EFFECT OF THE DIETARY N-3 AND N-6 FATTY ACIDS ON RABBIT CARCASS AND MEAT QUALITY

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ABSTRACT

Three groups of rabbits from the same genetic type were fed respectively with three experimental diets supplemented with 100 ppm of α-tocopherol and including a 3% of added fat: animal fat (A), sunflower oil (SF) or linseed oil (L). Fifty-two rabbits per group were used. Animals were slaughtered at 63 days of age. Live weight, dressing out percentage and carcass and meat quality traits were measured. A Bayesian analysis was performed. Animals fed with diet A showed higher live weight and higher carcass weight than animals fed with diets SF and L. SF and L animals had 96% and 95% of the LW that A group showed. The reference carcass in SF and L animals was 96% as heavy as in A animals. No differences were found between the SF and L animals for these traits; however, some differences appeared for dressing out percentage (DoP), having L animals higher DoP than SF (1% higher values). L animals also showed higher DoP than A animals, but the evidence of the differences was lower (P>1=0.93). Nevertheless, the effect of dietary fat on these traits was small even if its presence can be detected. Animals fed with a diet enriched with animal fat showed higher lumbar circumference (around +3%), liver weight and carcass and retail cuts weights than animals fed with diets SF and L. No differences between SF and L animals were found for the main carcass traits except for meat to bone ratio (M/B). SF and A had higher M/B than L animals (5 and 3.4%, respectively). No diet effect was found for carcass fatness among the three groups of animals. Meat color was little affected by the diet. The evidence of a diet effect in redness was low. Carcass L* was higher in A than in SF and L animals but differences were small (around 3%). The highest distance between diets appeared for yellowness (b*). L animals showed lower carcass b* values than SF and A animals. Carcasses from SF animals had 78% higher b* values than carcasses from L animals, and carcasses from A animals showed double b* values than carcasses from L animals. Regarding the fat color, fat from SF and L animals had 92% and 93% of the L* values that A group showed, respectively. Fat yellowness was lower in A animals. SF and L had a 27% and 17% higher b* fat values than A (P>1=1). The evidence for the differences in fat b* between SF and L was low. SF had a 16% higher meat b* values than S. Effects on pH and moisture were not relevant. Diets enriched with n-3 and n-6 fatty acids have small effects on rabbit carcass characteristics. However, meat quality traits were not modified by the type of dietary fat.

Key words: Dietary fat, Carcass, Meat quality, Rabbit.

INTRODUCTION

The nutritive value of meat has an increasing importance among the factors determining meat quality and consumer acceptability. However, meat is also a major source of saturated fatty acids, for which a high consumption may be related to cardiovascular diseases. The recommendations from a nutritional point of view are to reduce saturated fatty acid amounts consumed and to increase ingestion of polyunsaturated fatty acids (PUFA), particularly n-3 PUFA. Rabbit meat has a high nutritional value compared with other meats (Hernández and Gondret, 2006). Moreover, the quantity and composition of fatty acids in the fat and rabbit meat can be manipulated by diet in order to produce meat with better nutritive value.

Different vegetable oil sources have been used in rabbit diet to increase the level of lipid unsaturation (see Dalle Zotte, 2002 for a review). In a previous study, Hernández *et al*. (2007) found an increase of linoleic and linolenic fatty acid in the rabbits fed with diets enriched with a 3% of sunflower oil and a 3% of linseed oil, respectively. However, the increase of unsaturated fatty acid intake could lead to soft and oily carcasses and the development meat quality problems.

The aim of this study is to examine the effect of diets enriched with n-3 and n-6 fatty acids on rabbit carcass characteristics and meat quality traits.

MATERIALS AND METHODS

Animals

Rabbits from the same genetic type (a three-way commercial cross) were used in this experiment. Rabbits were divided into three groups (52 rabbits of each group from both sexes) at weaning (4 wk old) and fed *ad libitum* with three different diets. The experimental diets included a 3% of added fat: animal fat (A), sunflower oil (SF) or linseed oil (L). The three diets were supplemented with 100 ppm of α-tocopherol. Live weight (LW) of the animals was recorded before the slaughter. Animals were slaughtered at 63±2 days of age. Animals were electrically stunned and bled without fasting. After slaughter and bleeding, the carcasses were cooled in a refrigerated chamber at 3ºC until 24 h *post-mortem*.

