

PAPER

Carcass traits and meat quality of two different rabbit genotypes

Gisella Paci, Francesca Cecchi,
Giovanna Preziuso, Roberta Ciampolini,
Maria D'Agata

Dipartimento di Patologia Animale,
Profilassi e Igiene degli Alimenti,
Università di Pisa, Italy

Abstract

To evaluate the effect of genotype on carcass traits and meat quality, sixty-four rabbits belonging to two genotypes (slow growing local population, LP; commercial hybrids, HY) were used. Rabbits were weaned at 35 days of age and slaughtered when they reached 2500 g of live weight, corresponding to 103 and 87 days of age for LP and HY, respectively. Comparing the slaughter traits of two genotypes, LP provided higher dressing out (59.4 vs 56.2%, $P<0.01$) and skin percentage (16.0 vs 14.2%, $P<0.05$), lower incidence of full gastrointestinal tract (18.5 vs 22.3%, $P<0.01$) and higher incidence of head (9.5 vs 8.9%, $P<0.05$) and kidneys (0.99 vs 0.86%, $P<0.05$) than HY. Reference carcasses from LP had greater incidence of perirenal fat (2.04 vs 1.12%; $P<0.01$), loin (21.5 vs 19.2%; $P<0.01$) and hind leg (34.4 vs 31.6%; $P<0.01$) than HY. Hind leg meat-to-bone ratio was significantly higher in HY than LP (4.7 vs 3.8%; $P<0.01$). The comparison between the variances of slaughter weight, chilled carcass weight, kidneys percentage, reference carcass weight, perirenal fat and hind leg percentage showed the greatest variability in the LP. Meat derived from LP showed lower L*, higher a*, b* and C* colour values than HY ($P<0.01$). In conclusion, LP showed good slaughter traits and favourable meat quality. The great variability observed in the LP could allow to improve the productive performances, however maintaining animal rusticity.

Introduction

The European Council (2009) stated that Sustainable development remains a fundamental objective of the European Union and

underlined the necessity to employ different urgent actions, as the conservation and the management of biodiversity and natural resources (Fortun-Lamothe *et al.*, 2009). Consequently the sustainable agriculture and alternative rearing system became an objective, but they require genetic resources characterized by high variability, as local breeds or population, suitable for extensive conditions: the genetic variability can supply subjects more resistant to disease and more able to fit the local environment changes and to utilise alternative feed sources reducing the environmental impact (Fortun-Lamothe *et al.*, 2009).

In recent years the effect of genetic variability on performances and meat quality of native breeds of different species was studied (Insausti *et al.*, 2001; Pugliese and Sirtori, 2012, Serra *et al.*, 2004), but only few researches were carried out on Italian local rabbit populations (Cavani *et al.*, 2004; D'Agata *et al.*, 2009; Lazzaroni and Pagano Toscano, 1998; Pagano Toscano *et al.*, 1983). Moreover only few studies analyzed the differences between commercial hybrids and autochthonous rabbit breeds or local populations (Metzger *et al.*, 2006, Pla *et al.*, 1996).

The aim of this research was to study the carcass and the meat quality of local rabbits, characterized by a slow growing, in comparison with commercial hybrids reared under the same rearing system.

Materials and methods

Animal and housing system

The trial was carried out at the rabbitry of Department of Animal Pathology, Prophylaxis and Food Hygiene in Pisa (Italy). Sixty-four female rabbits, thirty-two Grey coloured local rabbits (LP) and thirty-two commercial hybrids (HY), weaned at 35 days of age, were used. The rabbits were reared under the same conventional housing system in colony cages (cm 65×40×32) at the same stocking density of 15 rabbits/m². Throughout the trial the animals received the same dietary treatment (pelleted feed and alfalfa hay *ad libitum*), until the slaughter weight usually required by the market: since the two genotypes are characterized by different growth rate, they reached the same slaughter weight at different ages.

Slaughter traits and muscle sampling

At 103 days of age for local population (2519±83.9 g) and at 87 days of age for com-

Corresponding author: Prof. Gisella Paci,
Dipartimento di Patologia Animale, Profilassi e
Igiene degli Alimenti, Facoltà di Medicina
Veterinaria, Università di Pisa, viale delle
Piazze 2, 56124 Pisa, Italy.
Tel. +39.050.2216903 - Fax: +39.050.2216901.
E-mail: gpaci@vet.unipi.it.

