NATIONAL AGRICULTURAL AND FOOD CENTRE
RESEARCH INSTITUTE FOR ANIMAL PRODUCTION NITRA

The 4th International Scientific Conference "Animal Biotechnology"
Slovak J. Anim. Sci., 49, 2016 (4): 141–146

ISSN 1337-9984

THE RABBIT AS A MODEL AND FARM ANIMAL AT THE RESEARCH INSTITUTE FOR ANIMAL PRODUCTION NITRA: A REVIEW

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ABSTRACT

Use of the rabbit as a model and farm animals builds on the rich farming tradition in Slovakia. It is associated with the name of Jaroslav Zelnik, who put down the foundations for zootechnical and biological research of the rabbit at the early seventies of the 20th century. He built and managed the Department of Experimental Biology and Genetics, which had its own experimental farm for rabbit breeding. In the beginning of the existence of this department, the research program was focused mostly on the use of the rabbit as productive animals. The performance parameters of individual breeds were evaluated, the effects of inbreeding and hybridization on production abilities of rabbits were investigated and first rabbit broiler populations were created. Later, research activities were expanded to include physiological, immunological and behavioral experiments. At the turn of the eighties and nineties, genomic approaches and methods of biotechnology, especially in the area of reproduction, viability and genetic manipulations began to be used. In recent time, farming rooms have been reconstructed to meet the actual requirements of animal welfare. Concomitantly, the department has got a new laboratory equipment allowing experiments performed in a larger range of biological goals.

Key words: rabbit; breeding; model organism; biotechnological methods

INTRODUCTION

The institualization of research in rabbit breeding follows the years-long breeding tradition in Slovakia. The founder of this field of zootechnical and biological research was Jaroslav Zelník, who towards the end of the 70s established a specialized department for experimental rabbit husbandry within the Research Institute for Animal Production (RIAP) Nitra. At the beginning, this department focused on the zootechnical aspects of broiler rabbit production; later the experiments in the spheres of genetic, physiological, behavioral, immunological, morphological, and genomic biological research were conducted. The use of biotechnological and genomic techniques allowed the development of new methods, which expanded the existing knowledge on gene structure, function and expression. Nowadays this knowledge is extensively implemented in the development of rabbit husbandry.

Chronological development of rabbit research at the RIAP

Rabbit, a zoological species (*Oryctolagus cuniculus*), is an unexampled animal in consequence of several applications and uses similar importance and various economic values that depend on countries or economic interests. From this point of view there are five main directions of rabbit exploitation: 1) rabbit as livestock species kept mainly for meat, fur, skin and wool production; 2) rabbit as a hobby animal with broad possibilities for breeding process and competition in rabbit shows (exhibitions); 3) rabbit as mammalian

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Received: September 21, 2016
Accepted: September 29, 2016

model used in many biological branches; 4) rabbit as an effective biotechnological tool used to produce many recombinant proteins and other biological active substances (antibodies, antigens, hormones, coagulation factors etc.); 5) rabbit as a wild resource and model for processes in population level mainly in their natural and new settled regions. In recent years increasing interest has been addressed to this species to understand the biological factors affecting traits that are important in their numerous applied fields.

There is a years-long and voluminous tradition of rabbit husbandry in Slovakia established already in the mid-19th century. At the turn of the 19th century, numerous breeder societies are founded, which brought significant social and economic contributions to the husbandry of the existing breeds and creation of new ones.

In Slovakia, rabbit husbandry was applied to the research programs at the end of the 1960s at the Department of Genetics and Experimental Biology of the Research Institute for Animal Production (RIAP) Nitra. This department, composed of a breeding hall with capacity of 400 full-metal cages, laboratory facilities equipped for biochemical and physiological analysis of the biological samples and administrative offices, was implemented in 1972.

The initiator of the rabbit research at the RIAP Nitra and in Slovakia as a whole, was Jaroslav Zelník (1925–1986), who was focused primarily on the use of rabbit as a meat production animal. He developed a system for evaluation of growth performance, yield at slaughter, reproduction performance of rabbits and elaborated the methods for meat production breeding. In a series of publications, he evaluated the meat production of the existing rabbit breeds (Zelník, 1970; Zelník *et al*., 1971; 1977; 1978; 1984; 1985) and he studied the influence of inbreeding (Zelník, 1970; 1974; 1975) and hybridization (Zelník *et al*., 1977a; 1978a) on production markers. The result of these activities was the development of rabbit meat lines used directly for production or as a part of the newly-established hybridization projects (Zelník, 1976; Zelník *et al*., 1983).

Long-term cooperation between J. Zelník and small-scale breeders resulted in the creation of a national breed – "Nitra rabbit". This breed has been introduced into The Book of Rabbit Breed Standards within Slovak Breeders Association in 1977. The creation of this breed has been preceded by five-year intense work on the development of inbred lines using Himalayan rabbit and Argente Champagne rabbit breeds. The complete methods, as well as the basic morphometric and production characteristics of Nitra rabbit were disseminated in a series of publications (Granát and Zelník, 1972; Zelník *et al*., 1977b; 1983; 1985). In this period, breeding efforts were focused to another rabbit population, which was accepted twenty years later as a national breed under the name "Zobor rabbit" (Parkányi and Rafay, 1990). From the genetic point of view, Zobor rabbit is an example of an intergenic interaction of the recessive epistasis type. Homozygous alleles determining acromelanism, which belong to the allelomorphic albino series, create together with the homozygous recessive allele constitution for the Dutch spottiness the phenotype coat color of incomplete albinism, expressed in the absence of pigment in mask and the occurrence of reduced coloring of limbs. Due to the influence of other alleles on the coloring, this phenotype is difficult to stabilize on genetic basis, which represents a challenge for many breeders.

