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INFLUENCE OF THE MALE RABBIT CASTRATION ON MEAT QUALITY. 2/. PHYSICO-CHEMICAL AND SENSORY QUALITY

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ABSTRACT

A total of 450 commercial hybrid rabbits were employed to study on meat quality the effects of males castration in comparison with entire males and females when slaughtered at 14, 17 or 20 weeks of age. After unfreezing, left hindleg + ½ loin were cooked together in a oven at first during 5mn at 250 °C with a dry heat, then with humid heat in order to obtain a central temperature of 80°C to 85°C at the oven exit of pieces. Meat of hindleg and of *longissimus dorsi* (LD) were separated from bones and scoring tests were realised by a trained panel of tasters. At 14 weeks of age the male rabbits meat presented lower values for tenderness, juiciness and flavour than females and castrated males both for hindleg and LD even if for LD, differences were more significant. At 17 and 20 weeks of age, differences between sexes decreased and sometimes were inverted. Differences were less important between slaughter ages than between sexes. Physico-chemical measures were made on the right LD fresh meat. No significant variation of LD lipid content was detected (0.94% on average). Mechanical tenderness estimated through the shearing force necessary to cut the muscle with a Warner-Brazler blade was lower for entire males (Fmax =50.2 Newton) than for castrated males (F max 43.0N) and females (Fmax 39.5N); but no effect of age was observed. With age, luminosity of the LD section decreased.. Entire males had the darkest meat (L=55.0 *vs* 58.3 for castrated and 58.0 for females). Their meat was also more reddish, as was the meat of older rabbits. As conclusion, the authors recommended the slaughter age of 14 weeks for a best sensory quality of castrated rabbits meat, and if possible to fatten females instead of males, castrated or not.

INTRODUCTION

The male animal castration is one of the means used in different species to improve meat qualities (beef, pork...). In most species, this removal causes a mass increase of the fatty tissues, the quantity of intramuscular lipids (LIRETTE *et al.*, 1984) and, to the final, the meat tenderness and the juiciness (DIKEMAN *et al.*, 1986). The meat of rabbit is sometimes judged too dry by consumers also the increase of the quantity of intramuscular lipids is one of the criteria searched (GONDRET, 1998).

The aim of this work is to compare physico-chemical and sensory meat qualities of entire male rabbits, castrated males and female rabbits slaughtered at different ages. The growth performances and carcass characteristics of these animals were presented in an other communication (JEHL *et al.*, 2000).

MATERIAL AND METHODS

Animals

The experimentation was realised with a group of 450 commercial hybrid rabbits (Hyplus commercialised by *Grimaud Frères* France): 150 males, 150 castrated males and 150 females. Males were castrated by abdominal incision under general anaesthesia at 1 week of age (JEHL *et al.*, 1999). From weaning (36 days) to slaughter age, animals are grouped by sex and placed in collective wire mesh cages (5 per cage). Fifty rabbits of each were slaughter at three different ages : 14 weeks (99 days), 17 (120 days) and 20 weeks (141 days). Chilled carcasses were weighed. The fore part of the carcass was separated and the hind part (loin + hindlegs) was

divided in two pieces in the length sense and each half-hind part was preserved under vacuum at - 20°C until analyses.

Sensory analyses

Samples preparation

The left half-hind parts (1 hindleg + ½ loin) were defrosted during 24h at +4°C. They were put in a stainless steel plate and placed in a combined dry/humid oven (Thirode) for cooking. During the first 5mn, pieces were submitted to 250 °C with a dry heat. They were then cooked for a longer time with humid heat, in order to obtain a temperature to heart of 80°C to 85°C at the exit of pieces. The time of cooking has been adjusted in function of the pieces weight and varied between 30 and 55 mn.

