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Rabbit meat as a functional food: meat quality produced with and without fresh alfalfa *ad libitum*

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Abstract

Rabbit meat has widely recognized nutritional and dietetic qualities, but its contribution of bioactive substances can be improved through modifications in the diet of growing rabbits.

The aim of this study is to provide information on rabbit meat`s nutritional value obtained with two different feeding strategies: commercial pelleted food *ad libitum* (T1) and commercial pelleted food plus fresh alfalfa both *ad libitum* (T2). Samples of meat fat (*L. dorsi*) and dissectible fat were analyzed in order to determine intramuscular fat content and fatty acid composition. Vitamin E and mineral content (zinc, iron, magnesium and sodium) were analyzed.

Differences in content of intramuscular fat were not significant (1,41 vs. 1,39 g/100g of meat). The inclusion of fresh alfalfa in the rabbits' diet showed a significant effect on the composition of dissectible and intramuscular fat, with a relevant increase of α-linolenic acid (1,82% vs. 3,28% and 2,29% vs. 5,15%, P<0.0001, for T1 and T2 in intramuscular and dissectible fat respectively). Consequently the ratio n-6/n-3 was significantly improved.

The low fat content in rabbit meat allows to fulfill the recommendations in the nutritional energy contribution of these sources. The increase in fatty acids n-3 obtained in rabbits which were supplemented with alfalfa reinforces the recognized positive effects on the cardiovascular health and other non-transmissible chronic diseases. The nutritional value of rabbit meat can be improved even more by varying the composition of the diet. As a consequence, this product should be considered as a functional food and also an alternative to traditional meats.

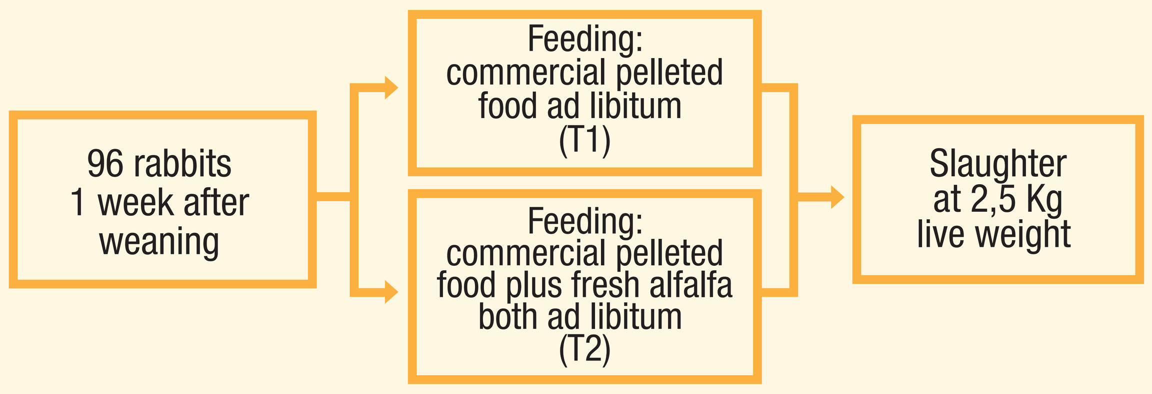
Introduction

The contribution of rabbit meat in bioactive substance can be improved through changes in the diet of growing animals. This attribute has led the search of mechanisms of management of production factors that contribute to enrich the nutritional content of this species meat (Hernández, 2008; Lazzaroni et al., 2009; Petracci et al., 2009; Capra et al., 2010). Zhang et al. (2010) and Dalle Zote and Szendro (2010) describe the improvement of the nutritional value of meat by supplementation of ingredients that enhance the contribution of bioactive compounds: CLA, vitamin E, n-3 fatty acids, selenium. Alfalfa, a relevant ingredient in the diet of rabbits, is a rich source of linolenic acid.