At the end of the 70s, the broiler rabbit farm was established in Podhorany near Nitra. Their capacity was about 6,000 breeding does, and it was the largest broiler rabbit breeding farm in the former Czechoslovakia.

The results of the breeding efforts in the 70s and 80s were manifested in the early 90s, when the changing political and social situation caused an interest in broiler rabbit breeding as a sphere of agriculture with a great commercial potential. The previous theoretical research as well as the creation of synthetic population (Rafay *et al.*, 1984; Jakubec *et al*., 1986; Oravcová *et al*., 1988) resulted in the establishment of maternal (M91) and paternal (P91) line. Besides the use for experimental research, these populations were used in several newly-built broiler rabbit farms.

During the period of the mid-80s, an extensive study of the chromosomal polymorphism in the rabbit lymphocytes was published (Parkányi, 1983; 1986), which then confirmed the importance of variability at the cytogenetic level for the vitality of rabbits. Later the variability in chromosome number was used as a criterion for genomic analysis of other cell cultures (Parkányi *et al.*, 2004) and the variability of electrophoretic fractions of histones in the rabbit lymphocytes (Palyga *et al*., 1990). Rabbit was used as an animal model for certain monolocus and polygene-determined anomalies of anatomical, morphological, and physiological structures. Their hereditary types in rabbits and their characteristic phenotype (alopecia, buphthalmia, mandibular prognathism, luxation, cyclopism etc.) were described (Zelník, 1979; Parkányi and Rafay, 1982).

In the early 1970s, methods of genetic biochemical polymorphism evaluation were developed at the department. Based on the tendency of this era to use electrophoretic protein fractions as production markers, the reproductive, growth and carcass characteristics of various genotypes of rabbits were evaluated. Later the biochemical genetic polymorphism was used for the determination of the homozygosity of inbred lines. Likewise, studies focused on the evaluation of the activity of selected

enzymes in blood and the descriptions of their genetic determination as well as their role from the standpoint of utility parameters were realized. Research in the field of physiology is perhaps well-represented by the experiments focused on the evaluation of the mitochondrial metabolic activity manifested by oxygen consumption dependent on the genotype (Rafay *et al.*, 1990). Phenomenon of mitochondrial heterosis was described, which correlated with the heterosis phenomenon in the intensity of the live weight gain (Oravcová *et al*., 1992).

In the field of behavioural genetics, the rabbits were used to study genetic determination of behavioural characteristics related to mobility and escape reaction. Open field concept was used to estimate the factors determining behaviour of rabbits under predefined conditions (Rafay and Schumacher, 1995; Rafay *et al.*, 1998; Zelník *et al*., 1990) and evaluation of the biochemical profile of their blood under different stress conditions (Parkányi *et al*., 1985; Rafay and Parkányi, 1987; Parkányi and Rafay, 1989; Klusek *et al.*, 1995; Kolataj *et al*., 2002; Witek *et al*., 2004; Swiderka-Kolacz, 2006). Part of the results of these studies helped in the adjustment of rabbit stabling facilities from the welfare standpoint.

Due to its advantageous biological characteristics, rabbit was used at the department also as a model animal for experiments in the field of reproduction (Bavin and Rafay, 1990; Kish *et al*., 2001; Makarevich *et al.*, 1994; 1998; 2008; 2010; Švarcová *et al*., 2003; Parkányi *et al*., 2008). In these studies the results of research oriented on the optimization of the superovulation process, evaluation of spermatogenesis under different experimental conditions, defining of the conditions for early embryo culture, influencing the ovarian functions of females by changes to the breeding conditions, as well as sex detection through PCR-SRY on the X-chromatin were published. The processes of artificial insemination (Makarevich *et al*., 1998; 2008; Ondruška *et al*., 2008) were optimized and the knowledge on the processes of oogenesis, spermatogenesis and fertilization of rabbits were disseminated.

Nutrition and the gastrointestinal processes in rabbits attract systematic attention. In addition to studies evaluating various feedstuffs from the aspect of their contribution to increased yield (Chrastinová *et al*., 2000; 2002; 2003), a series of experiments evaluated the intake of probiotic microorganism from the standpoint of vitality and yield parameters of animals (Pogány-Simonová *et al.*, 2009). Nowadays, attention is paid also to the effects of genetically modified feed components (Chrenková *et al*., 2013; Chrenková, 2014). The examination of the possible replacing of antibiotics with plant extracts with bactericide effects has begun in advance.

Application of biotechnological methods in animal models meant a qualitative shift in the research at the RIAP. Using the method of DNA microinjection into the pronucleus (Chrenek *et al*., 1998; 2005), first transgenic rabbits with a gene for human coagulation factor VIII were generated. These transgenic animals were subjected to detailed analyses of endocrine profile (Sirotkin *et al*., 2007), fertilizing capacity (Chrenek *et al*., 2005), digestibility of nutrients (Ondruška *et al*., 2010) and meat quality (Chrenek *et al*., 2009).

CONCLUSION

Current research programs are focused on the investigation of proper markers of vitality and production efficiency of rabbits. The future research is focused on the preservation of genetic resources of the national breed rabbits. Years-long and successful cooperation with breeders is a prerequisite for solving the task of the preservation of genetic resources of rabbits in the Slovak Republic.

Rabbit department of RIAP successfully cooperates with domestic as well as foreign scientific and educational institutions; the results are joint publications and exchange of study stays of researchers. Up to date, several dozens of PhD theses prepared by students of Slovak as well as foreign universities have been completed and successfully defended in the field of rabbit research. Nowadays, the experimental and breeding facilities have undergone a significant reconstruction and modernization, which meets stricter requirements for breeding and exploitation of rabbits as farm and experimental animals.

ACKNOWLEDGEMENTS

This study was supported by the project APVV-14-0043.

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