CROSSBREEDING PARAMETERS FOR CARCASS TRAITS OF BROILER RABBITS*

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The carcass traits of broiler rabbits HY PLUS – paternal line 59, maternal line 19 and crossbreds F_1 (59 x 19), F_2, F_{11} (59 x F_1), were analysed. The weight least squares means were used for estimating crossbreeding effects. The model of Dickerson (1969, 1973) was used to estimate of additive effect, heterosis and recombination loss. The analysed traits were fore part of body, shoulder, hind legs, carcass I, II, dressing percentage I, II. By the end of the fattening period, the paternal line showed the highest weight, the lowest weights were found for crossbreds F_{11} or F_2. The dressing percentage I and II were the lowest for the maternal line. Positive estimates of additive effect on behalf of line 59 were found for the all traits, mostly non-significant with exception of carcass II (103.7g). Heterosis was negative, significant for body weight (–174.7 g), shoulder (–20.5 g), hind legs (–31.0 g), carcass weight I (93.0g) and carcass weight II (–107.2 g). Recombination loss occurred significant and high, mostly negative except for dressing percentage I (1.64%) and dressing percentage II (1.40%).

rabbit; carcass traits; crossbreeding; maternal line; paternal line

INTRODUCTION

The broiler rabbit is generally a two-way or a four-way hybrid. A performance of these hybrids is determined by several crossbreeding effects, especially by heterosis. In addition, crossbreeding with specialized breeds or strains make use of the complementarity between dam lines, which have a good reproductive efficiency, and sire lines, which possess a good meat production efficiency. Knowledge of a magnitude and a direction of crossbreeding effects are important for crossbreeding scheme decision (Brun, Ouhayoun, 1989; Krogmeier, Dzapo, 1991; Afifi et al., 1994; Redel, 1996; Dědková et al., 2002; Bianospino et al., 2004).

The testing of broiler rabbits has been conducted by the Department of Genetic and Breeding of the Czech University of Life Sciences in Prague since 1992. The testing is concentrated on growth, feed consumption, feed conversion and carcass quality (Mach, 1992; Mach, Majzlík, 1993; Mach et al., 1997a, b; Dědková et al., 1999, 2002).

The aim of the study was to evaluate the crossbreeding effects (i.e. additive effects, heterosis, recombination loss) for carcass traits of straightbred and crossbred rabbits slaughtered at 84 days of age.

MATERIAL AND METHOD

The carcass quality of broiler rabbits HY PLUS: two parental lines: 59 (paternal) and 19 (maternal) and three groups of crossbreds F_1 (59 x 19), F_2, F_{11} (59 x F_1) was analysed. The test was carried out at the Department of Genetic and Breeding of the Czech University of Life Sciences in Prague. Rabbits were placed in individual cages and were fed *ad libitum* on commercial pelleted diet containing 16.5% crude protein, 4,5% crude fat and 15% crude fibber. They were slaughtered at the end of six week fattening period that started at 42 days and finished at 84 days of age of the rabbits. The rabbits were fasted for approximately 10 hours before slaughter. The analysed traits were body weight before slaughter, weight of fore part of carcass separated behind the last rib, weight of shoulder, weight of hind legs, carcass body I defined as a carcass with head, kidney and perirenal fat, hearth and lungs, carcass body II defined as carcass with head, kidney and perirenal fat and liver. Dressing percentage I (%) was the ratio of the carcass I weight plus the weight of liver to live body weight. Dressing percentage II (%) was the ratio of the carcass II weight to live body weight.

The analysis was carried out by the ordinary least squares method in the procedure GLM of statistical software SAS (SAS, 1988). A linear model included the factors of the rabbit group and factor of breeder. The estimated least squares means were used as input data for the program package CBE4, version 4.0 (Wolf, 1995) that was used for estimating of the crossbreeding effects.

The model of Dickerson (1969, 1973) was used in all calculations. Three kinds of crossbreeding effects were included: additive and heterosis effects and recombination loss. The additive effects for maternal line 19 were set to zero. The additive effects for paternal line 59 were therefore expressed as deviations from maternal line.

* The research was supported by the Ministry of Agriculture of the Czech Republic (Project MZE 0002701401) and Ministry of Education, Youth and Sport of the Czech Republic (MSM 6046070901).

