EFFECTS OF THREE REPRODUCTIVE SYSTEMS ON RABBIT CARCASS AND MEAT QUALITY

Guardia S.[1]*, Theau-Clément M.[2], Galliot P.[1], Souchet C.[1], Bouchier M.[1], Bignon L.[1], Fortun-Lamothe L.[3]

[1]ITAVI, 28 rue du Rocher, 750008 Paris, France
[2]INRA. UR 631 Station d'Amélioration Génétique des Animaux, BP 52627, 31326 Castanet-Tolosan, France
[3]INRA., UMR 1289, Tissus Animaux Nutrition Digestion Ecosystème et Métabolisme, 31326-Castanet Tolosan, France
*Corresponding author: guardia.itavi@tours.inra.fr

ABSTRACT

This study investigated the impact of three reproductive systems on the carcass and meat quality of rabbit kits. The extensive, semi-intensive and intensive systems had previously been studied to investigate doe performance. The extensive system was designed to reduce overlap between lactation and pregnancy (first artificial insemination, AI_1=16.6 weeks; reproduction rhythm, RR= 49d; weaning age, WA= 30d; slaughter age, SA= 70d), the semi intensive system corresponds to the main rabbit breeding system used in France (AI_1=19.6 weeks; RR= 42d; WA= 35d; SA= 70d) and the intensive system was designed to increase the maximum number of batches reared per year (AI_1=20.6 weeks; RR= 35d; WA= 32d; SA= 63d). The impact of the three reproductive systems and sex effect on carcass quality and composition (carcass yield, perirenal fat, hind part to fore part ratio) and on loin and hind leg meat quality (ultimate pH and color) were investigated. Animals from the extensive and semi-intensive systems had a higher dressing percentage (+5% and +6%, respectively), heavier carcasses (+18% and +17%, respectively) and more perirenal fat (+27% and +22%, respectively) than animals from the intensive system (P<0.001), probably due to the earlier slaughter age in the latter. Rabbits from the semi-intensive system had the highest hind part to fore part ratio (1.05 *vs* 1.03 and 1.02; P<0.001), and females were heavier (2540 g *vs* 2501 g; P<0.001) and fatter than males (1.54% *vs* 1.38%; P<0.001). Regarding meat quality, the reproductive system only had a slight effect on meat from loins and hind legs (P<0.01), however, none of the systems lead to decreased meat quality in terms of ultimate pH or color. Sex had a very limited impact on meat quality. In conclusion, the semi-intensive and extensive systems resulted in similar carcass quality. In contrast, the intensive system reduced the carcass quality (lower weight and dressing percentage). The impact of the rearing system on meat quality is probably not large enough to affect consumer acceptability.

Key words: Rabbit, meat quality, carcass quality, reproductive management, sex effect.

INTRODUCTION

The main French rabbit breeding system is based on semi-intensive management of reproduction (first artificial insemination, AI_1=19.6 weeks; reproduction rhythm, RR= 42d; weaning age, WA= 35d; slaughter age, SA= 70d). In order to improve rabbit husbandry, productivity and sustainability, several alternative reproductive systems have been considered. An intensive version (AI_1=20.6 weeks; RR= 35d; WA= 32d; SA= 63d) has been selected to improve productivity by increasing the number of reproductive cycles per year. However, intensive and semi-intensive reproductive management lead to an overlap of lactation and pregnancy causing a nutritional deficit in does which impairs doe health and productivity. Doe reproductive performance and kit growth have thus also been investigated using extensive reproductive management (AI_1=16.6 weeks; RR= 49d; WA= 30d; SA= 70d). The first results indicated that does were more productive in more extensive reproductive systems (Theau-Clément *et al*., 2011). Moreover, the three reproductive systems led to similar productivity in terms of the quantity of rabbit meat produced per doe and per year. However, slaughter age differs according to

the system used and this can influence carcass and meat quality (Dalle Zotte, 2002). Product quality is highly relevant for slaughter houses and the consumer and thus requires investigation.

The aim of this study was to evaluate carcass and meat quality of rabbits produced by mothers managed under extensive, semi-extensive and intensive reproduction rhythms.

MATERIALS AND METHODS

Animals and experimental design

Three reproductive systems (Rs 35, 42 and 49) were compared for the carcass and meat quality of rabbit kits, on the experimental farm of ITAVI Rambouillet (France). Hyplus does (Grimaud Frères Selection) were inseminated with heterospermic semen of Ps19 male rabbits (Grimaud Frères Sélection). The details of each breeding system are given in Table 1 (Theau-Clément *et al*., 2011). A different room under similar environmental conditions was used for each system. Nine rabbits were reared per cage (size: 45 x 100 x 60 cm).

