EFFECT OF THE DIETARY FAT ON FATTY ACID COMPOSITION AND OXIDATIVE STABILITY OF RABBIT MEAT

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Introduction

There is an increasing interest in the lipid composition of edible meat and fat because of its relationship with human health, particularly with cardiovascular illness. The recommendations since a nutritional point of view are to reduce saturated fat consumed and to increase the ingest of n-3 and n-6 polyunsaturated fatty acids (PUFA). However unsaturated fat could lead to the apparition of soft and oily carcasses and the development of rancidity problems as a consequence of lipid oxidation. One of the main factors limiting the quality of meat is lipid oxidation (Monahan, 2000). The objective of this project is to study the possibility to enrich rabbit meat with long-chain n-3 and n-6 PUFA, through dietary fat. The study is focused on how oxidative shelf life of rabbit meat is influenced by the n-3 and n-6 PUFA content of the dietary fat.

Materials and Methods

Rabbits from the same genetic type (a three-way cross) were divided into three groups 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. Ten animals per group were slaughtered (9 wk old). 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. A whole hind leg of each animal was entirely deboned to separate bone to edible meat. The different samples of meat were ground up using a domestic mincing machine and divided into Petri dishes and flattened. Each Petri dish was over-wrapped with oxygen permeable polyvinyl chloride film and stored a 4ºC for 1 or 4 days (2 or 5 post-mortem days, respectively). At each time of storage samples were vacuum-packed and stored at -80ºC for later analysis. Lipids were extracted from 5 g of minced muscle with dichloromethane-methanol (2:1 v/v). Fatty acid methyl esters (FAME) of total lipids were prepared. Analysis of FAME was carried out in a Fison 8160 gas chromatograph equipped with a split injector and a flame ionisation detector. The individual fatty acids were identified by comparing their retention times with those of standard fatty acids. The results were expressed as a percentage of the amount of present methyl esters. The extent of lipid oxidation was assessed by the thiobarbituric acid method outlined by Raharjo et al. (1992) with modifications. TBARS number was expressed as mg malonaldehyde/kg sample. The peroxide values (PV) of the lipid samples were measured using the method described by Shanta and Decker (1994) and were expressed as milliequivalents peroxide/kg fat. Least square analysis were fitted to a model including Diet (A, SF, L), sex and storage time (2 and 5 post-mortem days) as fixed effects.

Results and Discussion

The total amount of lipid of the rabbit hind leg meat was not affected by the diet (values around 5.5 g/100g of meat). Table 1 shows the relative percentage of the fatty acids of the meat of the hind leg of rabbits fed with three different diets. Our results show a dietary effect on fatty acid composition of the rabbit hid leg meat. The meat of the group A had lower PUFA and higher SFA and MUFA percentages than the meat from groups SF and L, with no differences between SF and L groups. However, large differences were found between SF and L groups in the PUFA components. The percentage of C18:2 was greater in SF than in L (42 and 25% in SF and L, respectively). Moreover, meat from L group had 20% of C 18:3 and lower values were found in A and SF group (around 2%). This is a consequence of the diet composition since sunflower and linseed oils are riches in C18:2 and C18:3, respectively. Linoleic acid is the precursor of n6 family of PUFA, while linolenic acid serves the same function for the n3 family, especially for eicosapentaenoic (C20:5) and docosahexaenoic (C20:6) fatty acids. These two fatty acids had higher percentage in meat from L group than in meat from A and SF groups. Our results confirmed the ability of rabbit tissues to synthesise these fatty acids from the dietary linolenic precursor. Due to the high content of linoleic acid in A and SF groups, the ratio n-6/n-3 fatty acids reaches higher values than the recommended values from a nutritional point of view. Therefore, decreasing the n-6/n-3 ratio up to 5 is an interesting goal to improve the nutritional value of rabbit meat for human benefits. In this sense diets enriched with linseed oil increase the n3 PUFA level and decrease the n-6/n-3 ratio.

No differences among groups for PV and TBARS were found at 2 post-mortem days (table 2). However, at 5 post-mortem days the meat from the L group had higher TBARS number. A level of approximately 1.0 mg

MDA per kg tissue in pork (Gray and Pearson, 1987) and 2.0 mg MDA per kg tissue in beef (Campo et al., 2006) have been suggested as the threshold level in which rancidity or warmed-over flavour could be detected by a taste panel. According to these values, the TBARS were well below for apparent rancidity in our experiment. Besides, no differences among groups were found in texture and sensory analysis (data not shown).