Carcass measurements

Carcasses were prepared according to the norms of the World Rabbit Science Association (WRSA) (Blasco and Ouhayoun, 1996). At 24 h *post-mortem*, carcasses were weighed to obtain the chilled carcass weight (CCW). Dressing out percentage (DoP) was calculated (100xCCW/LW). Dorsal length (DL), thigh length (TL) and lumbar circumference (LC) were measured. The head, liver, kidneys and thoracic viscera (lungs, thymus, trachea, oesophagus and heart) were removed to obtain the reference carcass weight (RCW). The liver was weighed (LvW). Perirenal (PFaW) and scapular (SFaW) were also removed and weighed. Dissectible fat percentage of the chilled carcass (DFaP) was calculated (100(PFaW+SFaW)/CCW).

Reference carcasses were divided into technological joints as the WRSA indicates. Joints obtained were weighed and consisted of: FLW: fore legs; TW: thoracic cage; LoW: loin; HPW: hind part. From the hind part a hind leg (HLW) was carefully dissected to separate bone (HLBW) from the edible meat (HLMW) for calculating meat to bone ratio (M/B) of the hind leg (HLMW/HLBW).

Color in the CIELAB space (L* a* b*) was measured on perirenal fat and on carcass loin surface at the 4^{th} lumbar vertebra at 24 h *post-mortem* using a CR300 Minolta Chromameter.

Meat quality variables

The muscle pH was measured at 24 h *post-mortem* in M. *Longissimus* at the level of the 5^{th} lumbar vertebra. Water holding capacity was measured on a sample from loin meat (7^{th} lumbar vertebra). A sample of intact meat weighing 300+5 mg was placed on a previously desiccated and weighed 7-cm disk of Whatmann No. 1 filter paper. After weighing, the paper with meat was placed between two Plexiglas plates and a load of 2.25 kg was applied for 5 min. The damp paper filter was rapidly weighed after accurately removing the compressed meat. The mean of two replicates were used in analysis. The percentage of released water (PRW) was calculated as ratio per cent of weight of released water (damp filter paper weight – dry filter paperweight) to intact meat.

Meat color was measured at the 7^{th} lumbar vertebra of the M. *Longissimus* transversal section at 24 h post-mortem. The parameters L*, a*, b* were recorded. Meat dissected of a hind leg was ground in a domestic grinder and scanned with a monochromator (Model 5000, NIR Systems Inc., Silver Spring, MD, USA) for measuring the protein, fat and moisture content by applying the calibration equations previously calculated (Pla *et al*,. 2004).

Statistical analysis

Data were analyzed using a model with diet (with three levels, A, SF, L diets) and sex effects. A Bayesian analysis was performed. All inferences were made from estimated marginal posterior distributions of the ratios of the different levels of each effect. Bounded flat priors were used for all unknowns. Data were assumed to be normally distributed. Marginal posterior distributions of all unknowns were estimated by using Gibbs Sampling (Blasco, 2005). After some exploratory analyses we used one chain of 10,000 samples, with a burning period of 2,000, thus marginal posterior distributions were estimated with 8,000 samples in each one. Convergence was tested for each chain using the Z criterion of Geweke.

RESULTS AND DISCUSSION

Table 1 shows the features of the marginal posterior distributions of the ratios among the different diets for live weight, dressing out percentage and carcass weight. Animals fed with a diet enriched with animal fat (A) showed a higher live weight (LW) and higher carcass weight than animals fed with diets enriched with sunflower (SF) and linseed oils (L). SF and L animals had a 96% and a 95% of the LW that A group showed. The reference carcass in SF and L animals was a 96% as heavy as in A animals. No differences were found between the SF and L animals for these traits; however, some differences appeared between SF and L animals for dressing out percentage (DoP), having L animals higher DoP than SF (1% higher values). L animals also showed higher DoP than A animals but the evidence of the differences was lower (P>1 = 0.93). Nevertheless, the effect of dietary fat on these traits was small even if its presence can be detected. There was a sex effect in DoP (data not shown), having males a 1% higher DoP than females (P>1 = 0.96). According to Fernández-Carmona *et al.* (2000), the use of either animal or vegetable fat had not significant effect on the rabbit growth. In fact, in a previous study with the same experimental diets no differences were found in live weight and feed conversion rate in rabbits of 17 to 44 days old (Casado *et al*., 2006). However, some differences in rabbit carcass traits appear at 63 days old.