Key words: Rabbit, Local population, Hybrids,
Meat quality, Carcass traits.

Received for publication: 30 January 2012.

Revision received: 5 April 2012.

Accepted for publication: 19 April 2012.

This work is licensed under a Creative Commons
Attribution NonCommercial 3.0 License (CC BY-
NC 3.0).

©Copyright G. Paci *et al.*, 2012

Licensee PAGEPress, Italy

Italian Journal of Animal Science 2012; 11:e45

doi:10.4081/ijas.2012.e45

mercial hybrids (2543±25.5 g), rabbits were weighed (SW), electrically stunned, and slaughtered at an EU-licensed abattoir.

The slaughtering and carcass dissection procedures followed the World Rabbit Science Association (WRSA) recommendations described by Blasco and Ouhayoun (1996). The slaughtered rabbits were bled, and then the skin, genitals, urinary bladder, gastrointestinal tract and the distal part of legs were removed. Hot carcasses (with head, thoracic cage organs, liver, kidneys, perirenal and scapular fat) were weighed, then chilled at +4°C for 24 h in a ventilated room. The chilled carcasses were weighed (CCW) and the head, thymus, trachea, oesophagus, heart, lungs, liver and kidneys were removed to obtain the reference carcasses (RCW). The dressing out (CCW as percentage of SW) and the ratio of head, liver and carcass parts to either CCW or RCW were calculated as required. The RCW was divided into joints at the left and right hind legs and loin region (between the 1st and the 7th lumbar vertebra) according to recommendations provided by Pla and Dalle Zotte (2000). The left hind legs were deboned and the meat-to-bone ratio was calculated (Blasco and Ouhayoun, 1996); the Longissimus lumborum (LL) muscle was used to determine the meat quality parameters.

Meat quality parameters

The ultimate pH (pHu) was determined *in situ* on the LL muscle at the level of the 5th lumbar vertebra with a portable pH-meter

(Hanna) equipped with a glass electrode (3 mm diameter conic tip) suitable for meat penetration. At 24 h *post mortem*, instrumental meat colour expressed as L* (lightness), a* (redness), b* (yellowness), C* (Chroma) and H* (Hue) according to CIElab system (CIE, 1976) was measured with a Minolta CR300 chromameter (Minolta, Osaka, Japan) on a transversal section of the LL muscle. The illuminant was D65 and an incident angle of 0 was used. The values corresponded to the average of three measurements per sample. Water holding capacity (WHC) was determined according to the filter paper press method on the LL muscles, and expressed as the ratio of meat area to total area (MT ratio) after compression (50 kg/cm²) of 300±5 mg of meat for 5 min (Grau and Hamm, 1957).

Statistical analysis

Data were analysed by analysis of variance, considering the genotype as fix factor. Slaughter traits were analyzed as weight and expressed as percentage. Data were also analysed testing the differences in variances to compare the two genotypes. Statistical significance of differences was assessed by the Student's *t*-test (SAS, 2002). With the aim to discriminate the genotypes (LP and HY) the Cluster analysis with the link Sum of Square method was applied on all parameters and the distribution of rabbits belonging to different groups within the genotypes was performed.

Results and discussion

Carcass and meat quality

The effect of the genotype on the slaughter traits is reported in Table 1. Since the age and the weight are important factors of variability for carcass and meat quality, the comparison between unselected local population and selected hybrids is difficult, because they reach the same weight at different age. In this trial the two genotypes were compared at the same slaughter weight, chosen to satisfy the requirements of the market (2500 g): for the hybrids this weight corresponds at about 60% of their adult weight (adult weight 4300 g), while for the LP at about 70% of their adult weight (adult weight 3600 g); for this reason the study will take into account not only the effect of the age but also the different degree of maturity of two genotypes.

The comparison between the variances of the slaughter weight showed significant dif-

ferences between LP and HY ($P<0.01$): the standard error of slaughter weight of HY was lower than that of LP. This indicates that the hybrids are characterized by a low variability, in fact they derive from an intensive selection that determines a greater homogeneity of development; on the contrary the local population, deriving from unselected animals, showed high variance (de Rochambeau, 1997; Estany *et al.*, 1992).

