TRAITS OF MEAT QUALITY IN RABBITS IN AN INTEGRATED ORGANIC FARMING SYSTEM

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ABSTRACT

The aim of the trial was to characterize the carcass and meat quality of New Zealand White x Californian (NZWxC) rabbits obtained from an organic farming system, associated with vegetable production. Twenty-five rabbits of both sexes and 35 days of age were bred during Autumn in 5 plots located in the Organic Vegetable Garden of the Faculty of Agronomy. The rabbits were fed with vegetables, fresh and dried alfalfa forage and cereals from the organic vegetable garden. At slaughter (107 days; 2,4 kg live weight), dressing percentages and qualitative trait measures of the carcass and nutritive values of the meat were recorded. The average of both sexes for carcass yield was 56% with a meat/bone ratio of 4.5. Despite the slaughter age, the levels of fat in the carcass (2.06% of carcass weight) and WB shear force values (1.82 and 1.52 for the loin and the hind leg, respectively) were low, corresponding to a lean carcass and very tender meat. The n6/n3 ratio was 4.4 (loin) and 3.7 (hind leg) and the PUFA/SFA measure was 0.88 (loin) and 0.80 (hind leg) which, according to the limits recommended for human consumption (n6/n3 <4 and PUFA/SFA >0.45), were lower and higher, respectively. The production of NZWxC rabbits reared on floor, integrated with the organic vegetable garden production, reached the slaughter weight required by the Argentine market (2.3 to 2.5 kg) after 107 days. Rabbit meat produced from the organic farming system as associated with horticultural production resulted in high nutritional values, according to the dietary recommendations for the care of human health.

Key words: Rabbit, vegetable garden, organic production, meat nutritional value.

INTRODUCTION

Organic production is regarded as 'more friendly' to the environment and animal welfare (Kouba, 2003) and consumers perceive their products as safer (Sylvander, 1999). Argentina has ideal conditions for the conversion of commercial farming systems into an organic productive system, which is regulated by the Resolution of the National Security Service and Food Quality (No. 423/92 and 1286/93). The Faculty of Agronomy of the University of Buenos Aires has implemented a system of organic vegetable production, which is associated with the recycling of rabbit faeces through composting. The “organic” rabbits are fed exclusively with products from the vegetable garden that allows 3-4 cycles /year.

The consumption of rabbit meat in Argentina is very low (100g/person/year). A tool for the promotion of the consumption would be the diffusion of the comparative nutritional values of the meat that is obtained from the use of organic forage and small-scale breeding. The objective of this work was to study the productive response of rabbits of commercial breeds (New Zealand White x Californian) and to evaluate the carcass and meat quality obtained from a breeding system associated with organic vegetable production.

MATERIALS AND METHODS

The study was carried out at the Organic Vegetable Garden of the Faculty of Agronomy, University of Buenos Aires, Argentina. An organic breeding rabbit unit (3-4 cycles/year with 25 to 30 rabbits/cycle) was associated with horticultural crop production. The vegetable garden used the compost obtained from faeces in rabbit beds as fertilizer. The experimental pens (n = 5; 1.5m x 2.0 m; 0.6 m^2/animal) were shady with wood and cane, supplied with a water container with a water nipple, a cement feeder, and a wood-grilled type floor. The animals (5/pen) were fed *ad libitum* with alfalfa hay, vegetables, fresh alfalfa forage, and cereal grains produced from the vegetable garden. Wilted vegetables and grains were weighed and recorded daily, as well as the weight of refuse food from the previous day.

To adapt rabbits to diets, 35 to 45 day-old rabbits that showed episodes of diarrhea were controlled through homeopathic treatment (Ars alb., Ignatia, Coccidinium, Ipecac, echinacea, all in a 12 Hannemaniana complex solution). During the next 30 days, rabbits were provided with alfalfa (hay and fresh) and a mixture of whole wheat and oat grains. By 70d days of age, vegetables were included. The chemical analysis of the feeds, expressed on a % of average of dry matter (AOAC, 1984, Goering and Van Soest, 1970), showed for the 'mix' of vegetables: 65.6% DM, 15.6% CP, 2.89% EE , 58.6% NDF, 8.3% LDA; 1878 kcal DE/kg (DM), 16.2% SFA, 4.7% MUFA, and 79.1% PUFA, and for the 'mix' of cereals: 87.1% DM, 13.8 % CP, 3.73% EE, 23.7% NDF, 0.7% LDA; 3139 kcal DE/kg (DM), 21.7% SFA, 20.2% MUFA, and 62.6% PUFA.

