PROCEEDINGS OF THE 11th WORLD RABBIT CONGRESS

Qingdao (China) - June 15-18, 2016

ISSN 2308-1910

Session

FEEDS & FEEDING

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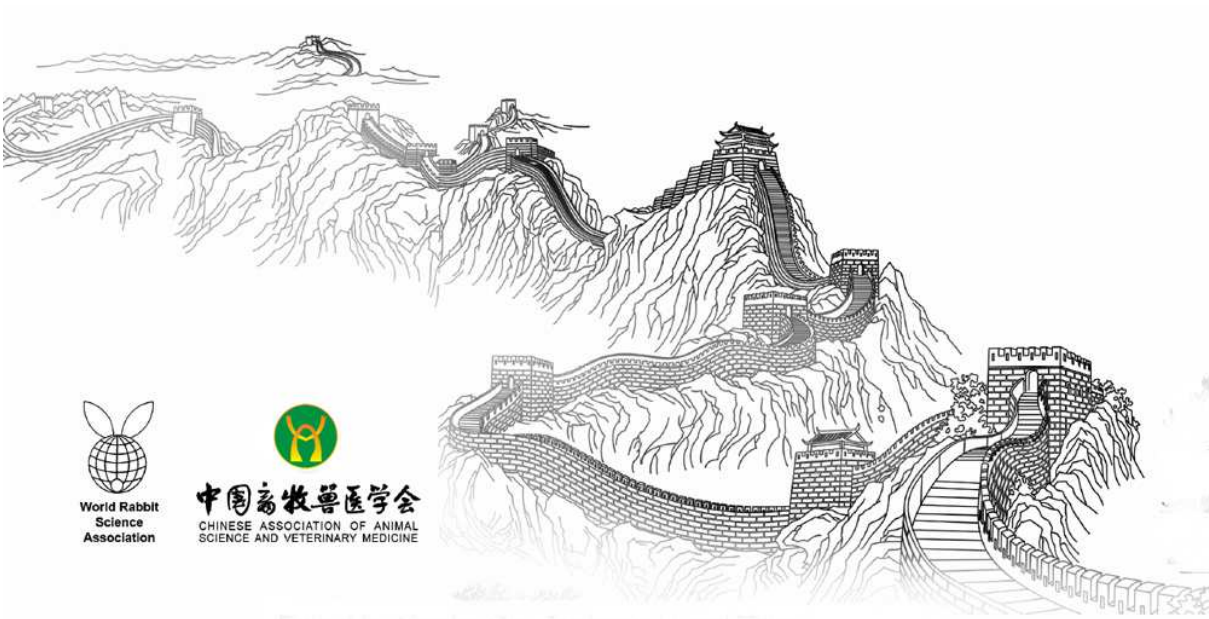
Full text of the communication

How to cite this paper :

Saiz A., Nicodemus N., Marco M., Fernandez B., Terreros E., García-Ruiz A.I., 2016 - Effect of type and dietary fat inclusion on growing rabbit performance and nutrient retention from 34 to 63 days of age. *Proceedings 11th World Rabbit Congress - June 15-18, 2016 - Qingdao - China, 451-454*