Table 1: Specificities of the three reproductive systems

Reproductive system	Does		Kits	
	First artificial insemination age (weeks)	Reproduction rhythm (days)	Weaning age (days)	Slaughter age (days)
35	20.6	35	32	63
42	19.6	42	35	70
49	16.6	49	30	70

Does and kits were fed with commercial feeds during all the experiment. During pregnancy, does of the Rs 42 and Rs 49 groups were fed a diet that met their nutritional requirements ("Lapety maternité"; Inzo, DE: 2500 kcal/kg, CP: 16.5%), and they were then given a lactating diet from parturition until 25 d of lactation ("Lapety lactation"; Inzo, DE: 2600 kcal/kg, CP: 17.2%). Does of the 35 Rs group were fed this latter diet during pregnancy and until 25 d of lactation. All the does from 25 d of lactation to weaning and all the kits from 25 d to 49 d of age were fed a lower energy diet ("Stabiconfort"; Sanders, DE: 2300kcal/kg, CP: 15.2%). Stabiwhite (Sanders, DE: 2445 kcal/kg, CP: 15.5%) was given to all the kits from 49 d up to slaughter. Kits were feed-restricted (20% to 40%) only when digestive problems occurred. Does' performance varied according to the reproductive system (Theau-Clément *et al*., 2011). Lower fertility was observed for Rs 35 (64%) than for Rs 42 (79%) and Rs 49 (81%). The total number of kits born (10.6) or born alive (10.1) were similar for all reproductive system, but the litter size at weaning was higher for Rs 49 (8.7) than for Rs 35 (7.9) and Rs 42 (7.9), even though nine rabbits were kept after birth for each reproductive system. Differences between breeding systems decreased after the third insemination cycle.

Carcass and meat quality measurements

Quality measurements were carried out on kits from the does' third reproductive cycle. For each reproductive system, 100 rabbits were slaughtered when they were 63 (Rs 35) or 70 days old (Rs 42 and Rs 49), under commercial conditions at the Experimental slaughter house of Rambouillet (France). Rabbits were weighed and sexed before slaughter. After 24h of chilling, carcasses were weighted and the dressing percentages calculated. Perirenal fat was weighted and the carcasses were then divided into fore and hind parts (between the last thoracic and the first lumbar vertebra; Blasco and Ouhayoun, 1993). The hind to fore part ratio was calculated. Regarding meat quality measurements, the pH of meat was measured 24h *post mortem* in the lumbar region (*Longissimus lumborum*, LL) and in the right hind legs (*Biceps femoris*, BF) with a glass penetrating electrode (Mettler Toledo). Meat color was assessed on the surface of freshly cut LL (first lumbar vertebra) and on the surface of the BF. A Minolta chromameter was set to the L* (lightness), a* (redness) and b* (yellowness) scales.

Statistical analysis

Abnormal measurements (differing from the mean by more than three times the standard deviation) were not included. Statistical analyses were carried out using the Statview® software program version 5 (Abacus Concepts, Berkeley, CA, USA). Analysis of variance was carried out on carcass and meat quality data using two fixed effects (breeding system: 3 levels and sex: 2 levels) and their interaction in the model. Significant differences between groups were determined by Student-Newman-Keuls test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Regarding carcass quality (Table 2), the slaughter weight increased as the reproduction rhythm decreased resulting in a higher carcass weight and percentage of perirenal fat for Rs 42 and Rs 49 than for Rs 35. The difference between Rs 42 and Rs 49, and Rs 35 can be explained mainly by the slaughter age, which was younger for Rs 35. Indeed, as rabbits grow older they become heavier and fatter (for review, Dalle Zotte 2002). Females were heavier (live weight) than males, and in line with Lazzaroni *et al*. (2009), they had a higher percentage of perirenal fat. Regarding the dressing percentage, an interaction between the rearing system and sex was observed (Figure 1). Rabbits of Rs 35 gave the lowest yields whatever their sex, probably due to their younger slaughter age (Rao *et al*., 1978; Dalle Zotte, 2002). Due to this interaction, no effect of animal sex was observed on the dressing percentage within a reproductive system. Females of Rs 49 resulted in a lower dressing percentage than males of Rs 42. The hind to fore part ratio was significantly higher for Rs 42. This could partly be due to the weaning age being higher for Rs 42; Zita *et al*. (2007) have shown that loin yields are higher for rabbits weaned later.

Table 2: Measurements of rabbit carcass quality in three reproductive systems (Rs), according to sex of animal.

