EFFECT OF DIETARY OIL FISH AND VITAMIN E ON THE FATTY ACID COMPOSITION AND MEAT QUALITY

LAMANNA ML*, COSSU ME, GAMBETTI P, GRIGOLI MC AND IGLESIAS MF.

Departamento de producción Animal, Facultad de Agronomía, Universidad de Buenos Aires. Av. San Martín 4453.BsAs. Argentina.
**Corresponding author:* lamanna@agro.uba.ar

ABSTRACT

The current search for food of high nutritional value is growing; consumers are aware to new products that help to improve the healthy lifestyle. Nowadays diets are unbalanced in fatty acid omega 6 and 3. One way of approaching the recommended ratio (n6/n3<5) is include omega 3 fatty acid on animal feed. Particularly, the most bioactive compounds for human system are EPA and DHA but the elongation capacity of linolenic fatty acid on over 20 carbons polyunsaturated FA is limited. The aim of this work was to increase EPA and DHA in rabbit meat with a low n6/n3 ratio, according with health recommendations. Eighty (80) growing rabbits (New Zeeland x Californian) were fed *ad libitum* from 35 to 70 days old, with four diets (20 animals/treatment), commercial diet (C) and three diets whit addition of 1.8% of oil fish: diet 'fish' (F), diet 'vitamin' (V: F+200 ppm vit. E) and diet 'algae' (A: 10.0%dry *Macrocystis* algae). The final weight and carcass yield were determined at slaughter time (2.5 kg live weight). After of 24 hours of slaughter, the measurements of pH (Testo 230), color (CIELAB system, Minolta-CR300), lipid oxidation (TBARS) and fatty acids profile (by GC) were determined on the right loins. Statistical analysis was performed using the Proc Mixed of SAS (2004) for univariate ANOVA; differences between treatments were analyzed by Tukey test ($p<0.05$). The slaughter weight was heavier for the control and fish treatments ($P<0.05$) but not differences were found in carcasses yields (mean 59.3%). The carcass traits, pH and color did not differ significantly according to diets, as well as TBARS values. The use of fish oil determined a lower n6/n3 ratio (4.5 for F, V and A) respect the control diet (15.1), in accordance to the limits recommended for human consumption. Furthermore, higher content of EPA (mean 1.09%) and DHA were found on

F, V and A (3.38, 3.37 and 4.54 %FAtot, respectively). In conclusion, the use of fish oil addition in fattening diets of rabbits, provides high content of n-3 in meat, particularly of EPA and DHA FA content and lipid oxidation in fresh meat is not observed.

Key words: Algae, oxidation, omega 3, EPA, DHA

INTRODUCTION

Meats with functional properties take more importance in today's market, comprising consumers demanding healthy products or with nutritional characteristics that provide some kind of health benefit.

At present, many studies have shown that consumption of unsaturated fatty acids may play a role in protecting against obesity, reduced risk of cardiovascular disease and diabetes. Besides PUFA content, it's also important the ratio between the omega 6/3's family fatty acids; recommendations lean toward of 5:1 ratio (Simopoulus, 2009). In the omega-3 family of fatty acids, the most bioactive compounds the high PUFA fatty acids (EPA y DHA) and their supply is of great importance due to the low capacity of 18:3 elongation to EPA and DHA in the human body (17:1) (Dalle zotte and Szendro 2011, Barceló-Coblijn and Murphy 2009).

Different strategies have been applied to manipulate the meat lipid profile, such as the use of flax or chia seeds in diets (Bernardini et al. 1999, Dal Bosco et al., 2004, Peiretti and Meineri, 2008) in order to obtain meats reach in omega 3 fatty acids and an omega 6/3 ratio closer to the nutritional recommendations for humans. Another strategy for manipulating the meat lipid profile aimed at increasing long-chain fatty acids (EPA and DHA) by use of fish oil or algae, where already been performed (Navarrete et al., 2007).

The aim of this study was to evaluate the productive results, carcass and meat quality of animals fed fattening diets rich in omega 3 long-chain fatty acids, and the effect of the addition of artificial (α tocopherol) and natural (algae) antioxidants, on the oxidative stability of the loins.

MATERIALS AND METHODS

The experimental work was performed in the rabbit Unit of the Animal Production Department of Faculty of Agronomy, UBA.

Eighty New Zeeland x Californian rabbits, individually housed, were fed *ad libitum* (35 to 70 days of age) with 4 diets (20 animals/treatment): one control diet with vegetable oil and 3 experimental diets containing fish oil and with/without presence of antioxidants. Treatments were randomized and named as 'C', commercial diet; 'F', fish diet with addition of 1.8% of oil fish with 35% of HPUFA (replacing commercial diet corn oil); 'V', vitamin diet ('F'+200 ppm α tocopherol, as an industrial antioxidant) and 'A', algae diet ('F' + 10% of *dry Macrocystis algae* as a natural antioxidant (partially replacing the alfalfa meal). All diets were isoproteic (20%) and isoenergetic (4050Mcal/Kg)

Individual live weights of each rabbit were evaluated weekly in order to control the normal growth, health status of the animals and the occurrence of enteric disturbances. The slaughter was performed at a commercial weight without fasting (2,5 kg live weight) following the scientific recommendations (Blasco and Ouhayoun, 1996). The chilled carcasses (24h post slaughter, 4-5°C) were transferred to the Meat Laboratory of the Faculty of Agronomy for its qualitative analysis

On the right loin, color (CIELAB System, L* (lightness), a* (redness), b* (yellowness) and C* as $\gamma(a^{*2} + b^{*2})$; Minolta Chroma Meter-CR300), pH (Testo 205) and lipid oxidation (TBAR's index; µg of malonaldehyde/g meat; Robards *et al.*, 1988) were determined. Fatty acids were extracted (Folch *et al*, 1957) and analyzed as methyl esters by gas chromatography (Shimatzu 14-B, capillary column Restec SP2560).