Scoring tests

Tests were realised with a trained panel of 12 tasters with 2 different pieces : boned hindleg meat and *longissimus dorsi* meat (LD) separated from loin immediately after cooking. After a training destined to choose the descriptors, two groups of sessions have been organised in which each taster noted a piece of hindleg and a piece of LD by treatment : 1 set of 4 sessions to compare the 3 sexes at the same age, and a second set of 3 sessions to compare ages at slaughter of each sex. The following descriptors defined by the taster panel took into account different criteria of sensation in mouth i.e. :

- Tenderness during the mastication
- Juiciness : juice liberated during mastication
- Floury sensation : sensation of flour in mouth
- Flavour : intensity of the flavour
- Fatty sensation : taste of fat [excess] in mouth
- Sticky sensation in mouth

Each criterion was noted by each member of the panel between 1 (very low intensity) and 10 (very high intensity)

Physico-chemical determinations

The right half-hind parts (1 hindleg + ½ loin) were defrosted during 24h at +4°C, and then the right *longissimus dorsi* was separated. Measures were made on this muscle for 30 rabbits.

LD share test (mechanical tenderness) was determined by section of the muscle with a Warner-Brazler blade fixed to an "Instron" apparatus. Method of use was described by COMBES *et al.* (2000). The criteria retained were maximum shear force (Fmax in Newtons) corresponding to the section of myofibres + endomysium + perimysium, the peak shear force (FC in N) corresponding to the final section of the epimysium, and the total shearing energy (Joules) as described by DELMAS *et al*. (1999) . The water holding capacity of freshly minced meat was estimated in triplicates by the relative quantity of liquid extracted after 2 very low speed centrifugations (70 g during 10 mn) separated by one night at +4°C. The "lipid" content of the meat was estimated in triplicate after chloroform extraction (at 0°C) of 1g of freeze-dried meat in presence of 2g anhydrous sodium sulphate. This methodology adapted from PIULSKAYA (1958) extracts mainly the triglycerides but not the phospholipids. Dry matter content of the meat was estimated taking in account the water lost during freeze-drying and the remaining water of the sample determined after 24h at 103°C.

The meat colour of LD immediately after section of the muscle was analysed with a Minolta CR300 chromameter giving indexes of luminosity : L index of ability of the object to reflect light, a index of red, b index of yellow and S index of saturation *i.e*. light brightness.

Statistical analyses

Sensory analyses have been processed by variance analyse and rank test with the software FIZZ. Fatty sensation results are not presented because this parameter was not influenced by sex or age. Physico-chemical results were treated by variance analysis with the SAS-GLM procedure according to a 3 ages x 3 sexes factorial design with interaction.

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RESULTS AND DISCUSSION

Incidence of sex on meat sensorial qualities of rabbits slaughtered at different ages. (table 1)
Differences between sexes were more important at 14 weeks of age than at 17 or 20 weeks.
For animals slaughtered at 14 weeks, the effect of the sex was significant for the hindleg and LD meat for tenderness, juiciness and the flavour. For all these parameters the male rabbits presented the lowest values.
Tasters have estimated the females LD flourier than those of males with intermediate values for castrated rabbits. The LD of castrated males were, on the other hand more sticky in mouth that these of entire males, with intermediate values for females. The fact that LD meat was more discriminating than that of hindleg is not surprising because this phenomenon was already described in a previous study (JEHL and JUIN, 1998).
At 17 and 20 weeks of age, between sexes differences decreased with some inversions for some criteria. Females presented a more tender meat for the hindleg and a less juicy LD at 20 weeks. The highest tenderness of the females meat and castrated males remained however a constant tendency for all ages and pieces analysed.

Effect of the slaughter age on sensory quality of rabbit meat. (table 2)
The general effect of the slaughter age was lower than the effect of the sex of the animal. Tenderness, juiciness and flavour intensity increased for castrated males until 17 weeks and then decreased.
For the entire males, tenderness and juiciness of the LD increased with age.
For females, no significant effect of the age was observed but trends went rather, as for castrated male, to an increase of the tenderness and the juiciness until 17 weeks and a diminution thereafter .
Effects of the slaughter age on sensory quality of the rabbit meat have been little studied. JEHL and JUIN (1998) have shown that differences were small between 10 and 14 weeks and based rather on aspect criteria (colour, odour) rather than on texture in mouth criteria. In agreement with present results; JUIN *et al* (1997) have observed that the LD meat of 18 weeks New-Zealand rabbits were more tender, less fibrous, but more floury, than that of 11 weeks old rabbits.