World Rabbit Science Association

中国畜牧兽医学会
CHINESE ASSOCIATION OF ANIMAL SCIENCE AND VETERINARY MEDICINE

EFFECT OF TYPE AND DIETARY FAT INCLUSION ON GROWING RABBIT PERFORMANCE AND NUTRIENT RETENTION FROM 34 TO 63 DAYS OF AGE

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ABSTRACT

The study was conducted to investigate the effect of fat source and level, on performance, mortality, nutrient retention, and the whole body and carcass chemical composition of growing rabbits from 34 to 63 d. Three diets were arranged in a 3 x 2 factorial structure with the source of fat: Soybean oil (SBO), Soya Lecithin Oil (SLO) and Lard (L) and the dietary fat inclusion level (1.5 and 4%) as the main factors. Sixty animals were allocated in individual cages (n=10) and 600 in collectives cages, in groups of 5 animals (n=20). Animals fed with 4% dietary fat level showed lower daily feed intake (DFI) and feed conversion rate (FCR) than those fed diets with 1.5%. In collective, DFI was a 4.8% higher in animals fed with lard than diets containing SBO ($P = 0.036$), being intermediate for diet SLO. Inclusion of lard also tended to reduce mortality ($P = 0.067$) around 60% and 25% with respect SBO and SLO diets, respectively. Mortality increased with the greatest level of soya lecithin (14% vs 1%, $P < 0.01$). Fat source and level did not affect the whole body or carcass chemical composition. An increase of the fat sources level led to a decrease of the digestible nitrogen intake (DNi) (1.69 vs 1.58 g/d; $P = 0.009$). As the nitrogen retained (NR) in the carcass was similar for both levels (0.708 g/d), the overall nitrogen retention efficiency (NRE) increased with the highest level of fat (41.1 vs 45.7%; $P < 0.01$). As a consequence, nitrogen excretion in faeces was lower in animals fed with the highest level of fat (0.901 vs 0.967 g/d; $P = 0.0128$), as well as nitrogen excreted as urine (0.403 vs 0.538 g/d; $P < 0.0001$). Although there were not differences in energy retention efficiency (ERE) the energy excreted in faeces decreased when the fat level increased (118 vs 139 Kcal/d; $P < 0.0001$). Energy excreted as urine and heat production was significantly higher in animals fed with the highest level of dietary fat (195 vs 184 Kcal/d; $P < 0.0153$). It can be concluded that, lard can be considered as an alternative source to soybean oil due to the reduction of the mortality, without negative effects on performances or nutrient retention. An increase of the dietary fat level improves FCR and overall nitrogen retention efficiency.

Key words: fat source, fat level, rabbit performance, body, carcass, nutrient retention, BIA

INTRODUCTION

Fat addition in rabbit diets increases digestible energy and improves feed efficiency (Partridge et al., 1986; Santomá et al., 1987; Maertens, 1998). When fat addition is low or moderate (2-6%), a moderate reduction of feed intake is produced and nutrient digestibility and feed efficiency may be improved (Santomá et al., 1987; Xicatto et al., 1998). Some authors have observed an increase on the nitrogen retention efficiency by increasing fat addition (Parigi-Bini et al., 1974) without differences on carcass nitrogen retention. Moreover, fatter carcasses are also found when increasing dietary fat content (Partridge et al., 1986; Fernández and Fraga, 1996b). The effect of fat source and their inclusion level on nutrient retention is related to their digestibility that also depends on the fatty acid profile, as the digestibility increases when the level of unsaturated fatty acids is greater (Maertens et al., 1998; Santomá et al., 1987; Xiccato, 2010). Soya oil is the most common fat source included in rabbit feeds, however, other fat sources like soya lecithins oil and lard, sources with a lower level of unsaturated fatty acids, are also available and at lower price. The aim of this study was to determine the effect of the fat level and source, on performance, mortality, nutrient retention and carcass composition of animals from 34 to 63 days of age.

MATERIALS AND METHODS

This study was carried out at the Poultry Research Centre of Trouw Nutrition, in Casarrubios del Monte (Spain) in collaboration with the Universidad Politécnica de Madrid (Spain). Six hundred sixty New Zealand x Californian rabbits were used. Animals were weaned at 34 d of age. Sixty rabbits were housed individually in flat-deck cages measuring 250 x 440 x 300 mm in the Individual Fattening Unit. Animals were blocked per litter, assigning one animal of each litter in each treatment. Other 600 animals were allocated in polyvalent cages (5 animals per cage) ensuring that 2 animals of the same litter were not allocated in the same cage in the Collective Fattening unit. Animals were fed until 63 d of age and were kept under controlled environmental conditions (room temperature between 16 and 24°C, with a light: dark cycle of 16-8 h). Six diets were arranged in a 3 x 2 factorial structure with the type of fat source: Soybean oil (SBO), Soya Lecithin Oil (SLO) and Lard (L) and the dietary fat inclusion level (1.5 and 4%) as the main factors. All diets were formulated to meet or exceed rabbit nutrient requirements according to the recommendations of de Blas and Mateos (2010). Diets were analysed for DM, CP, Ash, fat, NDF, ADF, ADL and GE content. The DE and DN of the diets were estimated by using the digestibility coefficient of each raw material described by Maertens et al. (2002). All diets contained the similar values of DM (90.5%), NDF (34.9%), and DP (1.44%). Levels of fat and DE were on average 3.5% and 2457 kcal/kg, 5.7% and 2660 kcal/kg for diets containing 1.5 and 4% of added fat, respectively. Values of total energy (Kcal) and nitrogen (protein x 6.25-1, g) body and carcass content were estimated by using the BIA method as described by Saiz et al. (2011 and 2013). These values were used to estimate the daily energy and nitrogen retention (ER, Kcal/d and NR, g/d respectively) between 34 and 63 d. Moreover, daily digestible nitrogen and digestible energy intake (DNi, g/d and DEi, Kcal/d) was also estimated to further calculate the overall nitrogen efficiency of retention (NRE, %) and overall energy efficiency of retention (ERE, %). Total nitrogen and energy excretion as skin and organs, faeces, or heat production and urine were calculated. Data were analysed by using the GLM procedure of SAS. In both facilities (individual and collective), data were analysed per experiment as a factorial design using the litter as a block effect and the fat source and level as the main sources of variation. Weaning weight was used as a linear covariate to analyse performance data. A Tukey´s test was used for mean comparisons.