The means for the main traits of the carcass composition are shown in Table 2. The largest differences appeared between A and the SF and L diets. A had higher lumbar circumference than SF and L (around a 3% higher values). Differences are also found in retail cuts and liver weight, being always higher in A animals than in SF and L. No evidence of differences between SF and L animals were found for the main traits of carcass composition except for meat to bone ratio (M/B). SF and A had higher M/B than L animals (5 and 3.4%, respectively). No diet effect was found for carcass fatness among the three groups of animals. These results are in agreement with the results obtained by Pla and Cervera (1997). These authors found no differences in dissectible fat percentage comparing rabbits fed with diets enriched with animal and vegetable fat. No differences between sexes were found for the carcass traits.

Table 1: Features of the marginal posterior distributions of the ratios among the diet effects for live weight, dressing out percentage and carcass weight

		SF/L			SF/A			L/A		
	Mean	Median	P>1	HPD	Median	P>1	HPD	Median	P>1	HPD
LW	2230	1.01	0.80	0.979; 1.05	0.963	0.01	0.931; 0.995	0.949	0.00	0.917, 0.981
DoP	55.5	0.991	0.00	0.964; 0.995	0.991	0.13	0.976; 1.00	1.01	0.93	0.996; 1.02
CCW	1238	0.994	0.38	0.959; 1.03	0.953	0.00	0.920; 0.985	0.958	0.01	0.927; 0.993
RCW	995	1.00	0.51	0.964; 1.03	0.958	0.01	0.924; 0.99	0.958	0.01	0.926; 0.993

A, SF and L: animal fat, sunflower oil and linseed oil diets. LW: live weight (g); DoP: dressing out percentage; CCW: chilled carcass weight (g); RCW: reference carcass weight (g). P>1: probability of the ratio (SF/L, SF/A, L/A) being higher than 1. HPD: high posterior density interval at 95% of probability

Table 2: Features of the marginal posterior distributions of the ratios among the diet effects for the main traits of the carcass composition in rabbits

		SF/L			SF/A			L/A		
	Mean	Median	P>1	HPD	Median	P>1	HPD	Median	P>1	HPD
DL	251	1.00	0.85	0.992; 1.02	1.00	0.73	0.989; 1.02	0.996	0.35	0.981; 1.01
TL	79.7	0.995	0.39	0.966; 1.02	0.976	0.06	0.947; 1.00	0.980	0.10	0.951; 1.00
LCL	170	1.00	0.65	0.983; 1.02	0.968	0.00	0.947; 0.987	0.963	0.00	0.944; 0.984
LvW	78.4	1.00	0.51	0.927; 1.08	0.931	0.03	0.867; 1.00	0.929	0.03	0.864; 1.00
SFaW	7.01	1.01	0.56	0.882; 1.15	0.998	0.49	0.880; 1.14	0.985	0.41	0.863; 1.11
PfaW	18.4	0.971	0.32	0.856; 1.10	0.966	0.30	0.846; 1.08	0.991	0.45	0.872; 1.11
DFaP	2.03	0.992	0.44	0.902; 1.08	1.02	0.67	0.928; 1.13	1.02	0.72	0.936; 1.13
FLW	159	1.00	0.51	0.961; 1.04	0.957	0.01	0.923; 0.994	0.956	0.01	0.921; 0.992
TW	122	1.00	0.56	0.946; 1.06	0.935	0.01	0.885; 0.987	0.930	0.01	0.880; 0.983
LOW	305	1.01	0.71	0.972; 1.05	0.967	0.05	0.930, 1.00	0.956	0.01	0.919; 0.995
HPW	380	0.992	0.33	0.959; 1.02	0.957	0.01	0.927; 0.989	0.964	0.02	0.933; 0.996
M/B	4.95	1.05	1.00	1.01; 1.08	1.01	0.83	0.982; 1.04	0.967	0.02	0.937; 0.997

A, SF and L: animal fat, sunflower oil and linseed oil diets. DL: dorsal length (mm); TL: thigh length (mm); LC: lumbar circumference (mm); LvW: liver weight (g); PFaW: perirenal fat weight (g); SFaW: scapular fat weight (g); DFaP: dissectible fat percentage; FLW: fore legs (g); TW: thoracic cage (g); LoW: loin (g); HPW: hind part (g); M/B: meat to bone ratio. P>1: probability of the ratio (SF/L, SF/A, L/A) being higher than 1. HPD: high posterior density interval at 95% of probability

Table 3: Features of the marginal posterior distributions of the ratios among the diet effects for carcass, fat and meat color in rabbits

