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INFLUENCE OF TYPE OF REARING, SLAUGHTER AGE AND SEX ON FATTENING RABBIT: II. MEAT QUALITY¹

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ABSTRACT

The influence of type of rearing, slaughter age and sex on meat quality was investigated on fattening rabbits housed indoors in “bicellular” cages or outdoors in “colony” cages and slaughtered at 90 or 120 days of age. *Longissimus lumborum* muscles resulted from 34 chilled reference carcasses were excised and analysed for colour, pH, water holding capacity, moisture, protein and intramuscular fat.

Type of rearing and age at slaughter affected the main qualitative traits of meat, whereas sex did not show any significant differences. However, in most of the variables significant interaction was found between “type of rearing × slaughtering age”. Open-air rearing in colony cage showed a marked influence on the qualitative characteristics of meat only in rabbits slaughtered at 120 days of age. Compared to same aged rabbits which are housed indoors in bicellular cages, the animals reared open-air have produced meats leaner (intramuscular fat: 1.22 vs. 2.03 %; $P \leq 0.01$), paler (L^* values: 52.5 vs. 46.2; $P \leq 0.01$) and with lower pH (5.54 vs. 5.76; $P \leq 0.01$).

INTRODUCTION

In the future, breeding systems for meat production will need to consider the welfare of animals as well as modern needs of the consumer. Under this point of view, a change can be foreseen from present breeding systems, to systems which are closer to the natural behaviour of rabbits (Drescher, 1992; Ferrante *et al.*, 1997) without comprising the economical objective of rearing and the safety of the produce (Morisse, 1998).

Open-air rearing can be considered as a promising alternative to intensive systems used at present especially in the fattening phase. When open-air rearing is adopted rationally, economic advantages and advantages to health are significant (Crimella *et al.*, 1996; Di Lella *et al.*, 1996; Mirabito, 1998).

Furthermore, the ever-growing diffusion of processed meat industry which is already portioned and ready for consumption, calls for raw materials which are technologically apt (Maertens *et al.*, 1998). The selection of genetic types which reach a slaughter weight which is superior to current weights and which can guarantee a superior maturity of meat without exceeding in intramuscular fat could be useful for such produce (Petracci *et al.*, 1999).

The aim of this research is to study the influence of rearing type (indoors in bicellular cages vs. outdoors in colony cages), slaughter age (90 vs. 120 days of age) and sex on the quality of rabbit meat.

MATERIAL AND METHODS

The present experiment is part of a wider research project conducted on intensive rabbit breeding in North-West Italy in which husbandry performance and quali-quantitative characteristics of carcasses in the fattening stage were examined (Luzi *et al.*, 2000).

¹ Part of these results was presented at the LIII SISVet Congress, Montecatini Terme (PT), 16-18 September 1999.

The rabbits were selected at the weaning (5 weeks of age) and divided in two groups. A control group of animals was placed in bicellular cages (California, 40×30×28cm) indoors, while the second group was placed in outdoor cages (*flat-deck* 40×90×28cm, 6 animals per cage) below a roof (open-air system). In both types of cages the surface for animal was 0.06 m². The animals were slaughtered at 90 and 120 days of age.

Thirty-four reference carcasses (commercial carcass minus the head, liver, kidney, organs of chest and neck; Blasco *et al.*, 1993) of rabbits were selected on basis of fixed effects. Carcasses were kept at 4°C for 24 h and from each *L. lumbrorum* muscles were excised and analysed for assessment meat quality.

The measurements of colour parameters L* (lightness), a* and b* (redness and yellowness, defined in a system of orthogonal axis), H* (Hue= $\text{tg}^{-1}(b^*/a^*)$) and C* (Chroma= $(a^{*2}+b^{*2})^{1/2}$) have been performed, according to Cielab system (CIE, 1976), with a Minolta CR-300 apparatus with a light source D₆₅ and diffuse illumination/viewing system on a 8 mm diameter area. pH has been measured at 36 hours *post mortem* (pH_u) by using portable pHmeter Crison 507 having a glass electrode with a 0.8 cm diameter conic tip (Double Bore, Hamilton). The water holding capacity (WHC) was measured according to filter paper press (Kaufmann *et al.*, 1986) and cooking loss (Honikel, 1998) methods and was expressed as percentage of initial sample weight. Moisture and proteins contents was measured by standard analyses methods recommended by AOAC (1990) whereas intramuscular fat according to Folch *et al.* (1957).

