World Rabbit Science

World Rabbit Sci. 2013, 21: 251-256
doi:10.4995/wrs.2013.1320

A STUDY OF GROWTH AND SOME BLOOD PARAMETERS IN CZECH RABBITS

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Abstract: The aims of this study were to describe selected performance characteristics of Czech local breeds and to compare these breeds with a commercial hybrid. Seven original Czech breeds were included in the study: the giant breed Moravian Blue (MB), the medium breeds Czech White (CW), Czech Spotted (CS), Czech Solver (CSo), Moravian White of Brown Eye (MW) and the small breeds Czech Black Guard Hair (CB) and Czech Gold (CG) and the Hyplus rabbits. Growth of the rabbits was significantly (P=0.001) affected by genotype; MB and CW breeds grew non-significantly faster than Hyplus. The highest daily weight gain was observed in MB (42.6 g/d) and the lowest was in CB (23.9 g/d). Digestibility of ether extract was significantly (P=0.001) affected by genotype, with the lowest value for MB (0.823). Slaughter characteristics mostly correlated with live weight; the highest dressing-out percentage was in the small breed CG (62.0%) and the lowest in the Hyplus rabbit (57.0%). Of the biochemical traits evaluated, only cholesterol concentration was significantly (P=0.041) affected by genotype, with the highest values observed in Hyplus rabbits (4.2 mmol/L).

Key Words: rabbit, genetic resources, population size, growth performance.

INTRODUCTION

Most of the production in Europe utilises specialised genotypes, and pure breeds play only a minor role in meat production (Bolet *et al.*, 2000). In the Czech Republic, approximately 43 t of rabbit meat is produced annually; however, approximately 70% of consumed rabbit meat is from fancy breeders. Bolet *et al.* (2000) stated that in Europe more than 150 national breeds have been registered from 11 countries. These breeds present a wide range of characteristics and constitute a unique reserve of genetic variability. The diversity of their adult size, growth, conformation, coat colour, fur type is well known, but little is known about their potential diversity in zootechnical performance or genetic polymorphism. Khalil (1993) suggested that performance, origin and domestic use of recognised breed populations should be registered. However, evaluations of local rabbit breed characteristics in the scientific literature are limited. Genetic resources are characterised by high variability, as local breeds or population, suitable for extensive conditions (Fortun-Lamothe *et al.*, 2009). Genetic variation between lines can be used for further research (Hernández *et al.*, 2006).

In the Czech Republic, seven national rabbit breeds were registered in the Rabbit Genetic Resources Programme in 1997. These breeds vary in body size, growth, colour and reproduction; however, all known data used for general description are from fancy breeders and there is a lack of information on the breeds in defined conditions. Comparison of local breeds with a commercial strain may show benefits of some breeds. Paci *et al.* (2012) stated that local breeds showed good slaughter traits and meat quality compared to commercial hybrids. Carcass traits are affected by the genetic type and by the relative growth of different body parts, organs and tissue types (Szendrő *et al.*, 2010; Ouyed *et al.*, 2011).

The aim of this study was to review the available data on Czech rabbit genetic resources, describe population size and compare selected performance characteristics of these breeds with those of a commercial hybrid.

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http://dx.doi.org/10.4995/wrs.2013.1320

MATERIAL AND METHODS

The study of the populations of Czech national rabbit breeds was conducted based on the Central Herd Book of Rabbits, which has been registered by the Czech Association of Breeders since 2000. Male population has been recorded since 2003. The rabbit breeds included in the study were the giant breed Moravian Blue (MB), the medium breeds Czech White (CW), Czech Spotted (CS), Czech Solver (CSo), Moravian White of brown eye (MW) and the small breeds Czech Black Guard Hair (CB) and Czech Gold (CG) and the Hyplus rabbits (PS 19×PS 39). MB, one of the oldest Czech breeds, is a slow grower with late slaughter maturation which has good fertility. CW was selected for higher growth intensity and carcass composition. In addition, it has good fertility and fur quality. CS is also one of the oldest breed with spotted fur and typically presents low weight gain but good fertility and resistance. CSo is characterised as a late matured breed with average fertility and good growth. MW was bred for a specific coat colour with brown eye. The breed is characterised by good fertility and growth. CB is a small breed with good meat quality and growth. CG was selected for fur and fertility. Other breed characteristics are in the study Tůmová *et al.* (2011).