Objective

The aim of this study is to provide information on the nutritional value of rabbit meat produced with two different strategies that coexist in the production conditions of Uruguay: commercial pelleted food *ad libitum* (T1) and commercial pelleted food plus fresh alfalfa both *ad libitum* (T2).

Materials and methods



- Lipid profile. For the determination of the intramuscular fat lipid profile twenty samples of 30 g each were used, ten of each feeding treatment. *Longissimus dorsi* muscle was removed from each carcass and submitted for lipid extraction.
For the dissectible fat lipid profile analysis, twelve samples were prepared, six of each feeding treatment. The dissectible fat included the perirenal, scapular and inguinal fat.
The fatty acid content was determined by gas chromatography and mass spectrometry following the AOCS Official Method Ce 2-66 "Preparation of Methyl Esters of Fatty Acids", AOCS Ce 1-62 "Fatty Acid Composition by Gas Chromatography", AOCS Ce 1-91 "Preparation of Methyl Esters of Long Chain Fatty Acids".

- Minerals. Twenty samples of 5 g each one were used for the iron, sodium, zinc and magnesium analysis, ten of each feeding treatment. The samples were taken from a meat pool obtained by crushing and homogenizing the whole carcass meat with a domestic processor.
Iron, sodium, zinc and magnesium were analyzed in digested samples in a closed high pressure system following the AOAC 999.10 adapted method, by atomic emission (ICP-OES) based on adapted ISO 11885:1996.

- Vitamin E. For the vitamin E analysis twenty samples of 10 g each one were used, ten of each feeding treatment. The samples were obtained from the meat pool and processed in the same way that the ones for the minerals analysis.
The vitamin E determination was made following the EN 12822 consisting of a saponification and extraction in organic solvent. The extracted organic layer was injected directly into HPLC after filtering through 0.22 micron. Chromatographic separation was done on normal phase (Phenomenex Silica) using a fluorescence detector at 290-330 nm.

- Statistical analysis by GLM procedure of SAS, 2003.

Results and discusion

Table 1. Effect of treatments on the dissectible and intramuscular fat composition (%)

	Intramuscular fat			Dissectible fat		
	T1	T2	P	T1	T2	P
C18:3 (n-3)	1.82 ± 0.50	3.28 ± 0.63	P < 0.0001	2.29 ± 0.45	5.15 ± 0.68	P < 0.0001
∑ SFA	40.36 ± 2.37	39.91 ± 1.99	N.S.	40.76 ± 3.12	39.37 ± 0.81	N.S.
∑ MUFA	32.10 ± 2.47	28.30 ± 2.57	P = 0.0035	30.10 ± 2.10	26.73 ± 1.58	P = 0.0105
∑ PUFA	27.04 ± 3.51	31.15 ± 4.00	N.S.	29.02 ± 3.91	33.89 ± 2.04	P = 0.0222
PUFA/SFA	0.68 ± 0.12	0.79 ± 0.13	N.S.	0.72 ± 0.15	0.86 ± 0.06	N.S.
SFA/(MUFA+PUFA)	0.69 ± 0.07	0.67 ± 0.06	N.S.	0.69 ± 0.09	0.65 ± 0.02	N.S.
∑ (n-6)	23.59 ± 2.79	25.83 ± 3.55	N.S.	26.77 ± 3.72	28.74 ± 2.00	N.S.
∑ (n-3)	2.81 ± 0.67	4.55 ± 0.81	P < 0.0001	2.38 ± 0.48	5.18 ± 0.71	P < 0.0001
n-6/n-3	8.60 ± 1.21	5.82 ± 1.19	P < 0.0001	11.58 ± 2.34	5.64 ± 0.86	P < 0.0002
n-3/n-6	0.12 ± 0.02	0.18 ± 0.03	P < 0.0001	0.09 ± 0.02	0.18 ± 0.03	P < 0.0001
AI	0.62 ± 0.07	0.58 ± 0.06	N.S.	0.70 ± 0.10	0.63 ± 0.03	N.S.
TI	0.96 ± 0.12	0.80 ± 0.10	P = 0.0057	1.12 ± 0.17	0.88 ± 0.04	P = 0.0065
h/H	1.95 ± 0.21	2.02 ± 0.17	N.S.	1.77 ± 0.21	1.91 ± 0.06	N.S.

