CARCASS COMPOSITION AND MEAT QUALITY OF RABBITS SELECTED FROM DIFFERENT CRITERIA

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Abstract - Three lines of young rabbits, selected from different criteria, with three different liveweights were slaughtered. The composition of their carcasses as well as some of the characteristics of their meat were then compared. Given that the slaughter yield was calculated from the liveweight without fasting, the value in all types of animals was smaller than that which is commercially acceptable in Spain. Hence, a certain amount of fasting is necessary. The thoracic cage is relatively more developed in younger animals, for they have been less fattened and have a smaller meat-to-bone ratio. The meat of R Line animals, selected for growth speed, presents a rather higher pH. It is poorer in proteins and loses more water when cooked than the meat of the other lines. Females have more fatty tissue than males. Female meat has a slightly more acid pH and retains more water.

INTRODUCTION

Rabbit selection generally involves the crossing of a crossbred female (the product of two lines selected for the litter size) with a terminal male, which has been selected for growth rate. Because the market fixes the selling price, the consequence of the selection is that terminal products are slaughtered at younger ages, which may affect the quality of the meat and carcass. On the other hand, the slaughter weight is different in Spain, France or Italy. Thus, the consequences of selection may vary from one country to another. It is also possible that the format of the commercial carcass will simply change in time. The same process has been observed in other species (i.e., pig and beef cattle) where the carcasses weight have changed in time. Relatively few studies have been done that compare the quality of the carcass and meat in breeds or lines of rabbit. There are studies that compare the quality of carcass among different breeds (ROUVIER, 1970; LUKEFAHR *et al.*, 1982, 1983; PERRIER and OUHAYOUN, 1990; and OZIMBA and LUKEFAHR, 1991). But these animals were slaughtered at different liveweights. Therefore, at the moment there are no comparisons of breeds that presented different adult liveweights, but which were slaughtered at a constant weight. Studies on quality meat have usually been based upon studies of muscular pH (OUHAYOUN and DELMAS, 1988; BLASCO and PILES, 1990). Only recently factors like colour or meat fat content have been studied (BERNARDINI BATTAGLINI *et al.*, 1994; XICCATO *et al.*, 1994). The purpose of this paper is to compare the quality of the meat and carcass in three lines with different adult liveweight. The comparison will be done using three different liveweights at slaughtering.

MATERIAL AND METHODS

Animals

The experiment was carried out at the Politechnical University of Valencia in the Spring of 1994 when the average exterior temperature varied from 13°C to 20°C. Rabbits of three lines and at three different weights were chosen for the experiment as a factorial model. Each of the nine groups was formed by 15 animals whose ages in days were :

Group and Weight (g)	Line A	Line V	Line R
Low (1750-1850)	53-57	53-57	50-53
Middle (2000-2100)	59-63	59-63	54-57
High (2250-2350)	65-69	65-69	58-60

Lines A and V were selected for litter size at weaning; line A on a family index (BASELGA *et al.*, 1984). The method used in line V was a reduced BLUP (ESTANY *et al.*, 1989). Line R was selected on daily growth rate from weaning--4 weeks old--to the time of slaughtering--9 weeks old (ESTANY *et al.*, 1992). All the animals were kept in the same building in cages of 8 rabbits. Young rabbits were fed *ad libitum* with a standard diet (16% crude protein, 15.5% fibre and 3.4% fat).

At the fixed age, animals with the defined weight (corresponding at a normal growth in our farm) were chosen and solid fasted for 12 hours, with free access to water. Inmediately before being slaughtered, they were weighed

again. The carcasses were measured and retailed according to the norms of the World Rabbit Scientific Association– WRSA (Blasco *et al.*, 1993). Sex was considered after the slaughter.