Table 1. Relative percentages of fatty acids of hind leg meat of rabbits fed with three different diets

	A		SF		L	
	Mean	SE	Mean	SE	Mean	SE
C14:0	2.43^{a}	0.07	1.35^{b}	0.07	1.46^{b}	0.07
C14:1	0.271^{a}	0.030	0.0686^{b}	0.0296	0.0971^{b}	0.0312
C16:0	27.0^{a}	0.5	21.3^{b}	0.5	21.2^{b}	0.6
C16:1	2.96^{a}	0.26	1.54^{b}	0.26	1.84^{b}	0.27
C17:0	0.740^{a}	0.020	0.570^{b}	0.020	0.553^{b}	0.021
C17:1	0.407^{a}	0.019	0.124^{b}	0.019	0.161^{b}	0.021
C18:0	9.56^{a}	0.25	8.17^{b}	0.25	7.54^{b}	0.26
C18:1	29.1^{a}	0.5	19.4^{b}	0.5	19.9^{b}	0.5
C18:2 n6	22.6^{b}	0.8	42.1^{a}	0.8	24.7^{b}	0.8
C18:3 n3	2.07^{b}	0.27	1.66^{b}	0.28	20.0^{a}	0.3
C20:1	0.254^{a}	0.013	0.178^{b}	0.013	0.148^{b}	0.014
C20:2 n6	0.199^{b}	0.018	0.467^{a}	0.018	0.186^{b}	0.019
C20:3 n6	0.230^{b}	0.013	0.285^{a}	0.013	0.208^{b}	0.014
C20:4 n6	2.02^{ab}	0.18	2.45^{a}	0.18	1.60^{b}	0.19
C20:5 n3	0.0503^{b}	0.0121	0.0355^{b}	0.0121	0.316^{a}	0.013
C22:6 n3	0.0687^{b}	0.0066	0.0516^{b}	0.0066	0.155^{a}	0.007
SFA	39.7^{a}	0.6	31.4^{b}	0.6	30.7^{b}	0.6
MUFA	33.0^{a}	0.7	21.3^{b}	0.7	22.1^{b}	0.8
PUFA	27.3^{b}	1.0	46.9^{a}	1.0	47.2^{a}	1.1
n6/n3	11.5^{b}	0.5	26.0^{a}	0.5	1.31^{c}	0.50
PUFA/SFA	0.688^{b}	0.053	1.50^{a}	0.06	1.55^{a}	0.05

A: diet with a 3% of added animal fat. SF: diet with a 3% of added sunflower oil. L: diet with a 3% of added linseed oil. ^{a,b,c,} Means within the same row with different letter differ significantly ($p<0.05$).

Table 2. Effect of diet and refrigerated storage (2 or 5 days post-mortem) on peroxide value (PV) and TBARS

	PV				TBARS			
	2 pm days		5 pm days		2 pm days		5 pm days	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
A	1.77^{A}	0.19	2.67^{bB}	0.29	0.286	0.018	0.296^{b}	0.040
SF	2.05^{A}	0.19	3.42^{abB}	0.28	0.301	0.018	0.319^{b}	0.040
L	2.26^{A}	0.19	3.88^{aB}	0.28	0.291^{A}	0.018	0.488^{aB}	0.040

A: diet with a 3% of added animal fat. SF: diet with a 3% of added sunflower oil. L: diet with a 3% of added linseed oil. Storage effect: ^{A,B} Means within the same row with different letter differ significantly ($p<0.05$). Diet effect: ^{a,b} Means within the same column with different letter differ significantly ($p<0.05$)

Conclusion

This study confirms the possibility of increasing n-3 fatty in rabbit meat without reducing its oxidative stability and quality.

References

Campo, M. M., Nute, G., R., Hughes, S. I., Enser, M., Wood, J. D., Richardson, R. I. (2006). Flavour perception of oxidation in beef. Meat Science, 72, 303-311.

Gray, J. I., Pearson, A. M. (1987). Rancidity and warmed-over flavour. Advances in Meat Research. 3: 221-269.

Monahan, F. (2000). Oxidation of lipids in muscle foods: Fundamental and applied concerns. In E. Decker, F. Faustman & C. López-Bote (Eds). Antioxidants in muscle foods. (pp. 3-23). New York: Wiley & Sons, Inc.

Raharjo, S., Sofos, J. N., & Schmidt, G., R. (1992). Improved speed, specify and limit of determination of an aqueous acid extraction thiobarbituric acid-C18 method for measuring lipid oxidation. Journal of Agricultural and Food Chemistry, 40, 2182-2185.

Shanta, N. C. & Decker, E. A., (1994). Rapid, sensitive, iron-based spectrophotometric methods for determination of peroxide value of food lipids. Journal of Association of Official Analytical Chemists, 77, 421-424.