Atherogenicity Index: AI= [C12:0 + (4*C14:0) + C16:0] / [(∑ PUFA) + (∑ MUFA)]
Thrombogenicity Index: TI= [C14:0 + C16:0 + C18:0] / [(0.5*∑ MUFA) + (0.5* ∑ n-6) + (3*∑n-3) + (n-3/n-6)]
h/H = (∑ MUFA + ∑ PUFA) / (C14:0 + C16:0)

- The intramuscular fat didn´t show significant differences in content: 1,41 g / 100 g of meat with T1 and 1,39 / 100 g of meat with T2.

- The incorporation of fresh alfalfa *ad libitum* in the growing rabbits diet showed a remarkable increase in the linolenic acid C18:3 n-3 in both intramuscular and dissectible fat.

- The fatty acid composition modified by the alfalfa inclusion in the diet has a beneficial effect in all the indexes used to evaluate the nutritive value and the potential impact on consumer's health. One of the most used indicators, the n-6/n-3 ratio, has relevant differences between both treatments.

- The Atherogenicity Index (AI) and Thrombogenicity Index (TI) proposed by Ulbricht and Southgate (1991) also showed an improvement with the alfalfa inclusion, particularly on the dissectible fat. Both indexes consider the effect of the different fatty acids related with coronary diseases incidence. The values obtained in this experiment showed significant differences in TI between treatments, with a positive effect of the alfalfa inclusion. The AI had lower values and the TI slightly higher values that the ones reported by Lazzaroni et al. (2009) in rabbits raised in two different housing systems.

- The h/H ratio showed in Table 1 is other index used to estimate the nutritive attributes of food (Herranz et al., 2008). In this experiment no statistically significant differences were observed between treatments in this ratio, either in intramuscular or dissectible fat.

Table 2. Effect of treatments on minerals and vitamin E contents

	T1	T2	P
Sodium (mg/100g)	44.10 ± 0.49	48.20 ± 0.30	P = 0.0382
Iron (mg/100g)	0.63 ± 0.46	0.65 ± 0.66	N.S.
Magnesium (mg/100g)	22.50 ± 0.17	24.40 ± 0.16	P = 0.0211
Zinc (mg/100)	1.29 ± 0.11	1.34 ± 0.14	N.S.
Vit.E (mg α -tocoferol/100g)	0.27 ± 0.04	0.31 ± 0.05	N.S.

- The values obtained for sodium and magnesium are framed within the ones that literature provides (Dalle Zotte, 2002; Combes and Dalle Zotte, 2005; Gigaud and Le Cren, 2006; Hermida et al., 2006), while the iron level is below and the zinc level over the range reported by those authors. Hermida et al. (2006) affirm that the low sodium and high potassium contents make the rabbit meat particularly recommended in diets for hypertension. These authors also remark that rabbit meat provides less zinc and iron than meat from other species.

- In the case of vitamine E the values obtained in this experiment are greater than the 0.186 mg/100 g reported by Combes and Dalle Zotte (2005) and similar to the range of 0.181-0.376 mg/100 g obtained for different feeding treatments by Kowalska and Bielanski (2009).

Conclusions

The low fat content of rabbit meat makes it advisable for restricted diets, while the increase in n-3 fatty acids reached in rabbits supplemented with alfalfa gives a positive effect in the treatment of dyslipidemias. This meat obtained under standard conditions can be considered as beneficial food for the treatment of obesity and cardiovascular diseases and can be incorporated as a choice within the group of meat in the diet of Uruguayans.

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