ANOVA was performed with the GLM/SAS package (SAS/STAT, 1990) which includes type of rearing (indoors and outdoors), slaughter age (90 and 120 d) and sex as fixed effects, and interaction between type of rearing and slaughter age, according to the following model:

$$Y_{ijkl} = m + a_i + b_j + g_k + a_i b_j + e_{ijkl}$$

where:

Y_{ijkl} = dependant variable;

m = general mean;

a_i = fixed effect of type of rearing (i = 1,2);

b_j = fixed effect of slaughter age (j = 1,2);

g_k = fixed effect of sex (k = 1,2);

a_ib_j = interaction effect between type of rearing and slaughter age

e_{ijkl} = random effect.

RESULTS AND DISCUSSION

Tables 1 and 2 show the qualitative characteristics of rabbit meat according to the type of rearing, slaughter age and sex.

As far as type of rearing adopted is concerned, it was observed that rabbits reared in open-air colony cages produced meat with lower pH values, paler colouring and with higher b* and H* with respect to meat from rabbits reared in indoor cages. The latter contained a higher quantity of intramuscular fats.

With regard to age of slaughtering, as expected, the chilled carcass of animals slaughtered at 90 days was lighter than those slaughtered at 120 days. The meat of latter carcasses had higher pH values and less light than the younger carcasses as well as containing a higher water holding capacity. This meat also had an high content of fats and proteins as well as a lower content of moisture as reported also by Szendro *et al.* (1998).

Sex had no significant influence on the main qualitative variables.

Table 1 - Least square means and standard error of quality meat characteristics.

	Reference carcass (g)	Perirenal fat (g)	Moisture (%)	Protein (%)	Intramuscular fat (%)	WHC (%)	Cooking loss (%)
<i>Type of rearing</i>							
Outdoor	1483±31	31.4±3.8	74.5±0.2	22.6±0.1	1.25±0.08B	17.5±1.0	30.1±0.3
Indoor	1531±34	37.4±4.1	74.6±0.2	22.7±0.1	1.58±0.08A	17.8±1.1	30.5±0.3
<i>Age (d)</i>							
90	1310±30B	31.4±3.6	74.9±0.1A	22.4±0.1B	1.23±0.07B	20.1±0.9A	30.1±0.3
120	1703±36A	37.4±4.3	74.1±0.2B	22.9±0.1A	1.59±0.09A	15.2±1.1B	30.4±0.3
<i>Sex</i>							
Female	1513±31	34.3±3.7	74.6±0.2	22.6±0.1	1.39±0.07	17.3±0.9	30.2±0.3
Male	1500±35	34.5±4.2	74.5±0.2	22.7±0.1	1.43±0.08	18.0±1.1	30.4±0.3
<i>Rearing×Age</i>							
Out 90	1349±20C	31.5±2.4	74.6±0.2AC	22.5±0.1AB	1.23±0.56B	19.5±1.0	29.7±0.5
Out 120	1602±49B	30.5±7.9	74.4±0.8BC	22.9±0.2A	1.22±0.60B	15.5±1.8	30.4±0.4
In 90	1256±24C	32.2±4.6	75.2±0.2A	22.0±0.2B	1.16±0.47B	19.7±1.3	30.9±0.3
In 120	1831±64A	45.6±6.8	73.8±0.3B	22.9±0.1A	2.03±0.18A	14.5±2.0	30.3±0.5

Means values with different capital letters showed a statistical significance of $P \leq 0.01$.