The coefficients for these effects were expressed as given in Wolf et al. (1995). The full model for crossbreeding effects has the following form:

$$CBE = \alpha_{59}a_{59} + \delta_{19,59}h_{19,59} + (4\alpha_{19}\alpha_{59} + \delta_{19,39})r_{19,59}$$

where: a – additive effect of line 59
h – heterosis for combination 19 x 59
r – recombination loss for breed combination 19 x 59

The α's and δ's are the coefficients, that are specific for each animal.

The estimation was carried out by weighted least squares using the reciprocals of the variances of the genetic group means as weights.

RESULTS AND DISCUSSION

By the end of the fattening period, the heaviest crossbreds F_1 attained 2771 g, paternal line 59 2936 g, whereas the lowest body weight was noticed for crossbreds F_{11} (2667 g) (Table 1). Likewise, the lower final body weight in crossbreds F_{11} and F_2 in comparison with F_1 crossbreds was reported by Redel (1996). The same weight rank occurred for other analysed traits i.e. the fore part of body, shoulder, distal legs, carcass I and carcass II. The paternal line showed the highest weight, while the lowest weights were found for crossbreds F_{11} or F_2. The dressing percentage I and II were lowest for the maternal line 19, which is in agreement with the fact that the line 19 is selected for reproduction traits. The differences among the remaining groups in dressing percentage were low. It is necessary to consider that the production of crossbred F_{11} and F_2 could be affected by a selection between does from F_1 generation. No significant differences among genetic groups for dressing percentages were found by Nofal et al. (1997).

The analysis of variance (Table 2) showed the importance of the farm of origin (the breeder effect) for all analysed traits. The genotype group significantly influenced all the traits except the shoulder. In agreement with our findings, significant influence of the genotype on carcass traits was found by Metzger et al. (2004). The effect of farm seems to be more important than the effect of genotype group. Therefore the adjustment for the effect of farm was considered necessary.

The least squares means for genotype groups adjusted for effect of farm and their standard errors were obtained by the above described analysis of variance (Table 3). The correction for the effects of breeder shifted the crossbreds F_2 on the last place for the all weighted traits. The crossbreds F_{11} and the paternal line remained the heaviest groups for this trait between crossbred groups or parental lines, respectively. The least squares means for the dressing percentage confirmed the best values for crossbreds F_2 and F_{11} that exceeded both parental lines (Table 3, Fig. 1). Bianospino et al. (2004) found interaction between genetic group and age for dressing percentage: crossbreds showed higher yield between at 70 day of age, in contrast to our results, the difference was not maintained after 84 days of age. At the same age, the lower dressing percentage of crossbreds was reported by Krogmeier and Dzapo (1991).

The estimates for crossbreeding effects are presented in Table 4. Positive estimates of additive effect on behalf of line 59 were found for the all analysed traits but mostly non-significant with exception of carcass II. Estimates of heterosis were negative, non-significant only for the fore part of body and the dressing percentage I and II. The dressing percentage I is only exception because the positive estimates of heterosis occurred for it. Non-significant but positive direct heterosis was reported by Afifi et al. (1994) for most carcass traits. Brun and Ouhayoun (1989) found that slaughter yield and the hind legs were

Table 1. Summary of data

		Body weight		Fore part	Shoulder	Hind legs		Carcass weight I	Carcass weight II	Dressing percentage I	Dressing percentage II
Group	N	Mean ± SD	N	Mean ± SD	Mean ± SD	Mean ± SD	N	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
19	45	2754 ± 276.0	24	581.3 ± 67.59	304.2 ± 42.62	497.1 ± 57.60	45	1587 ± 176.1	1624 ± 178.0	59.8 ± 1.60	59.0 ± 1.61
59	12	2936 ± 235.4	12	621.7 ± 54.41	315.0 ± 24.31	527.5 ± 41.81	12	1709 ± 116.1	1751 ± 120.4	60.5 ± 1.91	59.7 ± 1.93
F_1	190	2771 ± 301.0	155	580.0 ± 76.76	305.7 ± 37.32	499.4 ± 56.41	179	1589 ± 175.0	1639 ± 180.8	60.3 ± 1.83	59.2 ± 1.82
F_{11}	80	2667 ± 307.6	71	555.9 ± 70.98	295.4 ± 52.26	474.6 ± 56.77	80	1540 ± 191.2	1588 ± 206.1	60.6 ± 1.78	59.5 ± 1.80
F_2	92	2706 ± 254.1	62	549.8 ± 71.55	299.7 ± 42.35	480.3 ± 51.28	92	1574 ± 174.9	1619 ± 177.6	60.9 ± 2.27	59.8 ± 2.28