Population size was evaluated according to an FAO methodology based on number of females and males (Scherf, 2000). The author considers 3 classes of endangerment: for females not at risk ($N>1000$, where N is the number of breeding females), endangered ($100<N<1000$) and critically endangered ($N\leq100$), for males not at risk ($N>20$, where N is the number of breeding males), endangered ($5<N<20$) and critically endangered ($N\leq5$).

Rabbit husbandry and experimental design

Rabbit performance, nutrient digestibility, carcass composition and biochemical parameters were based on results of a nutrient balance experiment with 80 rabbits. The experiment was carried out from weaning (42 d) to 90 d of age. At the beginning of the experiment, the rabbits were split into 8 groups of 10 according to the 7 breeds and the Hyplus rabbits. Rabbits were individually housed in digestibility cages (50×40×42.5 cm). A 12-h photoperiod was used. Water and feed were available *ad libitum*. Rabbits were fed a pelleted commercial type diet which contained 18.6% crude protein, 16.3% crude fibre and 3.7% ether extract. The rabbits were weighed every 7 d, and the feed intake was measured every day. Nutrient digestibility was determined as a coefficient of total tract apparent digestibility using the method of Pérez *et al.* (1995). The collection period was from 56 to 63 d of age. During the collection period, the total faeces excretion was collected daily in plastic bags and stored at –18°C until analysis.

At the end of the experiment, 6 rabbits of average weight per group were slaughtered in an experimental slaughterhouse. They were fasted overnight and slaughtered the following morning by electric stunning and bleeding by jugular cut. The slaughter measurement method was harmonised by Blasco and Ouhayoun (1996). Slaughtered rabbits were bled and the skin, genitals, bladder, gastrointestinal tract and distal portion of the legs were removed. Carcasses (including the head but without thoracic cage organs, liver, kidneys and perirenal fat) were weighed to obtain the hot carcass weight for dressing-out percentage calculations. Dressing-out percentage (%) was calculated by dividing the hot carcass by the live weight at 90 d of age. Then, the carcass was cut to determine hind part, loin, hind leg meat and perirenal fat percentage from the carcass, evaluated according to Hernández *et al.* (2006).

Chemical analyses

Dry matter was determined by drying samples of feed and faeces at 105°C to a constant weight. AOAC International (2005) procedures were used to determine the crude protein (954.01), starch (920.40) and ash (942.05) contents. Ether extract was determined according to procedure 920.39 of AOAC (1995). The neutral detergent fibre (NDF) content was determined as described by Mertens (2002), and the analyses of acid detergent fibre (ADF) and lignin (ADL) were conducted according to procedure 973.18 of AOAC International (2000). Crude fibre was measured as described by Van Soest and Wine (1967).

Biochemical parameters were evaluated in rabbits at the age of 90 d. Blood was sampled from the jugular vein during slaughter. The blood serum obtained by blood centrifugation (1000 *g* for 10 min) was stored at –70°C for further analysis. Serum biochemical parameters, including total protein (TP), glucose, cholesterol and triacylglycerides (TAG) were determined photometrically in a Libra S 22 spectrophotometer (Biochrom Ltd., UK) by using standard commercial kits (Randox Laboratories Ltd., Crumlin, UK).

Statistical analyses

Data were processed by one-way analysis of variance, ANOVA method, using GLM procedure (SAS Institute Inc, Cary, NC, 2003). The individual rabbit was used as the experimental unit. The significance of differences between groups was tested by the Duncan test. A *P*-value $P<0.05$ was considered significant for all measurements.

RESULTS AND DISCUSSION

The population sizes evaluated following the FAO classification (Table 1) show that according to female number the CSo, MW and CB breeds are critically endangered. The same results were obtained when we estimated population size by effective population size (Tůmová *et al.*, 2011). A comparison of these 2 methods of population size estimation shows that both give similar results and it is possible to use only one of them for a population evaluation. Kerdiles and Rochambeau (2002) evaluated the effective population size (N_e) in 2 French breeds and stated that very low N_e is associated with increased inbreeding. However, the population size of critically endangered Czech breeds shows that the number of females is stable in these breeds and even slightly increased in CB. In the critically endangered breeds, one way to reduce inbreeding can be to introduce some animals from another conditions or country and afterwards try to increase the population. However, in male population size only CB is endangered and other breeds are not at risk. Results of the population size show that only the CB breed is critically endangered in male and female populations. In other breeds, male population is not at risk and therefore female population is the driving factor for endangerment classification of evaluated breeds.