Traits measured

The following variables were measured: Liveweight (LW); Liveweight after fasting (LWaf); Chilled carcass weight (CCW); CDP or Dressing out percentage (CCW/LW); CDPaf or Dressing out percentage after fasting (CCW/LWaf); Reference carcass weight (RCW); Dissectible fat percentage (DFaP); Thoracic cage percentage (TCP); Forelegs percentage (FLP); Loin percentage (LoP); and Hind part percentage (HPP).

A hind leg was separated and dissected to determine its meat/bone ratio (M/B), its bone percentage (BP) and its chemical composition: Protein percentage (PrHL); Fat percentage (Fa HL); and Moisture percentage (MoHL). Furthermore, the muscular pH of the *Biceps femoris* (pHBF) and the pH of the *Longissimus dorsi* (pHLD) at the level of the 5th lumbar vertebra were measured. Moreover, the electrical conductivity (EC) was also measured on the *Longissimus* at the level of the 5th lumbar vertebra.

Colour (L*, C* , H*) was measured with a CR-300 Minolta Chromameter on the carcass surface of the *Longissimus* at the level of the 4th lumbar vertebra, on the *Biceps* surface and on the meat of the 7th lumbar vertebra section of the *Longissimus* (Pla *et al.*, 1995-a).

The water holding capacity (WHC) of the *m. Longissimus* was measured according to the Grau and Hamm method (HAMM, 1986) and was expressed as the ratio (x100) of muscle area to total area. Cooking loss (CL) was determined by cooking an *m. Longissimus* in an electric oven at 200°C; the time in the oven and the time before the weighing were both 30 min. The WHC of this cooked meat (WHCc) was the WHC of 300±5 mg of cooked muscle as described above.

Statistical analyses

The least square means were computed by using the GLM procedure of the SAS package (SAS, 1990) in a model that considered the weight, line and sex as well as the interaction as fixed effects.

RESULTS AND DISCUSSION

Sex is only significant with respect to some variables. Therefore it need not be included in the tables. However, it will be commented on when the variables with regards to cases and effects are considered. As expected, the liveweight, the liveweight after fasting, the chilled carcass weight, the reference carcass weight and the hind leg weight are different among groups and related to the weights (Table 1). The dressing out percentage–calculated with respect to the chilled carcass–increases in the heavier rabbits (CANTIER *et al.*, 1969) with fasting or not. In our experiment the CDP difference in non-fasting rabbits between high and low groups is 3.5%, and 3% in twelve hour fasting animals. The commercial criterion generally used in Spain is to consider a slaughter yield between 56% and 58%. For this reason, it seems necessary in our lines to effectuate a certain amount of fasting, especially for lighter animals. The greatest loses during fasting and a smaller yield at slaughtering occur in the R line, where the animals were selected for growth speed and were also the youngest at the time of slaughtering. The A and V lines–selected for their reproductive traits–yielded similar results, though the V line animals had a better slaughter yield because they had a lighter gastrointestinal tract (PLA *et al.*, 1995-b).

The reference carcass is not modified much in the liveweight rank considered here. But animals with a low liveweight had a less developed loin and their thoracic cage was slightly more developed. The latter also occurred to the R line animals, because they were younger and the thoracic cage is an animal part with positive alometry. Much clear evidences can be found in the fattening percentage of the reference carcass (DFaP), which rises according to the liveweight of the animal. It is also a 1% smaller in R animals than in the other two lines (Table 1). Given these liveweight ranks, the percentage is also higher for females than it is for males (3.65% v.s. 4.07%). We also have found differences between sexes in the percentage of the hind part (HPP): it is more developed in males (38.5% v.s. 37.8%).

In a hind leg, the bone percentage (BP) decreases 2.5% between high liveweight and low liveweight groups; therefore, the meat/bone ratio (M/B) of this extremity - which is the advised predictor for the carcass M/B ratio (BLASCO *et al.*, 1993) - increases according to the liveweight of the animals. No differences were found among the lines, neither in the BP nor in the M/B. Our attention was drawn to the M/B value, which was very low when

compared to that which was achieved by other authors. But this might be due to the lower commercial liveweight in Spanish rabbits with respect to those of France or Italy.
Carcass colour, measured on the loin, does not show a difference at any of the parameters L, C, H, either in the liveweight function or in the line. However, we found that the R line rabbits showed less brightness at the biceps femoris and that their tone and Croma did not follow a consistent model.