SD – standard deviation

Table 2. Analysis of variance – statistical significance

	Body weight	Fore part	Shoulder	Hind legs	Carcass weight I	Carcass weight II	Dressing percentage I	Dressing percentage II
Model	**	**	**	**	**	**	**	**
Group	**	*	ns	*	*	*	**	**
Breeder	**	**	**	**	**	**	**	**

ns – non-significant, * $P < 0.05$, ** $P < 0.01$

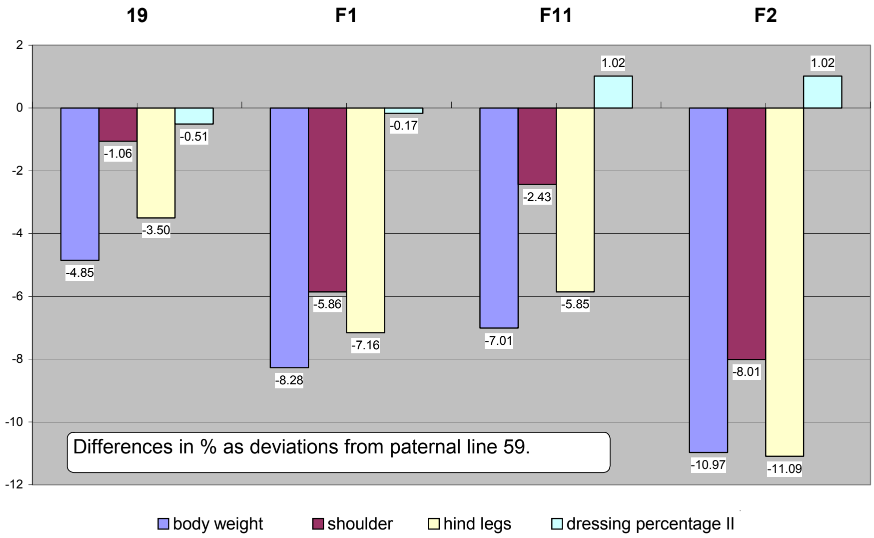

Fig. 1. Differences among line 59 and other groups for chosen traits

moderately but significantly influenced by additive effects but not by heterosis. N o f a l et al. (1997) estimated heterosis for carcass traits and their results varied between negligible negative or positive values. They mentioned low benefit of crossbreeding on carcass traits in rabbits.

Recombination loss occurred significant and high, mostly negative except for dressing percentage. These findings suggest that the crossing did not increased the quantity of carcass in rabbits but in the same time did not deteriorate the dressing percentage. Our findings are in agreement with N o f a l et al. (2004) that recommend crossing of rabbits for improving dressing percentage and total edible parts.

CONCLUSION

We can conclude that crossing of analysed lines of broiler rabbits is connected above all with negative estimates of heterosis and recombination loss but do not deteriorate the dressing percentage. In consequence of crossbreeding, the decrease of body weight and weight of carcass can be expected in crossbred groups.

Acknowledgements

We are grateful to J. Wolf for the program package CBE and for valuable discussions and to Barbora Hofmanová for her technical assistance.

Table 3. Least squares means of rabbits groups for analysed traits – standard errors in parenthesis

	Body weight	Fore part	Shoulder	Hind legs	Carcass weight I	Carcass weight II	Dressing percentage I	Dressing percentage II
Group	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
19	2863 (48.66)	588.4 (16.54)	317.6 (9.22)	515.9 (12.09)	1646 (29.85)	1685 (30.86)	59.6 (0.32)	58.8 (0.32)
59	3009 (89.59)	608.7 (24.28)	321.0 (13.54)	534.6 (17.75)	1739 (54.95)	1777 (56.82)	59.9 (0.58)	59.1 (0.58)
F_1	2760 (21.42)	579.6 (6.04)	302.2 (3.37)	496.3 (4.42)	1578 (13.30)	1628 (13.76)	60.1 (0.14)	59.0 (0.14)
F_{11}	2798 (40.29)	587.1 (11.02)	313.2 (6.14)	503.3 (8.05)	1619 (24.71)	1673 (25.55)	60.8 (0.26)	59.7 (0.26)
F_2	2679 (33.69)	546.2 (10.34)	295.3 (5.77)	475.3 (7.56)	1556 (20.77)	1600 (21.48)	60.8 (0.22)	59.7 (0.22)