Individual live weights of each rabbit were recorded weekly. Slaughter was performed at a commercial weight without fasting, following the European-style recommendations of Blasco and Ouhayoun (1996). The chilled carcasses (24 h post-slaughter, 4-5°C) were transferred to the Meat Laboratory of the Faculty of Agronomy for qualitative analyses. The final pH (Hanna pHmeter), instrumental colour (Minolta CR300; CIE, 1976), cooking losses (bain marie 1 and 2.30 h at 80°C, for the loin and hind leg, air dried) and tenderness (sample diameter:1.25cm, Warner-Bratzler on an Instron 1140) were measured on Longissimus Lumborum (LL) and Biceps Femoris (BF). The fatty acids profile (Folch *et al.*, 1957) of intramuscular fat were evaluated by means of gas chromatography using RT-2560 capillary column (100 m x 0.25 x 0.20) mounted on GC Shimadzu (GC-14BPFsc) and expressed as % of total fatty acids (% FAtot). Differences due to sex were tested using the GLM procedure of SAS (1990) and using the Tukey test ($P < 0.05$).

RESULTS AND DISCUSSION

The mean live weights (g) and daily gain (g/d) of the 'organic' rabbits are presented in Table 1. As rabbits were over 90 days old, the traits were analyzed by gender to test for the expression of sexual differentiation. Live weights at slaughter were met according to the requirements of the Argentine market (females: 2.478 kg *vs* males: 2.381 kg; $P>0.05$) and were reached before 107 days of age. Individual consumption (vegetables mix + cereal mix) was 131.8g/d DM/animal in agreement with results obtained by D'Agata *et al.* (2007) for rabbits reared on floor (balanced + alfalfa hay).

Table 1: Statistics for live weights and average weight gains of organic rabbits

Sex/parameters	Male	Female	Probability	Error variance
Initial weight (g)	985	1024	0.3545	80.9
Final weight (g)	2381	2478	0.5819	341
Daily gain (g/d)	22.2	23.1	0.7086	4.78

Results for carcass characteris are described in Table 2. The incidence of the full gastro-intestinal tract weight (20.3% LW) of organic rabbits was similar those reported by Dalle Zotte and Paci (2006a; 18.6% LW) for 111 days of age with rabbits being slaughtered at 2.8 kg of weight. The degree of fatness was similar for males and females. For dissectible fat percentage, Combes *et al.* (2003) and Pla (2008) found females to be more fat than males, while Dalle Zotte and Paci (2006a) found no significant difference due to gender.

Table 2: Dressing percentage, slaughter and carcass quality traits of organic rabbits.

Sex/parameters	Male	Female	Probability	Error variance
Chilled carcass weight (g) (CC)	1319	1406	0.4306	214
Dressing percentage (%)	55.2	56.7	0.3996	3.67
Full gastro-intestinal weight (% LW)	20.7	19.9	0.6465	3.5
Empty caecum (% LW)	2.62	2.94	0.3530	0.65
Reference carcass weight (g) (RC)	1319	1367	0.6645	217
Hind leg meat/bone	4.7	4.3	0.3990	0.93
Total fat (%RC)	2.10	2.03	0.8967	1.09

Table 3 presents the pH and colorimetric traits of the *Longissimus lumborum* (LL) and *Biceps femoris* (BF) muscles and the cooking losses and shear force (WB) for loin and hind leg cuts for both sexes.