RESULTS AND DISCUSSION

Performance and mortality results of rabbits collectively housed from 34 to 63 d of age are shown in Table 1. Rabbits fed with soybean oil showed significantly lower DFI (P = 0.036) and tended to have higher mortality rate (P = 0.067) than rabbits fed the diet containing lard. These results disagree with Casado et al. (2013) that observed an increase on the mortality rate of rabbits fed a diet with 3% lard addition (45%) regarding diets supplemented with vegetable oils (linseed (34%) or sunflower oil (37%)). Rabbits fed the diet with lecithin (SLO) showed intermediate values for both parameters, although rabbits fed with this source had the highest and lowest mortality rate (14.0 vs. 1.01%) for diets containing 4 and 1.5% of fat, respectively).

Table 1: Effect of dietary fat source and fat inclusion level on rabbit performance and mortality from 34 to 63 days of age (5 animals/cage).

Fat source[1]	SBO		SLO		L		Fat Source			Fat Level,					
Fat Level	1.5	4.0	1.5	4.0	1.5	4.0	SBO	SLO	L	1.5	4.0	rsd[2]	P_s	P_l	$P_{s\,x\,l}$
n	20	20	20	20	20	20	40	40	40	60	60				
BW 34 d , g	724	734	731	733	733	733	729	732	733	730	733	-	-	-	-
BW 63 d, g	1944	1875	1925	1912	1967	1931	1910	1919	1949	194	190	114	0.28	*0.063*	0.55
DWG, g/d	44.9	42.4	44.2	43.7	45.8	44.4	43.6	44.0	45.1	45.0	43.5	4.25	0.28	*0.063*	0.55
DFI, g/d	108	102	109	104	114	106	105^{b}	106^{ab}	110^{a}	110	104	8.94	**0.036**	**0.000**	0.72
FCR	2.42	2.40	2.48	2.39	2.49	2.39	2.41	2.43	2.44	2.46	2.39	0.11	0.58	**0.001**	0.22
Mortality, %	12.1^{a}	7.96^{ab}	1.01^{b}	14.0^{a}	2.96^{b}	4.97^{b}	10.0	7.49	3.97	5.36	8.97	12.0	*0.067*	0.16	**0.00**

[1]SBO: Soybean Oil; SLO: Soya Lecithin oil; L: Lard [2]rsd: residual standard deviation. BW: body weight; DWG: daily weight gain; DFI: daily feed intake; FCR: feed conversion rate. Experimental unit is the cage (5 rabbits per cage). Means in the same row with different letters show significant differences (P < 0.05) among treatments. P_s: probability of the source; P_l: probability of the level; $P_{s\,x\,l}$: probability of the interaction source x level.

Rabbits fed the lowest fat level (1.5%) showed a 6.0, and 2.97% higher DFI and FCR respectively, than rabbits fed the highest level (4.0%), although BW at 63 d and DWG tended to be respectively, 2.1 and 3.4% higher with the lowest fat level. These results are in agreement with other studies (Partridge et al., 1986; Santomá et al., 1987) showing that an increase on fat level over 2-3% led to a decrease on feed intake and an improvement on feed efficiency. In this sense, Santomá et al., (1987) did not find significant differences between diets including lard or lecithin, either 3% or 6% inclusion level, being mortality on average 3.5%.

Differences in whole body and carcass composition among animals fed different fat sources, inclusion levels and their interaction were not detected. Mean values of whole body composition were 68.7±1.34%, 51.1±1.79%DM, 10.30±0.66%DM, 32.5±3.16%DM and 2397±73.0 Kcal/100 g DM for water, protein, ash, fat and energy respectively. Animals carcass water, protein, ash, fat and energy average contents were 64.6±1.38%, 57.9±2.14%DM, 13.4±1.67%DM, 31.1±2.63%DM and 2376±111 Kcal/100 g DM.

An increase of the fat sources addition tended to decrease digestible nitrogen intake (DNi) (1.83 vs. 1.92 g/d; P = 0.0678) (Table 2). As the nitrogen retained (NR) in the carcass was similar for both levels (0.708 g/d) the overall nitrogen retention efficiency (NRE) increased with the highest level of fat (37.8 vs. 64.9 %; P < 0.0001). This result agrees with Fernández and Fraga (1996b) that also observed an improvement in NRE with an increase of 3% dietary fat content. Due to the same DE ingestion and retention, energy retention efficiency (ERE) was not affected by treatments (18.8%), despite animals excreted less energy in the faeces when the dietary fat content was higher, due to the higher, but not significant, energy retention in the carcass.