Table 4. Estimates of crossbreeding effects for analysed traits (± standard deviation of the estimate)

Trait	Additive effects		Heterosis		Recombination loss	
Body weight	143.6 ± 82.89	ns	–174.7 ± 50.60	**	–338.8 ± 86.96	**
Shoulder	13.5 ± 13.53	ns	–20.5 ± 8.32	**	–30.9 ± 14.54	*
Hind legs	24.7 ± 17.74	ns	–31.0 ± 10.90	**	–70.9 ± 19.07	**
Fore part	35.8 ± 24.27	ns	–24.0 ± 14.91	ns	–85.6 ± 26.08	**
Dressing percentage I	0.66 ± 0.538	ns	0.23 ± 0.329	ns	1.64 ± 0.567	**
Dressing percentage II	0.68 ± 0.539	ns	–0.10 ± 0.330	ns	1.40 ± 0.567	**
Carcass weight I	93.0 ± 50.85	ns	–114.2 ± 31.12	**	–159.9 ± 53.54	**
Carcass weight II	103.65 ± 52.59	*	–107.2 ± 32.18	**	–160.8 ± 55.37	**

ns – non-significant, * $P < 0.05$, ** $P < 0.01$

REFERENCES

AFIFI, E. A. – KHALIL, M. H. – KHADR, A. F. – YOUSSEF, Y. M. K.: Heterosis, maternal and direct effects for postweaning growth traits and carcass performance in rabbit crosses. J. Anim. Breed. Genet., *111*, 1994: 138–147.

BIANOSPINO, E. – WECHSLER, F. S. – MOURA, A. S. A. M. T. – FERNANDES, S.: Growth traits and dressing percentage of straightbred and crossbred rabbits. In: 8th World Rabbit Congr., Puebla Mexico, 2004.

BRUN, J. M. – OUHAYOUN, J.: Growth performance and carcass traits in three strains of rabbits and their two-way crosses. Ann. Zootech., *38*, 1989: 171–179.

DĚDKOVÁ, L. – MACH, K. – MAJZLÍK, I. Growth and feed conversion in broiler rabbits. Scientia Agric. Bohem., *30*, 1999: 315–323.

DĚDKOVÁ, L. – MACH, K. – MAJZLÍK, I. – MOHSEN, A.: Analysis of growth and feed conversion in broiler rabbits by factorial crossing, Czech J. Anim. Sci., *47*, 2002: 133–140.

DICKERSON, G. E.: Experimental approaches in utilizing breed resources. Anim. Breed. Abstr., *37*, 1969: 191–202.

DICKERSON, G. E.: Inbreeding and heterosis in animals. In: Proc. of Animal Breeding and Genetics Symposium in Honor of Dr. Jay L. Lush. American Soc. Anim. Sci., 1973, pp. 54–77.

KROGMEIER, D. – DZAPO, V.: Leistung Merkmale von Kaninchen der Rassen Weisse Neuseeländer, Helle Großsilber und deren reziproker Kreuzungen 2. Mitteilung: Heterosissteigerungen in Mastleistungs-, Schlachtkörperqualitäts- und Fleischbeschaffenheitsmerkmalen. Arch. Geflügelk., *55*, 1991: 162–169.

MACH, K.: Některé genetické a chovatelské aspekty masné užitkovosti králíků (Some genetic and breeding aspects of meat performance of rabbits). [Thesis for habilitation.] Prague, Czech Agriculture University 1992. 72 pp.

MACH, K. – MAJZLÍK, I.: Uplatnění dialelního křížení při testaci masných plemen králíků (Application of dialel crossing in testing of meat breeds of rabbits). In: Proc. of XVIth Days of Genetic of Livestock, Nitra, SR, 6–8 September 1993, pp. 219–223.