Table 2 - Least square means and standard error of quality meat characteristics.

	pH _u <i>L. lumborum</i>	pH _u <i>B. femoris</i>	L*	a*	b*	C* Chroma	H* Hue
<i>Type of rearing</i>							
Outdoor	5.44±0.02B	5.71±0.03B	52.6±0.6A	2.58±0.13	1.07±0.15A	2.78±0.17	21.6±2.8A
Indoor	5.66±0.02A	5.86±0.03A	49.5±0.6B	2.28±0.14	0.37±0.17B	2.27±0.19	6.9±3.7B
<i>Age (d)</i>							
90	5.57±0.02b	5.75±0.03	52.5±0.6A	2.21±0.12b	0.76±0.15	2.38±0.19	16.0±3.5
120	5.64±0.02a	5.82±0.03	49.6±0.7B	2.64±0.15a	0.68±0.17	2.78±0.17	12.9±3.9
<i>Sex</i>							
Female	5.60±0.02	5.81±0.03	51.1±0.6	2.06±0.12B	0.52±0.15	2.18±0.15b	13.1±3.7
Male	5.60±0.02	5.76±0.04	51.1±0.7	2.80±0.15A	0.92±0.17	2.99±0.20a	16.8±3.7
<i>Rearing×Age</i>							
Out 90	5.54±0.01B	5.70±0.04B	52.9±0.6A	2.37±0.25	1.06±0.25	2.64±0.31	22.2±4.1a
Out 120	5.54±0.01B	5.71±0.04B	52.5±0.9A	2.70±0.10	1.06±0.22	2.96±0.12	20.9±4.0b
In 90	5.56±0.03B	5.78±0.04B	52.6±0.6A	2.18±0.21	0.74±0.20	2.11±0.23	9.8±5.2abc
In 120	5.76±0.03A	5.95±0.06A	46.2±0.9B	2.48±0.32	0.23±0.24	2.54±0.34	2.11±4.9c

Means values with different small letters, in the same column, showed a statistical significance of $P \leq 0.05$ and with different capital letters a statistical significance of $P \leq 0.01$.

Moreover in most of the variables significant interaction was found between “type of rearing × slaughtering age”.

In rabbits slaughtered at 90 days of age, no significant differences were observed. On the contrary, delayed slaughtering (120 days) revealed significant modifications in some parameters of meat evaluation. In particular, rabbits which were reared with an open-air system revealed lower carcass weights (1602 vs. 1831 g; $P \leq 0.01$), and meat with lower pH values (5.54 vs. 5.76; $P \leq 0.01$), paler colour (52.5 vs. 46.2; $P \leq 0.01$) and lower content of intramuscular fat (1.22 vs. 2.03%; $P \leq 0.01$).

Lowest pH values observed in the *L. lumborum* muscle of older rabbits (120 days of age) in the open-air group could be attributed to a greater degree of movement allowed in these animals, compared to the restrained rabbits housed in indoor bicellular cages. The effect of greater exercise of animals during growing phase is the elaboration of increased stores of muscle glycogen which leads to a lower ultimate pH *post mortem* (Lawrie, 1998). This evidence in synergy with a lower susceptibility of rabbits housed in large groups to pre-slaughtering stress (Xiccato *et al.*, 1999) could explain the lower pH_u values found in the *L. lumborum* muscle. Xiccato *et al.* (1999) also observed a greater cooking loss in meat of rabbits reared under low density condition. Similar effects have been observed in pig breeding (Enfält *et al.*, 1997), where a higher level of lactate as a consequence of a higher content of muscle glycogen as well as a lower pH value and a higher drip loss were found in lean pigs reared in large pens. The meat of these animals also contained more protein and fewer intramuscular lipids as well as less water content.

The increasing training carried out by the open-air rabbits is confirmed by their greater weight of the fore and hind paws (Luzi *et al.*, 2000). Also Xiccato *et al.* (1999) observed that rabbits reared in wider cages had a higher diameter of the tibia and were more resistant to fractures.

This research has highlighted that open-air rearing in colony cage showed a marked influence on the qualitative characteristics of meat only in rabbits slaughtered at 120 days of age. Compared to same aged rabbits which are housed indoors in bicellular cages, the animals reared open-air have produced meats leaner, paler and with lower pH values.

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