Comparing the slaughter traits of the two genotypes, LP provided higher dressing out and skin percentage and lower incidence of full gastrointestinal tract than HY ($P<0.01$; $P<0.05$; $P<0.01$; respectively). The highest value of dressing out percentage in LP was mainly due to the difference of full gastrointestinal tract between local population and hybrids (3.8% lower in LP than HY; $P<0.01$) in spite of skin incidence (1.8% higher in LP than HY). The ratio of full gastrointestinal tract weight to live weight decreases with age or maturity (Cantier *et al.*, 1969). Since in our study the animals were slaughtered at the same body weight but at different age and degree of maturity, it is difficult to ascribe the reduction of this tract to only one of the two factors.

The favourable dressing out percentage, observed in LP, is in agreement with other study carried out on the same population (D'Agata *et al.*, 2009). Genetic origin significantly affected other carcass traits: a higher incidence of head and kidneys was observed in LP than HY ($P<0.05$). Some authors

observed that the selection for growth rate, in rabbits slaughtered at about 2 kg, determined the increase of intestinal content, the decrease of dressing out percentage, the reduction of fat deposits and lower development of head and kidneys (Hernández *et al.*, 2004; Khalil and Al-Saef, 2008; Piles *et al.*, 2000).

The reference carcass traits percentages showed significant differences: carcasses from LP had greater incidence of perirenal fat ($P<0.01$), loin ($P<0.01$) and hind leg ($P<0.01$) than HY carcasses. The lower incidence of perirenal fat in HY could be in relation to the late development of fat tissues confirming the lower degree of maturity that characterizes the hybrid rabbits (Cantier *et al.*, 1969; Deltoro and Lopez, 1985). In addition the results of the retail cuts could be related to the different stage of maturity. The greater development of hind leg and loin in LP depends on the reaching of the commercial live weight at an older age and a higher degree of maturity due to the slow-growth of the local population. Hind leg meat-to-bone ratio was significantly higher in HY than LP ($P<0.01$) confirming the fast growth of HY and the effect of the selection programmes for improving the meat content of carcass. Similarly to the live weight, the chilled carcass weight ($P<0.01$), the kidneys percentage ($P<0.05$), the reference carcass weight ($P<0.05$), the perirenal fat ($P<0.01$) and the hind leg percentage ($P<0.05$) of LP showed higher standard error than HY, confirming

Table 1. Effect of genotype on slaughter traits. Data are expressed as means ± standard error.

	LP	HY	Comparison between	
			Means	Variances
Rabbits samples, n	32	32		
Slaughter weight (SW), g	2519±83.9	2543±25.5	ns	**
Skin, % SW	16.0±0.31	14.2±0.20	*	ns
Full gastrointestinal tract, % SW	18.5±0.47	22.3±0.41	**	ns
Chilled carcass weight (CCW), g	1498±54.3	1433±18.9	ns	**
Dressing out, % SW	59.4±0.45	56.2±0.35	**	ns
Head, % CCW	9.5±0.20	8.9±0.11	*	ns
Liver, % CCW	5.8±0.25	6.0±0.16	ns	ns
Kidneys, % CCW	0.99±0.037	0.86±0.018	*	*
Reference carcass weight (RCW), g	1227±42.5	1181±18.3	ns	*
Reference carcass, % CCW	82.0±0.39	82.4±0.23	ns	*
Perirenal fat, % RCW	2.04±0.219	1.12±0.059	**	**
Loin, % RCW	21.5±0.17	19.2±0.22	**	ns
Hind leg, % RCW	34.4±0.25	31.6±0.11	**	*
Hind leg meat to bone ratio	3.8±0.08	4.7±0.09	**	ns

LP, local population; HY, hybrid; ** $P<0.01$; * $P<0.05$; ns, not significant.

the great variability in the local population.