Table 1. Dressing and carcass characteristics of three groups of weight (low, middle and high) and of three lines (A, V, R) of young rabbits selected by different criteria.

	WEIGHT			LINE			
	Low	Middle	High	A	V	R	s.e.
LW	1804.7^{a}	2059.5^{b}	2324.2^{c}	2070.7^{n}	2070.3^{n}	2047.4^{m}	5.8
LWaf	1660.7^{a}	1926.4^{b}	2163.2^{c}	1944.3^{n}	1922.9^{n}	1883.0^{m}	9.3
CCW	938.6^{a}	1124.4^{b}	1291.8^{c}	1144.6^{n}	1155.7^{n}	1054.6^{m}	6.2
CDP	52.06^{a}	54.65^{b}	55.56^{c}	55.13^{n}	55.67^{n}	51.48^{m}	0.28
CDPaf	56.58^{a}	58.40^{b}	59.72^{c}	58.75^{n}	59.99^{p}	55.97^{m}	0.30
RCW	751.9^{a}	908.1^{b}	1052.8^{c}	929.1^{n}	949.8^{p}	833.8^{m}	6.9
DFaP	3.44^{a}	3.90^{b}	4.23^{c}	4.14^{n}	4.23^{n}	3.20^{m}	0.11
TCP	11.71^{b}	11.46^{ab}	11.28^{a}	11.21^{m}	11.29^{m}	11.95^{n}	0.12
FLP	16.24	16.19	16.16	15.97^{m}	15.88^{m}	16.72^{n}	0.10
LoP	28.91^{a}	30.06^{b}	30.30^{b}	30.20	29.41	29.66	0.23
HPP	38.58	37.89	38.05	38.39	38.00	38.13	0.26
HLW	132.0^{a}	159.0^{b}	182.3^{c}	162.0^{n}	165.0^{n}	145.3^{m}	1.3
BP	19.40^{c}	18.35^{b}	16.96^{a}	17.87	18.04	18.79	0.31
M/B	4.16^{a}	4.47^{b}	4.87^{c}	4.59	4.56	4.35	0.09
Lo L*	53.28	53.86	53.30	53.75	53.39	53.30	0.27
Lo C*	3.50	3.26	3.42	3.44	3.35	3.38	0.16
Lo H*	-1.44	-11.06	-1.52	0.34	-8.41	-5.92	4.5
BF L*	49.56	49.85	50.28	50.67^{m}	50.01^{m}	49.01^{n}	0.35
BF C*	4.83^{a}	4.17^{b}	4.70^{a}	4.60	4.44	4.67	0.18
BF H*	42.2	42.2	41.9	45.9^{m}	40.2^{n}	40.2^{n}	1.6

LW: Liveweight; Lwaf: Liveweight after fasting; CCW: Chilled carcass weight; CDP: Commercial dressing percentage; RCW: Reference carcass weight; DFaP: Dissectible fat percentage; TCP: Thoracic cage percentage; FLP: Fore legs percentage; LoP: Loin percentage; HPP: Hind part percentage; HLW: Hind leg weight; BP: Bone percentage; M/B: Meat/bone; Lo L*,C*,H*: L*,C*,H* on the loin; BF L*,C*,H*: L*,C*,H* on *Biceps femoris*.
Means in the same row with different letter are statistically different at $p<0.05$

The pH values at the Biceps femoris (Table 2) were, in any case, higher than those of the *longissimus* because it corresponds to a more oxidizible muscle (OUHAYOUN and DELMAS, 1988). The R line animals had a higher pH in the muscles than those of the A and V lines. However, we found no difference in the pH24 for any of the muscles--unlike what BLASCO and Piles (1990) pointed out. Sex is also a clear effect, given the fact that males have a higher pH than females do (5.65 v.s. 5.59 in LD and 5.75 v.s. 5.70 in BF). The group effect, closely tied to age, does not show any significance--contrary to that which DALLE ZOTTE and OUHAYOUN (1995) indicated. According to them, the pH count decreases from 28 to 70 days.