	Slaughter weight (g)	Carcass weight (g)	Dressing percentage (%)	Perirenal fat (%)	hind part / fore part ratio
P-value					
Rs	<0.001	<0.001	<0.001	<0.001	<0.001
Sex	0.001	0.09	0.06	<0.001	0.19
Rs x Sex	0.72	0.28	0.03	0.60	0.99
Mean±SD					
Rs 35	2348±11^{c}	1267±9^{b}	53.9±2.5^{b}	1.25±0.04^{b}	1.03 ± 0.01^{b}
Rs 42	2586±12^{b}	1482±7^{a}	57.3±1.7^{a}	1.53±0.05^{a}	1.05 ± 0.01^{a}
Rs 49	2626±11^{a}	1491±7^{a}	56.8±2.0^{a}	1.59±0.04^{a}	1.02 ± 0.01^{b}
Males	2501±13^{b}	1410±11	56.3±2.8	1.38±0.04^{b}	1.03±0.01
Females	2540±14^{a}	1417±11	55.7±2.3	1.54±0.04^{a}	1.04±0.01
Males Rs 35	2326±16	1250±13	53.7±0.4^{c}	1.17±0.06	1.03±0.01
Females Rs 35	2369±13	1284±13	54.2±0.4^{c}	1.32±0.06	1.04±0.01
Males Rs 42	2556±16	1477±9	57.7±0.2^{a}	1.42±0.07	1.05±0.01
Females Rs 42	2620±17	1488±11	56.8±0.2^{ab}	1.66±0.06	1.06±0.01
Males Rs 49	2608±13	1491±8	57.2±0.3^{ab}	1.53±0.05	1.01±0.01
Females Rs 49	2649±19	1491±11	56.3±0.3^{b}	1.67±0.05	1.02±0.01

Means with different letters on the same column differ significantly.

Regarding the quality of meat (Table 3) of the lumbar region, the reproductive system had no impact on the ultimate pH. However, compared to Rs 42, meat of rabbits from Rs 35 was lighter and yellower and that from Rs 49 was lighter, redder and yellower. With regard to the meat quality (Table 3) of the hind legs, meat was more acid from Rs 35 and Rs 49 rabbits. Compared to Rs 42, hind-leg meat from Rs 35 rabbits was lighter, and less colored, and that from Rs 49 rabbits was lighter, and less red.
In the present study sex had no impact on the ultimate pH of meat and a very limited impact on meat color. Several studies have reported that the ultimate pH of rabbit meat decreases as slaughter age

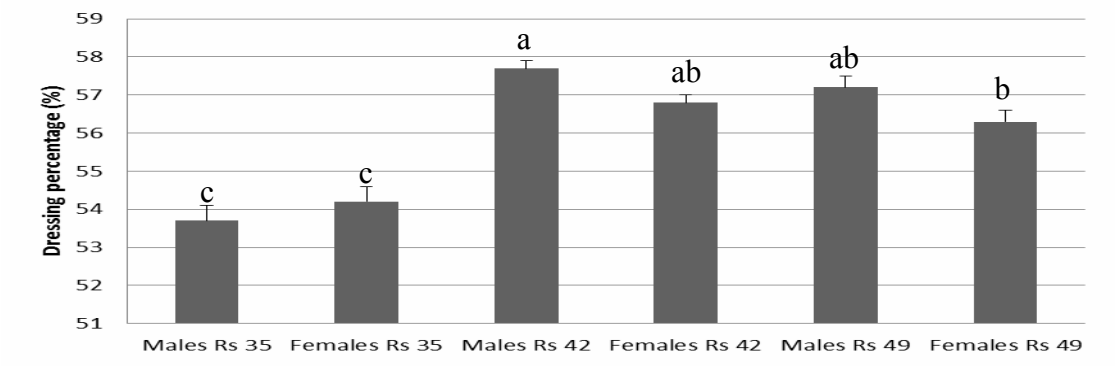

Figure 1: Impact of the three reproductive systems (Rs) and sex of animal on dressing percentage

Table 3: Measurements of rabbit meat quality in three reproductive systems (Rs), according to sex of animal.