In agreement with other authors (Dalle Zotte, 2002; Hernandez *et al.*, 2006; Hulot and Ouhayoun, 1999; Khalil and Al-Saef, 2008; Zgur and Kermauner, 2005) who indicated that selection for growth rate has little effect on meat quality, the pH_u and WHC were not significantly influenced by genetic origin of rabbits (Table 2). Meat colour values revealed significant differences between genotypes ($P<0.01$): meat derived from LP showed lower lightness (L^*), higher redness (a^*) and yellowness (b^*) than HY. This result suggests that local population furnished less pale meat, as confirmed by the higher C^* value ($P<0.01$) and it was probably due to their higher slaughtering age: the more coloured meat in older animals could be a consequence of a decrease in the oxidative metabolism, correlated with the increase of glycolytic energy metabolism (Dalle Zotte, 2002; Pla, 2008; Zgur and Kermauner, 2005). As regards meat colour traits, significant differences between variances are noted for b^* and C^* ($P<0.05$) showing the highest variability in local population parameters.

The Cluster analysis for genotype recognition on the basis of the carcass quality traits showed that 51.6% of the animals could be correctly assigned to the population they belong to, revealing the existence of three distinct groups: Group 1 was constituted by only LP (12 animals, corresponding to 37.5% of total LP), Group 3 was constituted by only HY (21 animals, corresponding to 65.6% of total HY), Group 2 was constituted by 20 LP and 11 HY (Table 3). High percentage of assignment of commercial hybrids to Group 3 confirmed the high homogeneity of rabbits derived from the selected strains, as observed previously by the variances comparison, while the low assignment of LP to Group 1 testify the great variance of this genotype.

Significant differences for all parameters, with the exception of slaughter weight, head and liver percentages, were observed among the three groups, mainly between Group 1 and the other groups, confirming the differences between the two genotypes. Many parameters were significantly different between Group 1 and Group 2 and since the Group 2 was mainly represented by LP, this leads to further underline the presence of high diversity within the local rabbit population. Regarding meat quality traits, the Cluster Analysis supports the results mentioned above (Table 4): meat colour values showed significant differences among Group 2 and the other Groups, confirming the high variability of unselected population.

Table 2. Effect of genotype on meat quality traits of *Longissimus lumbarum*. Data are expressed as means \pm standard error.

	LP	HY	Comparison between	
			Means	Variances
Rabbits samples, n	32	32		
pH _u	5.59 \pm 0.041	5.63 \pm 0.022	ns	ns
Colour				
L^*	59.09 \pm 0.705	61.89 \pm 0.733	**	ns
a^*	3.25 \pm 0.247	1.98 \pm 0.143	**	ns
b^*	3.78 \pm 0.343	2.74 \pm 0.169	**	*
C^*	5.09 \pm 0.364	3.50 \pm 0.160	**	*
H^*	48.64 \pm 2.377	53.51 \pm 2.357	ns	ns
WHC				
MT ratio	0.49 \pm 0.018	0.48 \pm 0.011	ns	ns

LP, local population; HY, hybrid; pH_u, ultimate pH; WHC, water holding capacity; MT, meat area/total area; ** $P<0.01$; * $P<0.05$; ns, not significant.

Table 3. Cluster analysis of slaughter traits. Data are expressed as means \pm standard error.

	Group 1	Group 2	Group 3
Rabbits samples, n	12	31	21
Genotype	LP	20 LP + 11 HY	HY
Slaughter weight (SW), g	2669 \pm 83.8	2475 \pm 52.1	2543 \pm 77.6
Skin, % SW	16.8 \pm 0.38 ^A	14.4 \pm 0.23 ^B	14.9 \pm 0.35 ^B
Full gastrointestinal tract, % SW	16.8 \pm 0.56 ^C	20.8 \pm 0.35 ^B	23.8 \pm 0.52 ^A
Chilled carcass weight (CCW), g	1644 \pm 54.7 ^A	1467 \pm 34.0 ^B	1417 \pm 50.6 ^A
Dressing out, %	61.5 \pm 0.54 ^A	59.2 \pm 0.33 ^B	55.7 \pm 0.50 ^C
Head, % CCW	9.6 \pm 0.24	9.1 \pm 0.15	8.9 \pm 0.22
Liver, % CCW	6.2 \pm 0.30	5.7 \pm 0.19	6.2 \pm 0.28
Kidneys, % CCW	1.0 \pm 0.04 ^A	0.9 \pm 0.03 ^B	0.9 \pm 0.04 ^B
Reference carcass weight (RCW), g	1309 \pm 43.9 ^a	1185 \pm 27.3 ^b	1142 \pm 40.6 ^b
Perirenal fat, % RCW	2.4 \pm 0.22 ^A	1.4 \pm 0.14 ^B	1.2 \pm 0.21 ^C
Loin, % RCW	21.6 \pm 0.38 ^A	20.2 \pm 0.24 ^B	18.9 \pm 0.35 ^B
Hind leg, % RCW	34.2 \pm 0.43 ^A	32.7 \pm 0.27 ^B	31.6 \pm 0.31 ^C
Hind leg meat to bone ratio	3.5 \pm 0.18 ^B	4.61 \pm 0.12 ^A	4.34 \pm 0.15 ^A