Rabbit growth (Table 2) was highly significantly (P=0.001) affected by breed and generally coincided with body size. The giant breed MB significantly and medium breed CW non-significantly grew faster than the control hybrid Hyplus, while the small breeds (MW, CB) had significantly lower growth, consistent with the results of Bolet *et al.* (2000), who compared 10 breeds registered in the European Rabbit Genetic Resources. Those authors reported that the giant breed Flemish Giant and medium breed Argenté de Champagne grew faster than the broiler rabbit strain C77. Trends in the growth of the breeds in this study were similar to those in our previous experiment (Tůmová *et al.*, 2011). In agreement with Szendrő *et al.* (2010), live weight at 90 d of age and daily weight gain of rabbits in this study corresponded with adult body weight. In general, breeds with higher growth had significantly higher feed intake ($P<0.001$), but feed conversion ratio (FCR) was not significantly affected by breed. Similarly, Bianospino *et al.* (2006) described higher feed consumption in faster growing cross breeds compared to straightbreds, but no differences in FCR between genetic groups, in their study of Botucatu rabbits.

Dry matter and crude protein digestibility (Table 3) were not significantly affected by breed; however, ether extract digestibility was significantly influenced by genotype (P=0.001). The lowest digestibility of ether extract was observed

Table 1: Development of rabbit doe and buck population size and FAO risk classification.

	Breed													
	MB		CW		CS		CSo		MW		CB		CG	
Year	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
2000	164		104		426		53		36		9		1	
2001	186		121		433		38		34		6		4	
2002	189		133		459		30		37		5		30	
2003	180	63	143	55	402	133	46	23	54	16	17	4	76	30
2004	182	61	135	54	332	119	46	23	89	19	19	4	73	30
2005	183	75	136	59	308	116	62	28	88	31	26	11	99	53
2006	161	75	154	59	289	116	65	28	93	31	45	11	106	53
2007	165	73	160	67	318	115	67	44	88	39	56	16	128	53
2008	164	57	138	54	314	131	67	45	75	31	46	28	158	114
2009	145	55	145	54	298	94	65	33	87	43	53	5	163	28
2010	141	55	136	54	296	94	61	33	82	43	52	5	131	28
2011	106	47	97	43	251	82	43	22	68	44	59	9	106	35
FAO class	E	N	E	N	E	N	C	N	C	N	C	C	E	N

MB: Moravian Blue; CW: Czech White; CS: Czech Spotted; CSo: Czech Solver; MW: Moravian White of Brown Eye; CB: Czech Black Guard Hair; CG: Czech Gold. E: endangered; C: critical; N: not at risk.

Table 2: Growth performance (42-90 d of age) of rabbits.

Breed	Live weight at 90 d of age (g)	Daily weight gain (g)	Daily feed intake (g)	FCR (kg)
MB	3248[a]	42.6[a]	166[a]	3.68
CW	2769[ab]	39.6[ab]	132[ab]	3.34
CS	2188[b]	30.7[bc]	123[ab]	4.01
CSo	2015[b]	29.8[bc]	107[b]	3.58
MW	2188[b]	25.9[c]	103[b]	3.98
CB	1960[b]	23.9[c]	98[b]	4.26
CG	1938[b]	26.6[bc]	102[b]	3.83
Hyplus	2575[ab]	34.0[b]	138[ab]	4.16
SEM	49	1.2	4	0.01
P-value	0.001	0.001	0.001	*P*>0.05

MB: Moravian Blue; CW: Czech White; CS: Czech Spotted; CSo: Czech Solver; MW: Moravian White of Brown Eye; CB: Czech Black Guard Hair; CG: Czech Gold. SEM: Standard error of the means. FCR: feed conversion ratio. ns: no significant.