The fore leg meat had a similar protein percentage in all three liveweight groups (Table 2). The fat percentage increases with age, contrary to what happens with water. This occurred in a much clearer way than that which OUHAYOUN and DELMAS (1989) indicated. The R line rabbits, the youngest, had the poorest meat in terms of protein and fat; and they contained as a bit more water.

Cooking losses, although measured for a different muscle, evolved in the same way that water content in the meat had. Animals with lower liveweight - that is to say, the R line animals - lost more water than the others (Table 2). Being that our animals were younger and had more water in the meat, the values were higher than those found by BERNARDINI BATTAGLINI *et al.*, (1994). Furthermore, in our case we found some differences with regards to the animals' liveweight, even with less difference in weight than the ones used in the study of said authors.

The water holding capacity in raw meat does not present any differences, either among liveweights or lines - although the tendency seems to point out that it increases according to animal weight, as was also noted by BERNARDINI BATTAGLINI *et al.*, (1994). Said study showed similar values to those yielded in our experiment. The water holding capacity in cooked meat did not effect any of the factors. However, there were some difference in sexes. Therefore, the female meat held by far more water (36% as opposed to 34.43%), though there were no

differences in the water composition of the meat. This seems to indicate the effect of structural differences on the muscle in both sexes.

The meat of the R line rabbits differed from that of the other lines because it has a smaller C and a higher H, though it had the same brightness. Differences in Croma did not seem to be due to the fact that the animals were younger. The meat tone (H) seemed to be higher for younger animals, but it is not yet possible to explain just what that means.

Table 2. Meat quality traits of three groups of weight and of three lines

	Low	WEIGHT Middle	High	A	LINE V	R	s.e.
PHLD	5.63	5.61	5.62	5.58^{m}	5.58^{m}	5.69^{n}	0.016
pHBF	5.74	5.71	5.72	5.71^{m}	5.69^{m}	5.77^{n}	0.016
Pr HL	20.66	20.73	20.76	20.75^{n}	20.80^{n}	20.59^{m}	0.04
Fa HL	2.81^{a}	3.24^{b}	3.66^{c}	3.25^{n}	3.45^{n}	2.91^{m}	0.08
Mo HL	74.68^{c}	74.18^{b}	73.71^{a}	74.01^{m}	73.97^{m}	74.59^{n}	0.09
CL	39.89^{b}	38.96^{ab}	38.41^{a}	39.47^{n}	37.70^{m}	40.09^{n}	0.39
WHC	34.95	35.29	35.40	35.59	35.62	34.43	0.45
WHCc	25.50	23.56	23.73	24.85	24.04	23.87	0.46
EC	3.83	4.03	4.11	3.93	4.08	3.95	0.14
LD L*	50.68	50.58	49.99	50.68	50.56	50.01	0.36
LD C*	5.31^{b}	4.75^{a}	5.08^{ab}	5.33^{n}	5.05^{mn}	4.77^{m}	0.13
LD H*	39.25^{b}	36.37^{ab}	35.23^{a}	35.06^{m}	36.03^{m}	39.75^{n}	1.26

pHLD: pH of the *L. dorsi*; PHBF: pH of the *Biceps femoris*; PrHL: Protein of the hind leg meat; FaHL: Fat of the hind leg meat; MoHL: Moisture of the hind leg meat; CL: Cooking loss; WHC: Water holding capacity; WHCc: Water holding capacity of cooked meat; EC: Electrical conductivity; LD L*,H*,C*: L*,C*,H* of the *L. Dorsi* meat.
Means in the same row with different letter are statistically different al $p<0.05$

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