		SF/L			SF/A			L/A		
	Mean	Median	P>1	HPD	Median	P>1	HPD	Median	P>1	HPD
Carcass										
L*	54.9	0.993	0.14	0.980; 1.00	0.973	0.00	0.961; 0.985	0.979	0.00	0.967; 0.992
a*	4.11	1.02	0.62	0.912; 1.13	0.991	0.42	0.895; 1.10	0.973	0.32	0.872; 1.08
b*	1.51	1.78	1.00	1.08; 2.85	0.960	0.39	0.679; 1.27	0.535	0.00	0.315; 0.793
Fat										
L*	64.7	0.989	0.08	0.975; 1.00	0.921	0.00	0.908; 0.935	0.931	0.00	0.918; 0.945
a*	5.39	1.12	0.98	1.00; 1.24	1.05	0.84	0.946; 1.16	0.937	0.14	0.831; 1.04
b*	3.75	1.08	0.94	0.974; 1.20	1.27	1.00	1.13, 1.42	1.17	1.00	1.04; 1.31
Meat										
L*	51.0	0.991	0.18	0.970; 1.01	1.01	0.86	0.991; 1.03	1.02	0.97	1.00; 1.04
a*	7.21	1.05	0.89	0.963; 1.14	0.991	0.41	0.913; 1.07	0.940	0.08	0.863; 1.02
b*	3.15	1.09	0.91	0.952; 1.22	1.16	0.99	1.02; 1.31	1.07	0.85	0.940; 1.22

A, SF and L: animal fat, sunflower oil and linseed oil diets. L*: lightness; a*: redness; b*: yellowness. P>1: probability of the ratio (SF/L, SF/A, L/A) being higher than 1. HPD: high posterior density interval at 95% of probability

Table 3 shows the features of the marginal posterior distributions of the ratios among the diet effects for carcass, fat and meat color in rabbits. The evidence of a diet effect in redness was low. However, some differences appeared in lightness (L*) and yellowness (b*). Carcass L* was higher in A than in SF and L animals but differences were small (around 3%). The highest distance between diets appeared for yellowness (b*). L animals showed lower carcass b* values than SF and A animals. Carcasses from SF animals had a 78% higher b* values than carcasses from L animals, and carcasses from A animals showed double b* values than carcasses from L animals. Regarding to the fat color, fat from SF and L animals had a 92% and a 93% of the L* values that A group showed, respectively. Fat yellowness was lower in A animals. SF and L had a 27% and 17% higher b* fat values than A (P>1 = 1). The evidence for the differences in fat b* between SF and L was low. Meat color was little affected for the diet effect. SF had a 16% higher meat b* values than S.

Means for meat quality variables are shown in Table 4. No evidence for the diet effect was found for most of the traits. There was some effect in pH and in moisture but differences were not relevant. Pla and Cervera (1997) did not find differences between rabbits fed with diets enriched with animal and vegetable fat for these meat quality traits.

Table 4: Features of the marginal posterior distributions of the ratios among the diet effects for loin pH, percentage of released water and chemical composition on rabbit leg meat

		SF/L			SF/A			L/A		
	Mean	Median	P>1	HPD	Median	P>1	HPD	Median	P>1	HPD
pH	5.49	1.00	0.81	0.997; 1.00	0.997	0.17	0.993; 1.00	0.995	0.03	0.991; 1.00
PRW	34.0	0.999	0.38	0.970; 1.02	1.00	0.52	0.973; 1.03	1.00	0.65	0.978; 1.03
Fat	3.61	0.980	0.39	0.904; 1.07	1.00	0.52	0.919; 1.09	1.01	0.63	0.923; 1.09
Protein	21.3	0.997	0.15	0.991; 1.00	0.994	0.03	0.988; 1.00	0.997	0.21	0.992; 1.00
Moisture	74.2	0.996	0.04	0.991; 1.00	1.01	1.00	1.00; 1.01	1.01	1.00	1.00; 1.01

A, SF and L: animal fat, sunflower oil and linseed oil diets. PRW: percentage of release water. P>1: probability of the ratio (SF/L, SF/A, L/A) being higher than 1. HPD: high posterior density interval at 95% of probability.

CONCLUSIONS

Diets enriched with n-3 and n-6 fatty acids have small effects on rabbit carcass characteristics. Retail cuts, lightness and yellowness were the most affected traits. However, meat quality traits were not modified for the type of dietary fat.

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