ANALYSIS OF CZECH RABBIT GENETIC RESOURCES*

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The aim of the study was to describe an effective population size, fertility and growth characteristics of Czech rabbit breeds included in the Program of Rabbit Genetic Resources. In the study, seven Czech original breeds were included, giant breed Moravian Blue (MB), medium breeds Czech White (CW), Czech Spotted (CS), Czech Solver (CSo), Moravian White of Brown Eye (MW) and small breeds Czech Black Guard Hair (CB) and Czech Gold (CG). The effective population size of MB, CW, CS ad CG shows that breeds are not at risk and even though that CSo, MW and CB are endangered, their population grows. The significantly biggest litter size ($P \leq 0.001$) was in CW (6.83) and CS (6.74). CW had the significantly highest litter size ($P \leq 0.001$) at weaning (6.46) but CS one of the lowest (5.19). The result was connected with the highest mortality ($P \leq 0.001$) till weaning (21.18%) in this breed. Growth of rabbits was highly significantly ($P \leq 0.001$) affected by genotype during the whole experiment and the highest live weight at 91 days was in MB (2948 g) and the lowest in CB (1891 g).

rabbit; breed; effective population size; fertility; growth

INTRODUCTION

Biodiversity is one of the most important factors of sustainable agriculture. Farm animals which are used for meat production have been developed on a relatively narrow base and the genetic management of genetic resources has been receiving attention recently. There are several major concerns with regard to the genetic resources: genetic variation is the prerequisite for selection of desirable traits, highly differentiated strains are the basis to develop resource populations in quantitative trait loci mapping, detection and utilization for maker-assisted selection and old native breeds may be considered as living evidence of achievements of many generations of breeders (Weigend, Romanov, 2002). Farm Animal Genetic Resources are defined as animal species that are used, or may be used, for the production of food and agriculture. The Global Databank for Farm Animal Genetic Resources contained records for 16 mammalian and 14 avian species including 6379 breeds (Weigend, Romanov, 2002). Rabbit genetic resources in the Global Databank consist of 232 rabbit breeds. In rabbit genetic resources, 71.6% of breeds are no records of population and 20.3% are critically endangered (Duchev et al., 2006).

The rabbit (*Oryctolagus cuniculus*) originates from Spain. Up to Antiquity and even Middle Age, it was bred only in Spain and south of France, and we can consider that its domestication began only at the 18th century (Arnold, 1994). The most important step of creation of breeds occurred during the first half of the 20th century. In Europe, more than 60 breeds were registered by the national associations of rabbit breeders (Bolet et al., 1996). The European association of rabbit breeders and the FAO (Food and Agricultural Organization) created a databank more than 150 national breeds from 11 countries. The databank registered historical, morphological, demographic and basic zootechnical information. A European program RESGEN CT 95-060 coordinated by INRA (Institut national de la recherche agronomique, France), aimed at a more comprehensive description of these breeds and at evaluating ten of them at levels of both genetic diversity and zootechnical characteristics. Results revealed a large diversity with respect to growth, carcass and meat quality traits and original features for some breeds, with potential economic interest (Bolet et al., 2000). In the Czech Republic, national rabbit breeds were registered in the Program of Rabbit Genetic Resources in 1997. However, there is a lack of information about the breeds. The first data for the breeds are oriented mainly on population size development (Martinec et al., 2007; Zita et al., 2010).

The aim of the study is to receive the first data of Czech Rabbit Genetic Resources and to describe an effective population size, fertility and growth characteristics of seven Czech rabbit breeds included in the Program of Rabbit Genetic Resources.

MATERIAL AND METHODS

The study of population and reproduction of the Czech national rabbit breeds was analysed on the base of the Central Herd Book of rabbits which has been

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Table 1. Breed characteristics in breeding standards

Parameter	Breed						
	MB	CW	CS	CSo	MW	CB	CG
Invented	1890	1930	1900	1959	1984	1975	1959
Colour of genotype	ABCdgh	a----	ABCDgKk	Abcdg	a^{chi}bCDg	a^{chi}bCDG	$AbCDGy_3$
Live weight of adult rabbits (kg)	5.5–6.5	4.0–5.0	3.3–4.0	3.5–4.25	3.3–4.0	2.5–3.25	2.5–3.25
Live weight at 30 days of age (kg)	0.7	0.6	0.5	0.5	0.5	0.4	0.4
Live weight at 60 days of age (kg)	1.5	1.2	0.9	1.1	1.0	0.8	0.9
Live weight at 90 days of age (kg)	2.5	2.0	1.5	1.8	1.4	1.2	1.3
Share of genetic resources on population size (%)	80	70	50	80	80	90	90

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

registered by Czech Association of Breeders since 2000. Rabbit breeds, which were included into the study, are in the different breed classification, giant breed Moravian Blue (MB), medium breeds Czech White (CW), Czech Spotted (CS), Czech Solver (CSo), Moravian White of brown eye (MW) and small breeds Czech Black Guard Hair (CB) and Czech Gold (CG). Breed characteristics are in Table 1.