LP, local population; HY, hybrid; ^{a,b} $P<0.05$; ^{A,C} $P<0.01$.

Table 4. Cluster analysis of meat quality traits of *Longissimus lumbarum*. Data are expressed as means \pm standard error.

	Group 1	Group 2	Group 3
Rabbits samples, n	12	31	21
Genotype	LP	20 LP + 11 HY	HY
WHC	0.49 \pm 0.022	0.48 \pm 0.014	0.49 \pm 0.021
pH _u	5.80 \pm 0.049 ^A	5.52 \pm 0.030 ^B	5.61 \pm 0.046 ^A
Colour			
L^*	60.0 \pm 1.15	61.3 \pm 0.72	59.2 \pm 1.06
a^*	3.7 \pm 0.23 ^A	1.9 \pm 0.22 ^B	3.1 \pm 0.21 ^A
b^*	4.4 \pm 0.35 ^A	2.7 \pm 0.22 ^B	3.3 \pm 0.32 ^{AB}
C^*	6.0 \pm 0.30 ^A	3.4 \pm 0.18 ^C	4.6 \pm 0.28 ^B
H^*	49.6 \pm 3.47 ^B	55.3 \pm 2.16 ^A	42.23 \pm 3.21 ^C

LP, local population; HY, hybrid; ^{a,b} $P<0.05$; ^{A,C} $P<0.01$.

Conclusions

Meat derived from local population represents an alternative product for the consumers who equate their favourite products with a local breed/population reared under extensive production system. In this trial, the local rabbit population showed good slaughter traits and favourable meat quality even if derived from unselected and more mature animals; the study highlighted also the great variability of carcass and meat quality in the local population, confirmed by the Cluster analysis.

The genetic variability observed in local population traits represents an interesting possibility to improve the productive performances without loss rusticity and then adaptability to different local environmental conditions.