[a,b,c] Means with the same superscript within columns do not differ significantly *P*<0.05.

in Hyplus rabbits. Similarly, a significant effect of genotype (*P*=0.035) was recorded in crude fibre digestibility. The highest was in CW and the lowest in MB. Presumably, the high nutrient digestibility in CW resulted in the lowest feed conversion. The effect of genotype on nutrient digestibility was not evaluated by Tůmová *et al.* (1996); rather, that study was a comparison of different hybrids which are selected for growth, whose digestibility of nutrients was not influenced by genotype. However, Wolf *et al.* (2010) report higher nutrient digestibility in dwarfs and New Zealand rabbits compared to German Giants. Differences in nutrient digestibility may indicate variable requirements for nutrient content.

The carcass measurements (Table 4), which were presumably dependent on slaughter weight, were significantly affected by the genotypes of the rabbits. Dale Zotte (2002) stated that carcass traits are influenced mainly by the adult weight and maturity at slaughter. Hot carcass weight was highly significantly (*P*=0.001) affected by genotype. The highest hot carcass weight was in MB (1755 g) and did not differ from CW (1555 g). There were no significant differences between CW and Hyplus (1297 g). The significantly lowest hot carcass weight was in CB (1055 g). These results corresponded with Szendrő *et al.* (2010) in that larger carcasses were in larger rabbits. The dressing-out percentage results revealed significant effect of genotype (*P*<0.002). The lowest values were detected in Hyplus rabbits. The highest dressing-out percentage was measured in the small breed CG. Our data agree with those of Bolet *et al.* (2000) or Paci *et al.* (2012), who also reported higher dressing-out percentages in some pure breeds compared to control hybrids. Rabbits of large sized breeds are later in maturity at slaughter and have poorer dressing-out percentages than those of smaller breeds (Pla *et al.*, 1996; Hernández *et al.*, 2006; Metzger *et al.*, 2006). The significant effect of genotype was also detected in hind part percentage (*P*=0.002) and loin percentage (*P*=0.025); the highest values were observed in the small sized CG. Similar relationship between body weight and mid part ration was described by Metzger *et al.* (2004, 2006). Likewise, Paci *et al.* (2012) found higher a mid part in the local breed than in the commercial hybrid. Authors stated that greater development of hind leg and loin in a local breed depends on the reaching of commercial live weight at an older age and a higher degree of maturity due to slow growth of the local population. Results of carcass composition in this study might

Table 3: Coefficients of total tract apparent digestibility (CTTAD) of the diet for rabbits from days 56 to 63 of age.

Breed	Dry matter	Crude protein	Ether extract	Crude fibre
MB	0.586	0.733	0.823[c]	0.199[c]
CW	0.649	0.777	0.921[a]	0.346[a]
CS	0.603	0.729	0.901[a]	0.237[bc]
CSo	0.584	0.741	0.897[ab]	0.258[bc]
MW	0.609	0.722	0.901[a]	0.274[ab]
CB	0.583	0.678	0.890[ab]	0.238[bc]
CG	0.573	0.692	0.911[a]	0.216[bc]
Hyplus	0.609	0.730	0.882[b]	0.307[ab]
SEM	0.440	0.454	0.242	0.361
P-value	*P*>0.05	*P*>0.05	0.001	0.035

MB: Moravian Blue; CW: Czech White; CS: Czech Spotted; CSo: Czech Solver; MW: Moravian White of Brown Eye; CB: Czech Black Guard Hair; CG: Czech Gold. SEM: Standard error of the means. ns: no significant.

[a,b,c] Means with the same superscript within columns do not differ significantly *P*<0.05.

Table 4: Carcass characteristics.