MACH, K. – MAJZLÍK, I. – ŘÍČAŘ, L.: Testace výkrmnosti a jatečné hodnoty finálních hybridů brojlerového králíka. In: Sbor. přednášek IV. celostátního semináře Nové směry v chovu brojlerových králíků, ČZU, Praha, 19. 11. 1997a, pp. 46–49.

MACH, K. – MAJZLÍK, I. – KODEŠ, A. – RAIFOVÁ, I.: Rast, spotreba krmiva a jatočná hodnota brojlerových králikov (Growth, feed consumption and carcass value of rabbit broilers). In: Zbor. referátov z konferencie s medzinárodnou účasťou poriadanej pri príležitosti 50. výročia založenia VÚŽV v Nitre, 8.–9. 10. 1997b, pp. 172–174.

METZGER, S. – ODERMAT, M. – SZËNDRO, Z. – MOHAUPT, M. – ROMVÁRI, R. – MAKAI, A. – BIRÓ-NÉMETH, E. – RADNAI, I. – SIPOS, L.: Comparison of carcass traits and meat quality of HYPLUS hybrid, purebred Pannon white rabbits and their crossbreds. In: 8th World Rabbit Congr., Puebla Mexico, 2004.

NOFAL, R. – TOTH. S. – VIRAG. G.: Evaluation of seven genetic groups of rabbits for carcass traits. Arch. Anim. Breed., *40*, 1997: 61–67.

NOFAL, R. – SZËNDRO, Z. – KENESSEY, A. – JENSEN, J. E.: Crossbreeding effects on carcass traits at 12 weeks of age in Pannon and Danish white rabbits and their reciprocal crosses. In: 8th World Rabbit Congr., Puebla Mexico, 2004.

REDEL, H: Erprobung der Anwendung von kontinuierlichen Reproductionsverfahren in der Mastkaninchenhaltung. Lehr- und Versuchsanstalt für Tierzucht und Tierhaltung Rulhdorf, *7*, 1996: 162–165.

SAS: SAS-STAT. User's Guide, 6.03 ed. SAS Institute, Inc., Carry, NC, 1988. 1028 pp.

WOLF J.: CBE – a general program for estimating crossbreeding parameters. In: 46th Annual Meeting of EAAP, 4–7 September, Prague, 1995.

WOLF, J. – DISTL, O.– HYÁNEK, J.– GROßHANS, T.– SEELAND, G.: Crossbreeding in farm animals. V. Analysis of crossbreeding plans with secondary crossbred generations. J. Anim. Breed. Genet., *112*, 1995: 81–94.

Received for publication on October 24, 2007
Accepted for publication on January 14, 2008

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Efekty hybridizace jatečné hodnoty brojlerových králíků.

Scientia Agric. Bohem., *39*, 2008: 45–48.

U brojlerových králíků HY PLUS – otcovské linie 59, mateřské linie 19 a kříženců F_1 (59 x 19), F_2, F_{11} (59 x F_1), byla vyhodnocena jatečná užitkovost. Pro odhad efektů křížení byla využita metoda vážených nejmenších čtverců. Pro odhad aditivního efektu, heteroze a rekombinační ztráty byl použit model podle Dickersona (1969, 1973). Byly vyhodnoceny znaky: hmotnost před porážkou, předek, bedra, stehna, jatečné tělo I a II, jatečná výtěžnost I a II. Na konci výkrmu byla nejtěžší otcovská linie, nejlehčí kříženci F_{11} nebo F_2. Jatečná výtěžnost I a II byly nejnižší u mateřské linie. Kladné odhady aditivního efektu ve prospěch linie 59 byly nalezeny pro všechny znaky, většinou nevýznamné, vyjma jatečného těla II (103,7g). Heteroze byla záporná, významná pro hmotnost těla (–174,7 g), bedra (–20,5 g), stehna (–31,0 g), jatečné tělo I (93,0 g) a jatečné tělo II (–107,2 g). Rekombinační ztráta se projevila jako významná a vysoká, většinou záporná, kromě jatečné výtěžnosti I (1,64 %) a jatečné výtěžnosti II (1,40 %).

králík; jatečná hodnota; křížení; mateřská linie; otcovská linie

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