References

- Blasco, A., Ouhayoun, J., 1996. Harmonization of criteria and terminology in rabbit meat research. Revised proposal. *World Rabbit Sci.* 4:93-99.
- Cantier, A., Vezinhet, R., Rouvier, R., Dauzier, L., 1969. Allometrie de croissance chez le lapin (*O. Cuniculus*) 1. Principaux organes et tissus. *Ann. Biol. Anim. Biochim. Biophys.* 9:5-39.
- Cavani, C., Bianchi, M., Petracci, M., Toschi, T.G., Parpinello, G.P., Kuzminsky, G., Morera, P., Finzi, A., 2004. Influence of open-air rearing on fatty acid composition and sensory properties of rabbit meat. *World Rabbit Sci.* 12:247-258.
- Commission Internationale de l'Eclairage, 1976. Official recommendations on uniform colour spaces, colour differences equations and metric colour terms. CIE ed., Paris, France.
- D'Agata, M., Preziuso, G., Russo, C., Dalle Zotte, A., Mourvaki, E., Paci, G., 2009. Effect of an outdoor rearing system on the welfare, growth performance, carcass and meat quality of a slow-growing rabbit population. *Meat Sci.* 83:691-696.
- Dalle Zotte, A., 2002. Perception of rabbit meat quality and major factors influencing the rabbit carcass and meat quality. *Livest. Prod. Sci.* 75:11-32.
- de Rochambeau, H., 1997. Genetics of the rabbit for meat production: What's new since the World Rabbit Congress held in Budapest in 1988? A review. *World Rabbit Sci.* 5:77-82.
- Deltoro, J., Lopez, A.M., 1985. Allometric changes in rabbits. *J. Agric. Sci.* 105:339-346.
- Estany, J., Camacho, J., Baselga, M., Blasco, A., 1992. Selection response of growth rate in rabbits for meat production. *Genet. Sel. Evol.* 24:527-537.
- European Council, 2009. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development. COM(2009) 400 final. Available from: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0400:EN:NOT>
- Fortun-Lamothe, L., Combes, S., Gidenne, T., 2009. Contribution of intensive rabbit breeding to sustainable development. A semi-quantitative analysis of the production in France. *World Rabbit Sci.* 17:79-85.
- Grau, R., Hamm, R., 1957. Über das Wasserbindungsvermögen des Säugetiermuskels II. Mitt. Über die Bestimmung der Wasserbindung des Muskels. *Z. Lebensm. Untersuch. U. Forsch.* 105:446-460.
- Hernández, P., Aliaga, S., Pla, M., Blasco, A., 2004. The effect of selection for growth rate and slaughter age on carcass composition and meat quality traits in rabbits. *J. Anim. Sci.* 82:3138-3143.
- Hernández, P., Arino, B., Grimal, A., Blasco, A., 2006. Comparison of carcass and meat characteristics of three rabbit lines selected for litter size or growth rate. *Meat Sci.* 73:645-650.
- Hulot, F., Ouhayoun, J., 1999. Muscular pH and related traits in rabbits: a review. *World Rabbit Sci.* 7:15-36.
- Insausti, K., Beriain, M.J., Purroy, A., Alberti, P., Gorraiz, C., Alzueta, M.J., 2001. Shelf life of beef from local Spanish cattle breeds stored under modified atmosphere. *Meat Sci.* 57:273-281.
- Khalil, M.H., Al-Saef, A.M., 2008. Methods, criteria, techniques and genetic responses for rabbit selection: a review. pp 1-22 in *Proc 9th World Rabbit Congr.*, Verona, Italy.
- Lazzaroni, C., Pagano Toscano, G., 1998. Il colore del mantello nel coniglio Grigio di Carmagnola: risultati di una selezione fenotipica. *Riv. Coniglicolt.* 35:33-35.
- Metzger, S., Odermatt, M., Szendro, Z., Mohaupt, M., Romvari, R., Makai, A., Biro-Németh, E., Sipos, L., Radnai, I., Horn, P., 2006. A study of the carcass traits of different rabbit genotypes. *World Rabbit Sci.* 14:107-114.
- Pagano Toscano, G., Benfatti, G., Zoccarato, I., Andrione, A. 1983. Contributo alla conservazione di una popolazione locale di conigli grigi: primi risultati. *Riv. Coniglicolt.* 20:51-54.
- Piles, M., Blasco, A., Pla, M., 2000. The effect of selection for growth rate on carcass composition and meat characteristics of rabbits. *Meat Sci.* 54:347-355.
- Pla, M., 2008. A comparison of the carcass traits and meat quality of conventionally and organically produced rabbits. *Livest. Sci.* 115:1-12.
- Pla, M., Dalle Zotte, A., 2000. Harmonisation of criteria and methods used in rabbit meat research. pp 539-545 in *Proc 7th World Rabbit Congr.*, Valencia, Spain.
- Pla, M., Hernandez, P., Blasco, A., 1996. Carcass composition and meat characteristics of two rabbit breeds of different degrees of maturity. *Meat Sci.* 44:85-92.
- Pugliese, C., Sirtori F., 2012. Quality of meat and meat products produced from southern European pig breeds. *Meat Sci.* 90:511-518.
- SAS, 2002. *JMP In.* SAS Inst. Inc., Cary, NC, USA.
- Serra, X., Gil, M., Gispert, M., Guerrero, L., Oliver, M.A., Sañudo, C., Campo, M.M., Panea, B., Olleta, J.L., Quintanilla, R., Piedrafita, J., 2004. Characterisation of young bulls of the Bruna dels Pirineus cattle breed (selected from old Brown Swiss) in relation to carcass, meat quality and biochemical traits. *Meat Sci.* 66:425-436.
- Zgur, S., Kermauner, A., 2005. Carcass traits of four rabbit genotypes. *Ital. J. Anim. Sci* 4(Suppl.3):172-174.