning. Butcher *et al.* (1983) reported an interaction between the pre- and post-weaning diets on the live weight of the rabbits at the beginning of the post-weaning period (35 d), showing that kits fed a low energy diet before weaning were lighter compared to kits fed a high energy diet (804 *vs.* 930 g, respectively). After weaning, it has been well documented that rabbits regulate their ingestion according to the energy content of the feed (Xiccato and Trocino, 2010), yet studies have shown that before weaning the DE level of the feeds did not affect the feed intake (Debray *et al.,* 2002). Our results are similar to those reported in the latter study, suggesting that before weaning there is an opportunity to increase ADG in rabbit kits, resulting in higher live weight at weaning. In the present study, the difference in live weight incurred during the period before weaning was maintained until slaughter age. Similarly, piglets with lighter weaning weights have been found to have lower weight gains during the period immediately after weaning, and took longer to reach slaughter weight (Wolter and Ellis, 2001). This suggests that the preparation of the animals before weaning has an impact on subsequent growth performance.

In other species, such as swine, the increase in growth rate with an increase of DE has been well documented (Weis *et al.,* 2004; Oresanya *et al.,* 2008). Previous results on the effects of DE dietary content on growth performance of weaned rabbits are contradictory. As in the present work, Knudsen *et al.* (2014), studying the effects of dietary DE and feed intake levels, showed that growth was improved in animals fed diets containing 10.13 MJ DE/kg compared to 9.08 MJ DE/kg when feed was restricted (ADG: 42.5 *vs.* 41.5 g/d, respectively) or when fed *ad libitum* (ADG: 50.0 *vs.* 48.9 g/d, respectively). Likewise, Renouf and Offner (2007) found that growth was improved during the first 2 wk after weaning when fed *ad libitum* due to an increase in DE from 9.5 MJ to 11.3 MJ/kg (43.4 *vs.* 49.4 g/d ADG, respectively). Accordingly, a similar increase in ADG was also seen in the first 2 weeks after weaning when DE levels of diets differed by only 0.42 MJ/kg (9.96 MJ *vs.* 10.38 MJ/kg) and feed intake was restricted, although no effect on the final live weight of animals was observed (Bebin *et al.,* 2009). On the contrary, Montessuy *et al.* (2009) reported no differences in growth performance with an increase in DE content of the diet from 8.79 to 10.52 MJ/kg, which could be explained by the high mortality rate (>20%).

In the present study, the overall growth rate from weaning until slaughter was found to increase with a higher DE diet, contrary to previous studies (Renouf and Offner, 2007; Bebin *et al.,* 2009; Montessuy *et al.,* 2009). This could be explained by the management of DE intake from weaning to 63 d of age. As the DE ingested was similar between the 2 groups, the introduction of feed restriction was found to have a positive effect on feed digestibility in the animals, allowing animals to benefit more from the nutrients in a richer feed, as previously observed by Knudsen *et al.* (2014).

Montessuy *et al.* (2009) reported similar FCR to this study when animals were fed diets with similar digestible energy levels, although the FCR reported were higher at the end of the fattening period compared to this study. This decrease in the FCR is due to feed restriction, which has already been found to improve the FCR by around 12% (Gidenne *et al.,* 2012; Szendo *et al.,* 2008). When animals were fed *ad libitum* from 63 to 70 d of age, a compensatory growth rate was seen, similar to those in previous studies (Perrier, 1998; Gidenne *et al.,* 2012). The FCR during the compensatory growth period was found to decrease drastically in this study (0.68-0.96 points) compared to the previous studies where the decline was between 0.06 to 0.46 points (Gidenne *et al.,* 2009).

In conventional French rabbit farms, the mortality rate during the fattening period of young rabbits is 8% (Coutelet, 2012), which is higher than the mortality rate of <1.5% reported here. Both diets used in our study were formulated according to recommendations for young rabbits and were thus rich in fibre and low in starch (Gidenne, 2000; Gidenne *et al.*, 2000; 2013) whatever their DE content. The dietary content of the different types of fibre (NDF>30%, ADF>19%, ADL>5%) was been calculated to meet the requirements and maximise digestive health. So, the low mortality rate observed in the 2 groups could be explained by the nutritional balance of the diets designed to promote digestive health. Thus, our study allowed us to evaluate the benefits and risks of an increase in DE dietary content while meeting the fibre and starch level recommendations. Previous studies found that diets with high DE content have a negative impact on rabbit health (Renouf and Offner, 2007; Gidenne *et al.*, 2009), although others reported no effect (Cesari *et al.*, 2009). Montessuy *et al.* (2009) observed a mortality rate >20% independent of the DE level of the diet (8.79 to 10.52 MJ/kg) when fed *ad libitum*. Gidenne *et al.* (2009) found that a high DE diet (10.9 MJ/kg), fed *ad libitum* or restricted, increased the health risk index by 10% in growing rabbits after weaning compared to a diet low in DE (9.5 MJ/kg), even when the fibre levels were sufficient. A recent study on the effect of the energy content of the feed after weaning found that the DE of feed only moderately affected the health status of growing rabbits, as in our results (Knudsen *et al.*, 2014). In our study, the health status was not affected by the DE content of the diet when intake was controlled. This suggests that with a feed restriction in place, an increase in DE content could improve growth performance without undue risk to animal health.

CONCLUSION

The aim of this study was to assess the interest of a high concentrated diet distributed from the onset of solid feed intake until slaughter age, combined with a feed restriction plan after weaning, on the growth performance and health parameters of growing rabbits. Our results suggest that when the feed intake after weaning is controlled: i) the feeding strategy before weaning determines the weight at weaning and at slaughter age; and ii) rabbits fed a higher concentrate diet formulated according to recommendations for young rabbits increase their growth performance without negative consequences on their digestive health. Rabbit kits fed a diet with a higher energy content from an early age were found to have a better feed conversion rate with no negative effects on their health status, which could therefore be an advantage for rabbit farmers from an economic point of view.

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