Modifications of physico-chemical parameters with age and sex (table 3)
On average, the water holding capacity was significantly improved between 14 and 17 weeks and then remained constant. The significant interaction with sex is due to the fact than castrated males obtained the highest water lost at 14 weeks and the smallest at 20 weeks.
The lipids content of the LD muscle was not significantly modified with age or sex variations, despite the great variations of abdominal fat observed on the same rabbits (JEHL *et al*., 2000). This absence of variation with age is in opposition with the increase of 1.0% to 1.6% of triglycerides content of LD between 14 and 20 weeks for NZW rabbits reported by GONDRET *et al.* (1998). This may be a consequence of the relatively low precision of the quick method employed for the intra-muscular lipids in this study. Nevertheless, if there is effectively a difference, it was very small since each "age" value was the average of 90 individual measures in the present study and only 5 in the works reported by GONDRET (1998). In addition, it must be emphasised than the average "lipid" [trigycerides] content of LD analysed in this study (0.94%) was within the range reported by ALASNIER *et al.* (1996) for LD triglycerides (0.55%) and total lipids contents (1.24%).
The mechanical tenderness estimated by Fmax was significantly lower for entire males (Fmax = 52.2 N) than for females (39.5 N). Castration induced an intermediary value (43.0 N)

significantly different from the 2 others. This observation is in good agreement with sensorial tenderness (table 1). The shearing force necessary to cut the epimysium (FC) increased with age, but was not affected by sex on average. Since mechanical resistance of the epimysium is related to it's collagen content (and polymerisation) and since collagen is made soluble during cooking it is not surprising that FC and total shearing energy of crude LD meat may increase when sensorial tenderness increases too.

Colour of the LD section was highly affected by sex and age of the rabbits. With age, luminosity decreased which means that meat of older rabbits was darker. Entire males had the darkest meat (L=55.0 *vs* 58.3 for castrated and 58.0 for females). Their meat was also more reddish as was the meat of older rabbits. The colour saturation decreased with age but with an age evolution depending of sex. These great differences is colour may explain than in some previous sensory tests, types of rabbit meat were distinguished more easily according to appearance criteria than to sensation in mouth (JEHL and JUIN, 1998).

CONCLUSION

Concerning the quality of the product, the castrated rabbits meat and females meat was more tender than that of males whatever the method employed to estimate this parameter : sensory test on cooked meat or mechanical shearing of fresh meat. Rabbits slaughtered at 14 weeks of age were also juicier and have more flavour, but this observation cannot be related to any variation of the intramuscular lipids content. This slaughter age seems therefore recommendable.

In case of commercialising castrated rabbits, the time necessary for the surgical operation (10 mn / animal) as well as the cost of the equipment (anaesthetic products, wire etc...) would entail an important over-cost that could been amortised only in the case of selling a high quality product. According to an economic viewpoint it would be more profitable to fatten females.

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REFERENCES

ALASNIER C., RÉMIGNON H., GANDEMER G., 1996. Lipids characteristics associated with oxydative and glycolytic fibres in rabbit muscles. *Meat Science*, 43:213-224.

COMBES S., AUVERGNE A., LEBAS F., 2000. Effect of cooking temperature on Warner – Bratzler tenderness measurement in rabbit meat. *Communication to the 7th World Rabbit Congress, Valencia Spain 4- 7 July 2000* (accepted)

DELMAS D., DOUTRELOUX J.P., JEHL N., AUVERGNE A., LEBAS F., 1999. Incidence de l'âge à la castration chez le lapin II/Caractéristiques physico-chimiques de la viande. *8èmes Journées de la Recherche Cunicole en France, Paris 9-10 Juin 1999*, 93-96.

DIKEMAN M.E., REDDY G.B., ARTHAUD V.H., TUMA H.J., KOCH R.M., MANDIGO R.W., AXE J.B., 1986. Longissimus muscle quality, palatability and connective tissue histological characteristics of bulls and steers fed different energy levels and slaughtered at four ages. *J. Anim. Sci*., 63: 92-93.

GONDRET F., 1998. Lipides intramusculaires et qualité de la viande de lapin. *7èmes Journées de la Recherche Cunicole en France, Lyon,* 101-109.