	Lumbar region 24h pH	Lumbar region colour			Hind legs 24h pH	Hind legs colour		
		L*	a*	b*		L*	a*	b*
P-value								
Rs	0.86	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001
Sex	0.97	0.32	0.02	0.35	0.30	0.02	0.43	0.55
Rs x Sex	0.07	0.39	0.93	0.48	0.80	0.96	0.28	0.65
Mean±SD								
Rs 35	5.73±0.01	56.38±0.36^{a}	4.88±0.16^{b}	5.22±0.13^{b}	5.80±0.01^{b}	54.09±0.21^{a}	4.03±0.11^{c}	2.70±0.14^{b}
Rs 42	5.72±0.01	52.69±0.34^{b}	4.53±0.14^{b}	4.28±0.12^{c}	5.84±0.01^{a}	51.09±0.26^{c}	6.08±0.23^{a}	3.53±0.17^{a}
Rs 49	5.72±0.01	55.91±0.41^{a}	5.67±0.15^{a}	5.61±0.14^{a}	5.77±0.01^{b}	53.22±0.17^{b}	4.46±0.10^{b}	3.72±0.14^{a}
Males	5.72±0.01	55.21±0.32	5.23±0.12^{a}	5.12±0.11	5.79±0.01	53.06±0.21^{a}	4.93±0.13	3.40±0.13
Females	5.72±0.01	54.78±0.34	4.8±0.13^{b}	4.95±0.12	5.81±0.01	52.51±0.20^{b}	4.77±0.16	3.23±0.13

Means with different letters on the same column differ significantly.

increases (Hulot and Ouhayoun, 1999). However, in line with our results, some authors found no impact of age on ultimate pH (Dalle Zotte, 2002), or an increase as rabbits grow older (Lambertini *et al*., 1996). The impact of the reproductive system on pH and lightness could also be due to the weaning age as described by Bivolarski *et al*. (2011). They found a less acidic and darker meat when rabbits were weaned at 35d compared to 21d. The more acidic hind leg meat from Rs 35 and Rs 49 compared to Rs 42 could have impaired the water holding capacity of the meat, as a correlation between these two factors has been observed in rabbit meat (Hulot and Ouhayoun, 1999). However, differences between reproductive systems were very limited (<0.1 pH unit) and probably have no effect on meat processing or consumer perception. Similarly, the impact of the reproductive system on meat appearance is probably not great enough to affect consumer acceptability.

CONCLUSIONS

Rabbits of both Rs 42 and Rs 49 performed better than rabbits of Rs 35 in terms of carcass weight and yield, but they were fatter. Moreover, Rs 42 rabbits had a higher hind to fore part ratio, making them more suitable for retail cuts. Regarding meat quality, the reproductive system had a very limited impact on the ultimate pH and color of loins and hind legs. In the present study Rs 49 allowed rabbits to have a more extensive reproduction system without impairing carcass and meat quality. By contrast, Rs 35 enabled intensive production management without impairing meat quality, but resulted in a decrease in carcass weight and yield.

ACKNOWLEDGEMENTS

This work was funded by the CAS DAR special development fund (project n. 9023) and by the French rabbit interprofessional association (CLIPP).

REFERENCES

Bivolarski B.L., Vachkova E., Ribarski S.S. 2011. Effect of weaning age upon the slaughter and physiochemical traits of rabbit meat. *Veterinarski Archiv., 8, 499-511.*

Blasco A., Ouhayoun J. 1993. Harmonization of criteria and terminology in rabbit meat research. Revised proposal. *World Rabbit Sci., 4, 93-99.*

Dalle Zotte A. 2002. Perception of meat quality and major factors influencing the rabbit carcass and meat quality. *Livest. Prod. Sci., 75, 11-32.*

Hulot F., Ouhayoun J. 1999. Muscular pH and related traits in rabbits: a review. *World Rabbit Sci., 7, 15-36.*

Lambertini L., Lalatta Costerbosa G., Petrosino G., Zaghini G., Vignola G., Benassi M.C., Gatta P.P. 1996. Caractéristiques histochimiques du muscle et pH de la viande de lapins hybrides sacrifiés à différents âges. *World Rabbit Sci., 4, 171-179.*

Lazzaroni C., Biagini D., Lussiana C. 2009. Different rearing systems for fattening rabbits: performance and carcass characteristics. *Meat Sci., 82, 200-204.*

Rao D.R., Chen C.P., Sunki G.R., Johnson W.M. 1978. Effect of weaning and slaughter ages on rabbit meat production. II. Carcass quality and composition. *J. Anim. Sci., 46, 578-583.*

Theau-Clément M., Galliot P., Souchet C., Bignon L., Fortun-Lamothe L. 2011. Performances et productivité comparéees de trois systèmes d'élevage différant par la conduite de la reproduction. *In: Proc. 14èmes Journées de la Recherche Cunicole, 2011 Novembre. Le Mans, France, 35-68.*

Zita L., Tůmová E., Skřivanová V., Ledvinka Z. 2007. The effect of weaning age on performance and nutrient digestibility of broiler rabbits. *Czech J. Anim. Sci., 25, 341-347.*