Productive performance, carcass and meat quality traits data were analyzed by univariete ANOVA (GLM, SAS 2004). Differences between treatments were analyzed by Tukey test ($p < 0.05$).

RESULTS AND DISCUSSION

Table 1 showed the effect of diets on rabbit slaughter weight and loin characteristics.

The addition of fish oil in the 'P' diet did not affect final weight of the animals, while treatment 'V' (P diet with added vitamin E) showed lower growth rates, differing significantly from the control treatment ($p > 0.05$). The same grow ratio of 'P' indicated that there were not negative effects in the preference of diets with oil fish for animal intake.

The growth performance of rabbits fed diet A was seen strongly committed, being the group with the lowest final weight and higher morbidity (60%), probably due to the size of the ground dried algae that affect the digestive system causing enteric problems.

The carcass yield was not significantly different for the treatment and was similar to that found by other authors (Dal Bosco et al., 2004).

Respect to the meat quality, the pH value, the chroma and the level of oxidation of loins were not significantly different, with similar physical and chemical characteristics for the four treatments. In fresh meat, the effect of added antioxidants was not evident.

Table 1. Effect of diet on final live weight and loin meat quality of rabbits

	Diet				Root MSE	P-value *
	C	P	V	A		
Slaughter weight (g)	2335 a	2300 ab	2155 b	2069 cb	196.0	*
Carcass yield (%)	59.3	59.6	60.1	58.5	2.429	ns
pH	5.73	5.81	5.73	5.80	0.085	ns
C*	6.64	6.33	6.53	5.94	0.885	ns
TBARs	0.11	0.10	0.11	0.12	0.042	ns

Means with different letters on the same line differ significantly, *=P<0.05 ,**=P<0.0001

In table 2, the effect of fish oil added diets, with o without antioxidants, on fatty acid profile of rabbit loin, was shown. Both the content of saturated fatty acids as the thrombogenic index (IT, According to Ulbricht and Sothgate 1991) of the experimental diets were significantly different (p <0.05) from the control. The IT, associated with cardiovascular disease risk factor, was favorably reduced in the case of P, V and A diets; similar results were obtained with the use of chia seeds (Peiretti and Meineri, 2008).

Table 2. Effect of fish oil added diets on fatty acid profile of rabbit loin (% of total acids)

	Diet				**Root MSE**	**P-value ***
	C	**P**	**V**	**A**		
Saturated FA %	33.9 a	33.5 a	34.3 a	35.6 b	1.015	**
MUFA %	23.1	23.3	24.1	23.0	1.348	ns
PUFA %	40.4	40.5	38. 8	39.8	1.448	ns
EPA (C20:5) %	0.32 a	1.13 b	0.99 b	1.16 b	0.84	**
DHA (C22:6) %	0.20 a	3.38 b	3.36 b	4.54 c	0.89	**
Omega 3 %	2.48 a	6.64 b	6.37 b	7.36 c	0.720	**
Omega 6 %	36.8 a	32.8 b	30.7 c	31.1 c	1.335	**
omega 6/3 ratio	15.1 a	4.86 b	4.63 b	4.04 b	0.970	**
IT	0.85 a	0.65 b	0.69 b	0.67 b	0.825	**

Means with different letters on the same line differ significantly, *=P<0.05,**=P<0.0001

The content of polyunsaturated fatty acids (PUFA) was not significantly different between treatments; Gigaud and Combes (2008) and Peiretti and Meineri (2008) using vegetable sources to modify the lipid profile of the meat, obtained an increase in the content of PUFA due to experimental diets, although in both cases, the quantity of PUFA in control diets was lower than that obtained in this work for diet C.

The largest significant differences were evident in the content of omega 3 and omega 6 in the enriched with fish oil treatments. These changes in the concentration of omega-3 were mainly due to the increase in the content of EPA and DHA (3:1 for EPA and 16:1 in the case of DHA for P, V and A vs C). In particular, the loins from treatment A showed the highest content of DHA (4.54%) compared to the other treatments with the addition of fish oil; this response could be due to the additional contribution of HPUFA by algae (Dantagnan et al., 2009).

Regarding the omega-6/3, it was significantly lower ($p < 000.1$) in the case of diets were included fish oil respect C diet, reaching the nutritional recommended values for human (Barceló-Cobijn and Murhy 2009).

CONCLUSSION

The addition of fish oil in the diet allows obtaining nutraceutical meat by the highest content of omega-3 and the omega 6/3 ratio value according to medical recommendations, without affecting the parameters of growth and carcass yield. For fresh consumption, the addition of antioxidants would not be necessary. The sensory evaluation of the obtained products, in order to ensure the absence of off flavors that condition consumer acceptance, should be done.

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