Table 2. Effect of dietary fat source and fat inclusion level on nitrogen and energy balance and excretion from 34 to 63 days of age (experiment 1) (n=10).

	Fat source			Fat level		rsd[3]	P_s	P_l	$P_{s\,x\,l}$
	SBO	SLO	L	1.5	4.0				
n	20	20	20	30	30				
Nitrogen Balance[2]									
DNi2 , g/d	1.84	1.89	1.89	1.92	1.83	0.255	0.678	*0.0678*	0.148
NR, g/d	0.673	0.674	0.694	0.671	0.690	0.109	0.643	0.369	0.587
NRE, %	36.5	35.8	36.7	34.9	37.8	0.032	0.453	**<0.0001**	0.105
Nitrogen Excretion, g/d									
Skin and organs	0.437	0.426	0.440	0.431	0.437	0.060	0.619	0.619	0.174
Faeces	0.804	0.844	0.828	0.868	0.782	0.110	0.321	**0.0001**	0.122
Urine	0.736	0.788	0.762	0.822	0.702	0.144	0.326	**<0.0001**	0.109
Energy Balance									
DEi, Kcal/d	305	310	311	301	316	40.6	0.828	0.150	0.105
RE, Kcal/d	57.4	58.2	59.6	57.3	59.6	11.4	0.708	0.294	0.234
ERE, %	18.7	18.6	19.1	18.9	18.7	0.020	0.586	0.536	0.691
Energy Excretion, Kcal/d									
Skin and organs	39.7	39.2	40.8	39.4	40.3	7.86	0.651	0.560	0.205
Faeces	145	150	152	156	142	19.8	0.343	**0.0004**	0.116
Urine+heat	208	212	211	204	216	26.3	0.810	**0.0168**	0.205

[1]SBO: Soybean Oil; SLO: Soya Lecithin oil; L: Lard.
[2]DNi (g/d): Digestible Nitrogen Intake. NR (g/d): g Nitrogen retained on the carcass; NRE: Nitrogen Retention Efficiency; Nitrogen excreted in skin and organs (g/d): (g N retained in whole body -g N retained on the carcass); Nitrogen excreted in faeces (g/d): (N total intake –DNi. Nitrogen excreted as urine (g/d): (DNi – g N retained on carcass – N excreted on skin and organs); DEi (Kcal/d): Digestible Energy Intake. RE (Kcal/d): Retained Energy in the carcass; ERE: Energy Retention Efficiency; Energy excreted in skin and organs (MJ): (GE retained in the whole body – GE retained in the carcass); Energy excreted in faeces (MJ): (GEi –DEi). Energy excreted as Urine+heat production (MJ): (DEi – GE retained in carcass – GE excreted in skin and organs).
[3]rsd= residual standard deviation. P_s: probability of the source; P_l: probability of the level; $P_{s\,x\,l}$: probability of the interaction source x level.

Current values were similar than those obtained using BIA by Delgado et al. (2015) (36.6% and 18.6% of NRE and ERE, respectively). The values of nitrogen excretion (2.00 g/d of N retained in skin and organs, and excreted in faeces and urine) and energy excretion (341 Kcal/d retained in skin and organs, and excreted faeces and urine and heat production) were similar to those obtained by these same authors (2.01 g/d and 327 Kcal/d of nitrogen and energy excreted, respectively). Likewise, Crespo et al. (2015) also observed similar values of excretion (2.06 g/d and 382 Kcal/d of nitrogen and energy excreted, respectively) in animals fed *ad libitum*. As the protein content among diets was similar, independently of the level of fat, the intake of digestible protein of those animals were lower. When animals have a lack, or not an excess of nutrients, they are more efficient regarding nutrient absorption and retention (Falcão e Cunha et al., 2004). This is in agreement with the higher NRE, and lower nitrogen excretion in skin and organs, faeces and urine found in our study.

CONCLUSION

It can be concluded that, lard can be considered as an alternative source to soybean oil due to the reduction of the mortality, without negative effects on performances or nutrient retention. An increase of the dietary fat level improves FCR and overall nitrogen retention efficiency.

ACKNOWLEDGEMENTS

The authors would like to thank to the personnel of Trouw Nutrition R&D Poultry Research Centre for their work and collaboration.

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