JEHL N., JUIN H., 1999. Effet de l'âge d'abattage sur les qualités sensorielles de la viande de lapin. *8èmes Journées de la Recherche Cunicole en France, Paris 9-10 Juin 1999*, 85-88.

JEHL N., DELMAS D., LEBAS F., 1999. Incidence de l'âge à la castration chez le lapin. I. Performances zootechniques, *8èmes Journées de la Recherche Cunicole en France, Paris 9-10 Juin 1999,* 89-92.

JEHL N., DELMAS D., LEBAS F., 2000. Influence of the male rabbit castration on meat quality. 1/ Performances during fattening period and carcass quality. *Communication to the 7th World Rabbit Congress, Valencia Spain 4- 7 July 2000* (submitted)

JUIN H., LEBAS F., MALINEAU G., GONDRET F. , 1998. Aptitude d'un jury de dégustation à classer différents types de viande de lapin selon des critères sensoriels : aspects méthodologiques et application à l'étude des effets de l'âge et du type génétique. *7èmes Journées de la Recherche Cunicole en France, Lyon,* 123-126

LIRETTE A., SEOANE J.R., MINVIELLE F., FROEHLICH D., 1984. Effects of breed and castration on conformation, classification, tissue distribution,

composition and quality of lamb carcasses. *J. Anim. Sci..*,58: 1343-1357.

PIULSKAYA V, 1958. [Méthode d'extraction rapide des lipides des tissus adipeux]. *Myasnaya industrya CCCP*: 29, 69-10

Table 1 : Incidence of sexual type on meat sensorial qualities of rabbits slaughtered at different ages *(42 determinations/point)*

AGE	Sensory Criteria	HINDLEG					*longissimus dorsi*				
		Males	**Castrated**	**Females**	Anova	Ranks	**Males**	**Castrated**	**Females**	Anova	Ranks
14 WEEKS	Tenderness	3.50 b	6.18 a	5.30 a	***	ns	3.67 b	4.99 a	5.37 a	***	**
	Juiciness	2.49 b	3.78 a	3.76 a	***	ns	2.49 b	3.60 a	4.00 a	***	*
	Flavour	4.20 b	5.61 a	5.36 a	***	ns	3.93 b	4.85a	5.22 a	***	ns
	Floury sensation	1.87	2.17	2.14	ns	*	2.25 b	2.92 ab	3.20 a	*	ns
	Sticky sensation	1.85	2.10	2.02	ns	ns	1.55 b	2.52 a	2.38 ab	*	**
17 WEEKS	Tenderness	5.50	5.68	5.27	ns	*	4.82 b	5.23 ab	5.64 a	*	*
	Juiciness	4.05	3.82	3.87	ns	ns	3.76	3.70	4.25	ns	ns
	Flavour	5.73	5.79	5.77	ns	ns	4.84	4.81	5.15	ns	ns
	Floury sensation	1.98	1.88	2.01	ns	ns	3.13	2.95	3.49	ns	ns
	Sticky sensation	1.91	1.97	2.24	ns	ns	2.40	2.65	2.48	ns	ns
20 WEEKS	Tenderness	4.68 b	5.12 ab	5.52 a	*	**	4.69	5.19	4.78	ns	ns
	Juiciness	3.31	3.57	3.75	ns	ns	3.06 ab	3.56 b	2.97 a	ns	*
	Flavour	5.22	5.47	5.35	ns	ns	5.00	5.07	4.68	ns	ns
	Floury sensation	1.78	1.92	1.95	ns	ns	3.82	3.82	3.65	ns	ns
	Sticky sensation	2.00	2.15	2.06	ns	ns	2.45	2.42	2.56	ns	ns

Table 2 : Effect of the slaughter age on sensory meat quality of males, females and castrated males *(33 to 35 determinations /point)*