Population size and effective population size

Data for survey of population size, the effective population size were evaluated for a year ranging from 2003 to 2008. In total, details of 6865 rabbit litters of seven rabbit breeds were included in the study of population size. The effective population size was evaluated on a number of rabbits in each breed according to the formula of Wright (1931):

$$N_c = 4(N_m \times N_f)/(N_m + N_f)$$

where:
N_m – number of males
N_f – number of females

Fertility

Fertility analysis was done on characteristics like number of litters, litter size, number of weaned kits and number of registered kits. In total, data of 6865 litters, 43580 born kits, 37494 weaned kits in years 2003 to 2008 were estimated.

Growth characteristics

A feeding experiment with seven rabbit breeds was carried out from weaning age at 42 days to 91 days of age. One hundred fifty four weaned rabbits were split into seven groups according to a breed (22 rabbits in a group). The rabbits were from fancy breeders and were placed into commercial cages for two rabbits with the floor space 0.09 m^2 per rabbit. There were identical conditions for rabbits, a temperature 16°C and relative humidity 55% were kept for the whole fattening period. A twelve-hour photoperiod was used. Water and feed were available ad libitum. Rabbits were fed on pelleted commercial type diets (18.6% crude protein, 16.5% crude fibre, 3.69% crude fat). In the experiment, rabbits were weighed individually in a week interval. Data of growth were processed by one-way ANOVA using GLM procedure. The significance of differences among groups was tested by the Scheffe test on the level of significance $P \leq 0.05$.

Scheme of the experiment

Group	Number of rabbits	Body size	Breed
1	22	giant	Moravian Blue
2	22	medium	Czech White
3	22	medium	Czech Spotted
4	22	medium	Czech Solver
5	22	medium	Moravian White of Brown Eye
6	22	small	Czech Black Guard Hair
7	22	small	Czech Gold

RESULTS AND DISCUSSION

Results of the study show the first information about situation in rabbit breeds which are in the Program of Czech Animal Genetic Resources. In addition, there is the first comparison of growth of these rabbit breeds in identical conditions. Data of Table 2 give information about rabbit population and number of breeders of each breed. In the analysed period, the highest population size was in MB and MS. In both breeds population size decreased about 100 rabbits in the evaluated period. In CS breed, it was connected with declining of breeders number for 10 breeders. In MB number of breeders is stabilized on a range of 25–27 breeders. Similar situation was in CW, where population size and a number of breeders reduced, however the number of breeders is relatively stabilized

Table 2. Population size and number of breeders

Year		Breed						
		MB	CW	CS	CSo	MW	CB	CG
2003	population	1072	944	1071	242	263	98	411
	number of breeders	27	24	46	8	11	4	14
2004	population	1080	900	960	239	342	86	374
	number of breeders	28	23	45	8	13	6	13
2005	population	1074	792	844	340	338	154	455
	number of breeders	26	21	38	13	12	8	19
2006	population	986	915	927	338	383	243	453
	number of breeders	25	22	38	11	16	11	22
2007	population	856	908	961	352	376	288	656
	number of breeders	25	21	36	12	13	14	22
2008	population	917	786	919	308	340	205	671
	number of breeders	27	20	36	13	15	13	30

Legend see Table 1

Table 3. Effective population size

Year		Breed						
		MB	CW	CS	CSo	MW	CB	CG
2003		244	185	465	77	67	25	108
2004		224	181	415	78	89	29	127
2005		230	189	372	94	92	35	149
2006		223	207	377	109	127	66	155
2007		233	206	398	102	107	76	186
2008		236	169	412	117	109	68	205
2003–2008	mean	231.7	186.2	406.5	96.2	98.5	49.8	155
	index (%)	92.6	91.4	88.6	151.9	162.7	272.0	189.8
Classification of EAAP		not at risk	not at risk	not at risk	endangered	endangered	endangered	not at risk

Legend see Table 1

on the range from 20 to 24 breeders. On the other hand, population size and the number of breeders are the highest in these breeds in the group of evaluated breeds. In other breeds, increasing of population size and the number of breeders was found out. It is possible to assume that growth of population of these breeds is due to a support of the Program of Rabbit Genetic Resources, which subsidize mainly keeping of these breeds.