Breed	Carcass weight (g)	Dressing-out percentage (%)	Hind part (%)	Loin (%)	Thigh meat (%)	Perirenal fat (%)
MB	1755^{a}	59.5^{ab}	50.6^{c}	19.2^{b}	24.5^{b}	1.86^{bc}
CW	1555^{ab}	60.2^{ab}	52.0^{ab}	18.6^{b}	25.8^{a}	1.47^{bc}
CS	1192^{c}	60.6^{ab}	49.7^{d}	20.9^{ab}	23.3^{c}	2.98^{a}
CSo	1107^{c}	60.2^{ab}	50.6^{c}	18.4^{b}	25.7^{ab}	1.95^{bc}
MW	1228^{c}	61.3^{a}	51.0^{bc}	20.1^{ab}	25.0^{ab}	1.89^{bc}
CB	1055^{c}	58.1^{bc}	50.2^{cd}	19.6^{ab}	24.9^{ab}	1.24^{c}
CG	1090^{c}	62.0^{a}	52.7^{a}	22.1^{a}	24.8^{ab}	2.69^{a}
Hyplus	1297^{bc}	57.0^{c}	52.1^{ab}	20.1^{ab}	24.6^{ab}	1.72^{bc}
SEM	198	0.4	0.2	0.3	0.2	0.15
P-value	0.001	0.002	0.002	0.025	0.009	0.039

MB: Moravian Blue; CW: Czech White; CS: Czech Spotted; CSo: Czech Solver; MW: Moravian White of Brown Eye; CB: Czech Black Guard Hair; CG: Czech Gold; SEM: Standard error of the means.

[a,b,c] Means with the same superscript within columns do not differ significantly $P<0.05$.

also have been affected by slaughtering at the same age and differences between genotypes were thus determined by the point of growth curve at which the rabbits were slaughtered (Tyler *et al.*, 1985). There were significant (P=0.039) differences in fat content among breeds. The lowest perirenal fat percentage was in CB. Fat tissue is late developing and Pla *et al.* (1996) reported that differences between large and small sized breeds are caused by different slaughter weights, but may be partially due to true genetic differences between breeds. We can assume that the effect of live weight on fat percentage was in CS and CG, which had significantly lower slaughter weight and the highest levels of fat percentage, but the low fat percentage and low live weight of the CB breed might have been affected by origin. Lower fat percentage of Hyplus rabbits correlated with suggestions by Szendrő *et al.* (2010) that the crossbreed rabbits have less of a predisposition to be fat.

Biochemical parameters (Table 5), TP, glucose and TAG were not affected by genotype and are consistent with Cazabon *et al.* (2000) and our previous results with the same breeds (Martinec *et al.*, 2012). However, Abdel-Azeem *et al.* (2010) found a highly significant effect of genotype on TP and TAG concentration and describe highly significant correlations between TP final body weight, total weight gain and dressing percentage. In our results, only cholesterol concentration was affected by genotype (P=0.041). Serum cholesterol concentrations more correlated with body size, which confirm our previous results using the same breeds (Martinec *et al.*, 2012) where a significant correlation (r=0.39) between live weight and serum cholesterol concentration was observed.

CONCLUSIONS

Results of this study show increasing population within evaluated period of CG. However, preliminary results describing the growth, feed consumption, nutrient digestibility and carcass traits of CW suggest that this breed has good performance and may be used for alternative or organic rabbit meat production. On the other hand, the need remains for further studies of all production characteristics in Czech rabbit breeds.

Table 5: Selected biochemical characteristics of rabbits at 90 d of age.

Breed	Total protein (g/L)	Glucose (mmol/L)	Cholesterol (mmol/L)	Triacylglycerides (mmol/L)
MB	73.9	5.3	3.2^{a}	0.9
CW	69.6	3.9	2.4^{ab}	1.3
CS	68.7	5.1	1.8^{b}	0.9
CSo	66.4	4.8	2.0^{b}	1.2
MW	65.7	5.2	1.8^{b}	0.8
CB	65.3	5.0	1.9^{b}	1.1
CG	62.4	4.3	1.5^{b}	1.1
Hyplus	61.5	5.4	4.2^{a}	1.1
SEM	9.5	3.7	1.5	0.4
P-value	$P>0.05$	$P>0.05$	0.041	$P>0.05$

MB: Moravian Blue; CW: Czech White; CS: Czech Spotted; CSo: Czech Solver; MW: Moravian White of Brown Eye; CB: Czech Black Guard Hair; CG: Czech Gold; SEM: Standard error of the means. ns: no significant.

[a,b] Means with the same superscript within columns do not differ significantly $P<0.05$.

Acknowledgments: The study was supported by the Ministry of Agriculture of the Czech Republic (Project NAAR No. QI101A164).

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