HINDLEG	**Entire males**					**Castrated males**					**Females**				
Age in Weeks	**14**	**17**	**20**	Ranks	Anova	**14**	**17**	**20**	Ranks	Anova	**14**	**17**	**20**	Ranks	Anova
Number	*34*	*34*	*34*			*35*	*35*	*35*			*33*	*33*	*33*		
Tenderness	5.23	5.66	5.49	ns	ns	4.86 a	5.65 a	5.17 ab	*	ns	5.70	6.02	5.43	ns	ns
Juiciness	3.60	4.01	3.71	ns	ns	3.61 a	3.91 b	3.89 b	*	ns	3.33	3.77	3.57	ns	ns
Flavour	5.58	5.85	5.60	ns	ns	5.52	5.89	5.59	ns	ns	5.85	5.74	5.68	ns	ns
Floury sensation	1.56	1.24	1.37	ns	ns	1.86	1.85	1.70	ns	ns	2.07	1.91	2.08	ns	ns
Sticky sensation	1.46	1.74	1.47	ns	ns	1.92	1.66	1.79	ns	ns	1.75 a	1.94 ab	2.13 b	*	ns
LD	**Entire males**					**Castrated males**					**Females**				
Number	*34*	*34*	*34*			*35*	*35*	*35*			*33*	*33*	*33*		
Tenderness	4.97 b	5.37 ab	5.85 a	*	*	4.96	5.77	5.59	*	*	5.42	5.84	5.27	ns	ns
Juiciness	3.29	3.76	4.22	**	ns	3.76	4.41	4.02	ns	ns	3.33	4.15	3.56	ns	ns
Flavour	5.06	5.16	5.04	ns	ns	4.73 b	5.73 a	5.05 ab	**	**	4.81	5.31	4.95	ns	ns
Floury sensation	3.34	3.10	2.54	**	ns	3.51	2.88	3.13	ns	ns	3.83	3.35	3.62	*	ns
Sticky sensation	2.10	1.68	1.84	ns	ns	1.94	2.36	2.07	ns	ns	2.08	2.03	2.32	ns	ns

For tables 1 to 3 : ns : non significant; * P< 0.05; ** P<0.01 ; *** P<0.001 ; a, b, c : on the same line means having a common letter did not differ at the level P=0.05

Table 3 : Physico-chemical characteristics of LD of rabbits of the 3 sexes at the 3 slaughter ages and **age mean effect** (bolt printing)

	Means									Effects Probability		
	males	*castrated*	females	males	*castrated*	females	males	*castrated*	females	Sex	Age	S*A
	14 weeks			**17 weeks**			**20 weeks**					
Water holding capacity (lost %)	7.04	*7.94*	5.08	3.38	*3.85*	3.31	3.62	*2.89*	4.54	ns	***	***
		6.69 a			**3.51 b**			**3.69 b**				
Lipids % fresh meat	0.85	*1.06*	0.77	1.06	*0.82*	0.95	0.96	*1.05*	0.93	ns	ns	ns
		0.89			**0.94**			**0.98**				
Maxi fibres shear force **Fmax** (N)	50.0	*45.0*	41.8	50.7	*43.8*	38.1	56.1	*40.3*	38.6	***	ns	**
		45.4			**44.5**			**44.2**				
Peak shear force **FC** (in Newton)	72.0	*66.2*	57.4	74.7	*88.1*	82.7	90.7	*77.9*	79.2	ns	***	***
		65.2 a			**81.8 b**			**82.6 b**				
Total shearing **Energy** (Joules)	1.26	*1.25*	1.03	1.39	*1.43*	1.29	1.65	*1.25*	1.34	***	***	**
		1.17 a			**1.37 b**			**1.41 b**				
L (luminosity)	60.1	*60.3*	61.3	53.0	*57.8*	56.5	52.0	*56.7*	56.1	**	***	ns
		60.5 a			**55.8 b**			**54.9 b**				
a (index of Red)	-0.97	*-2.12*	-1.53	0.28	*-1.59*	-1.59	0.75	*-1.59*	-1.18	***	**	*
		-1.54 a			**-0.95 b**			**-0.67 b**				
b (index of Yellow)	7.26	*7.18*	7.24	4.60	*7.32*	5.72	4.74	*5.15*	5.68	ns	**	ns
		7.22 a			**5.88 b**			**5.19 b**				
S (Saturation)	7.32	*7.48*	7.40	4.61	*7.48*	5.94	4.80	*5.39*	5.80	**	***	ns
		7.40 a			**6.01 b**			**5.33 c**				