Table 3: pH_{24}, colour, cooking losses and WB shear force from organic rabbit meat

Sex/parameters	Male	Female	Probability	Error variance
pH_{24} LL	5.66	5.68	0.6546	0.11
pH_{24} BF	5.77	5.84	0. 2802	0.13
L* LL	65.9	65.4	0.5525	1.85
a* LL	2.89	1.47	0.0029	0.79
C*LL	4.92	5.65	0.2165	1.13
L* BF	54.7	54.4	0.8052	2.70
a* BF	7.75	6.06	0.0110	1.16
C*BF	8.13	6.91	0.0179	0.90
Hind leg cooking losses (%)	20.2	22.0	0.7697	6.00
Loin cooking losses (%)	29.0	29.7	0.7504	2.17
Loin WB shear force (kg/cm^2)	2.12	1.62	0.1742	0.31
Hind leg WB shear force (kg/cm^2)	1.83	1.31	0.1481	0.30

There were no significant sexual differences for pH and luminosity values (L*) in both muscles in agreement with Combes *et al.* (2003), Dalle Zotte (2007) and Pla (2008). Males had a higher red-index (a*) for both muscles compared to females ($P<0.01$), but no significant difference was found for yellow-index (b*). Our results agree with those of Combes *et al.* (2003) and Pla (2008) for trait a* of LL muscle, where the males significantly differed compared to females. Regardless of sex, the hind leg colour values were slightly higher than those obtained by Combes *et al.* (2003) for the rabbit 'bio' slaughtered at 105 days of age.

Cooking water losses and Warner-Bratzler shear force (WB) of the loin and hind leg of the rabbits showed non-significance for sex differences, which is in agreement with the literature. For LL muscle, WB shear force values reported by Pla (2008) were higher than those of the present study and those presented by Dalle Zotte (2007). Regardless of sex, breeding on floor with a larger area for movements than a conventional cage and the older slaughter age did not affect the tenderness of meat rabbits in the organic system, compared with conventional farming.

Table 4 describes the fat content (EE) and the fatty acid profile of intramuscular fat of loin and hind leg, and the average values for both sexes (sex showed no significant differences). The hind leg showed a greater presence of linoleic acid, n6 FA and, consequently, a higher PUFA value and n6/n3 ratio. The values obtained for the n3 and n6 FA were higher and lower, respectively, than those obtained by Dalle Zotte and Paci (2006b) and Pla (2008) for organic rabbits. This difference could be attributed to the incorporation of green alfalfa (*Medicago sativa*), chicory (*Cichorium intybus L)*, and vegetables in the fattening period, increasing the supply of dietary linolenic acid.

Table 4: Lipid content (EE) and fatty acid composition (%Tot. FA) of organic rabbit meat

Muscle	Loin	Hind leg	Probability	Error variance
Dry matter DM (%)	25.3	25.0	0.3772	0.53
Ether extract (%DM)	4.35	10.7	0.0001	1.32
C 18:0	8.85	8.44	0.7602	1.02
C 18:1 cis 9	23.5	22.5	0.6097	3.02
C 18:2 cis 9,12	18.6	22.0	0.0186	1.52
C18:3 cis 9,12,15	4.19	3.64	0.3990	0.91
SFA	46.7	44.5	0.2235	2.48
MUFA	25.1	24.1	0.6035	3.09
PUFA	28.3	31.5	0.0379	1.95
n6/n3	3.67	4.48	0.0691	0.51
PUFA/SFA	0.61	0.71	0.6768	2.03

SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.

The n6/n3 ratio value is close to the recommended value (40) as beneficial for good health (Department of Health and Social Security, 1994). For the loin and hind leg cuts, the PUFA/SFA ratio was 0.66, which is higher than the recommended value (> 0.45; Department of Health and Social Security, 1994), being similar to that found by Pla (2008) for the hind leg cut (P:S= 0.6).

CONCLUSIONS

Live weights at slaughter of “organic rabbits” were met according to the standard requirements of the Argentine market. At 107 days of age and for both sexes, no differences were found in the dressing percentage, meat to bone ratio, carcass fatness or chemical composition of meat. The meat color was more 'red' in loin and hind leg of males than females. The breeding plot location did not affect the meat tenderness, resulting in “very tender” meat despite the age of slaughter. Taking into account the values obtained for the health-related indices, the meat of rabbits raised in the integrated system with the organic vegetable garden produced nutritional qualities consistent with dietary recommendations for human consumption.

ACKNOWLEDGMENTS

To Mr. Adolfo de Alcantara, who was in charge of field work in the organic orchard, for his daily care and feeding of animals and to Mr. Miguel Bornico for his invaluable assistance in data collection post-slaughter and laboratory tasks.

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