In results of population size, effective population size (Table 3) is more important parameter because it has a direct relationship with the rate of inbreeding, fitness and the amount of genetic variation. The highest N_c value was detected in CS and according to EAAP (European Association for Animal Production) categorization (Duchev et al., 2006), the breed is not at risk. Also breeds CW, MB and CG are not classified as a risk. However, CSo, MW and CB with lower N_c, are endangered. The smallest population size is CB. Even though that the effective population size index in this breed was 272, the population size is still endangered. The effective population size is not commonly described parameter in rabbits and livestock. Weigel (2001) stated that very low N_c in Holstein cattle 39 and 30 in Jersey cattle may cause reproduction problems. In rabbits, Kerdiles, Rochambeau (2002) reported N_c between 30 and 50 for strain 1077 and from 37 to 62 for strain 2066. Both strains are genotypes of broiler rabbits in French Program of Genetic Resources. The low number of N_c is associated with an increase of inbreeding and large deterioration of fitness (Kerdiles, Rochambeau, 2002). Nagy et al. (2010) reported for Pannon White rabbit in last 16 years that N_c varied from 37.19 to 91.08, depending on the method of estimation and the estimates stabilized after the year 2002. The N_c did not depend on the negative inbreeding trends. From our results, none of the evaluated breeds was critically endangered according to EAAP classification. The positive outcome was that in MW, CSo and CB effective population size index has increased during the Program of Rabbit Genetic Resources.

Fertility parameters (Table 4) show high significant effect of genotype on litter size and number of weaned kits. The significantly highest litter size ($P \leq 0.001$) was in mediate breeds CW (6.83) and CS (6.74) and the

Table 4. Fertility

Parameter	Breed							SEM	Significance
	MB	CW	CS	CSo	MW	CB	CG		
Number of litters	1421	1087	2400	396	566	237	756	–	–
Litter size	6.34^{b}	6.83^{a}	6.74^{a}	5.92^{c}	5.72^{c}	5.63^{cd}	5.37^{d}	0.02	0.001
Number of weaned	5.56^{b}	6.46^{a}	5.19^{cd}	5.37^{bc}	5.22^{cd}	5.38^{bc}	4.95^{d}	0.02	0.001
Mortality till weaning (%)	11.72^{b}	5.38^{bc}	21.18^{a}	8.32^{cd}	8.91^{bc}	4.78^{e}	7.91^{cd}	0.02	0.001

^{a,b,c,d} Statistically significant differences ($P \leq 0.05$) in rows are indicated by different superscripts. Legend see Table 1

Table 5. Growth of rabbits

Live weight (g)	Breed							SEM	Significance
	MB	CW	CS	CSo	MW	CB	CG		
42 days of age	1016^{a}	889^{ab}	750^{bc}	950^{a}	873^{ab}	705^{c}	751^{bc}	254.01	0.001
49 days of age	1215^{a}	1129^{a}	969^{b}	1244^{a}	1094^{ab}	777^{c}	963^{b}	253.58	0.001
56 days of age	1423^{a}	1363^{a}	1141^{b}	1484^{a}	1295^{ab}	874^{c}	1140^{b}	301.03	0.001
63 days of age	1732^{a}	1629^{a}	1389^{b}	1654^{a}	1403^{b}	1052^{c}	1295^{b}	341.65	0.001
70 days of age	2106^{a}	1946^{ab}	1630^{c}	1868^{b}	1622^{c}	1279^{d}	1488^{cd}	333.71	0.001
77 days of age	2444^{a}	2265^{ab}	1878^{c}	2129^{b}	1868^{c}	1554^{d}	1711^{cd}	323.87	0.001
84 days of age	2759^{a}	2562^{a}	2099^{c}	2330^{b}	2054^{cd}	1757^{e}	1880de	315.66	0.001
91 days of age	2948^{a}	2747^{b}	2240^{d}	2453^{c}	2210^{d}	1891^{e}	2004^{e}	296.34	0.001

^{a,b,c,d,e} Statistically significant differences ($P \leq 0.05$) in rows are indicated by different superscripts. Legend see Table 1

lowest in small breeds CG (5.37). These results are in agreement with findings of Lukefahr et al. (1983), Mach (1992) or Bolet et al. (2004), who revealed that albino breeds have higher fertility in comparison with other medium breeds. CW was in the past affected by some albino genotypes including broiler rabbits and presumably it is the result of the crossing. Roberts, Lukefahr (1992) or Bolet et al. (2004) describe that litter size of medium breeds is between 6 and 7.3 and our results are similar. Generally, fertility of small breeds is lower and litter size of CB 5.63 and CG 5.37 corresponds with Bolet et al. (2004) in small breeds like Himalayan 5.51 or Chinchilla 5.73. On the other hand, a number of weaned kits is not correlated with body size. The significantly highest number of weaned kits ($P \leq 0.001$) was in CW and the smallest in CG. Bolet et al. (2004) in a study of fertility of the European Rabbit Genetic Resources stated that higher number of weaned kits was in medium size breeds in comparison with giant or small breeds. The significantly highest mortality at time to weaning ($P \leq 0.001$) was recorded in CS and this result was connected with a genotype of CS where parents are heterozygots and kits with genotype KK died in the first several weeks of life. Gene K for English spot negatively affects coat pigmentation and health status of rabbits.

Growth of rabbits (Table 5) was highly significantly ($P \leq 0.001$) affected by genotype during the whole experiment. Kits were weaned at the age of 42 days and the significantly lowest live weight was in small breeds CB and CG. Differences in growth among breeds continued till the end of the experiment. The significantly highest final live weight was in the giant breed MB and this live weight was higher in comparison with growth standard for the breed (Table 1) and is comparable with broiler rabbits. Very similar results were recorded for a medium breed CW and also growth of this breed is similar to growth of broiler rabbits (Tůmová et al., 1996; Skřivanová et al., 2000). The significantly lowest live weight ($P \leq 0.001$) was in small breeds CB and CG. On the other hand, rabbits of these both breeds grew faster than in standards described in Table 1. Our results agree with data of Bolet et al. (2000) in 10 breeds of the European Rabbit Genetic Resources. In their result the giant breed Flemish Giant and medium breed Argenté de Champagne grew faster than broiler rabbit strain C77. Other medium breeds Belgian Here and Vienna White breeds exhibited the slowest growth rate. The small sized breeds Chinchilla, Himalayan and English had a 25–35% slower growth rate than C77.

CONCLUSION

Results of the study show the first data of Czech Rabbit Genetic Resources and it is clear that due to the support of the Program of Animal Genetic Resources in endangered breeds, population size increased, which is important for maintenance of original rabbit breeds in the Czech Republic. The preliminary data of fertility and growth revealed that Mb and CW are breeds which may be a source of traits suitable for meat

production. On the other hand, there is the need for further studies of all production characteristics Czech Rabbit Genetic Resources.

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Analýza českých genetických zdrojů králíků

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Cílem práce bylo zhodnocení efektivní populace, plodnosti a růstu českých plemen králíků zařazených do Programu genetických zdrojů. Ve studii bylo posuzováno sedm původních českých plemen, velké plemeno Moravský modrý (MB), střední plemena Český albín (CW), Český strakáč (CS), Český luštič (CSo), Moravský bílý hnědooký (MW) a malá plemena Český černopesíkatý (CB) a Český červený (CG). Z hodnot efektivní populace je zřejmé, že plemena MB, CW, CS a CG nejsou ohrožena. Přestože plemena CSo, MW a CB jsou řazena do ohrožených plemen, jejich populace roste. Signifikantně nejvyšší počet narozených králíčat ($P \leq 0.001$) byl zjištěn u CW (6,83) a CS (6,74). Plemeno CW mělo průkazně nejvyšší ($P \leq 0.001$) počet odstavených králíčat (6,46). Na druhou stranu u CS byl počet odstavených králíčat jeden z nejnižších, což bylo způsobeno nejvyšší ($P \leq 0.001$) mortalitou do odstavu, 21,18 %. Vyšší mortalita králíčat do odstavu u tohoto genotypu je dána genetickým založením, protože králíčata s homozygotním založením KK pro anglickou strakatost mají nižší životnost. Také růst králíčat byl vysoce signifikantně ovlivněn genotypem. Nejvyšší živou hmotnost ($P \leq 0.001$) v 91 dnech věku mělo plemeno MB (2948 g) a nejnižší CB 1891 g. První výsledky naznačují možnost využití plemen MB a CW pro masnou produkci.

králík; plemeno; efektivní populace; plodnost; růst

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