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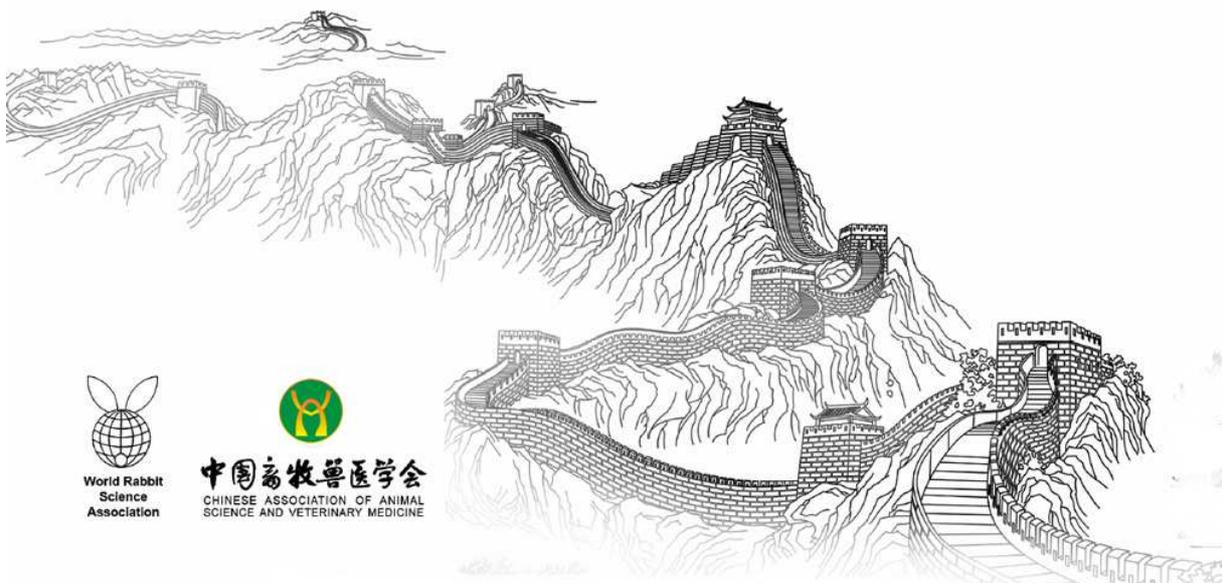
***Qian Q.X., Ma J.X., Zhang G.Z., Xie C.S., Ren L., Qian B.Q.***

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## BREEDING AND APPLICATION OF ZHEXI ANGORA RABBITS

Qian Q.X.<sup>1\*</sup>, Ma J.X.<sup>1</sup>, Zhang G.Z.<sup>2</sup>, Xie C.S.<sup>3</sup>, Ren L.<sup>4</sup>, Qian B.Q.<sup>1</sup>

<sup>1</sup>Zhejiang Baizhongwang Angora Corp., 312400, Shengzhou City, Shaoxing City, China

<sup>2</sup>Ningbo Jugao Rabbit Development Co., Ltd., 315202, Ningbo City, China

<sup>3</sup>Pingyang Quansheng Rabbit Co., Ltd., 325400, Wenzhou City, China

<sup>4</sup>Zhejiang Bureau of Animal Husbandry and Veterinary Medicine, 310000, Hangzhou City, China

\*Corresponding author: info@cn-rabbit.com

### ABSTRACT

In the mid-1980s, the introduced German Angora rabbits were intentionally used to cross with the domestic Chinese Angora Rabbit for breeding new type of Chinese Angora rabbit in Shaoxing, Ningbo, and Wenzhou cities of Zhejiang Province. After more than two decades of genetic selection, three new varieties were established, which are the Shengzhou Angora rabbits, Zhenhai Angora rabbits, and Pingyang Angora rabbits. In March 2010, the three new varieties were officially acknowledged by the Chinese Domestic Animal Genetic Resources Committee and named Zhexi Angora rabbits. The Zhexi Angora rabbit was characterized by large body size, high wool yield and quality, good adaptability, and stable performance. At present, three million Zhexi Angora rabbits have been widely distributed among more than 20 provinces (cities, and autonomous regions), which have made great contributions to the development of Chinese Angora rabbit industry.

**Key words:** Zhexi Angora rabbits, rabbit breed, selection, breeding

### INTRODUCTION

Angora is the excellent material for woolen textile, which is well known as the white, clean, soft, warm, light, and strongly hygroscopic characteristics (Rougeot *et al.*, 1984). China started its Angora rabbit breeding program in the 1950s and exported Angora for the first time in 1954; its Angora rabbit breeding program began to really take shape in the 1960s. By the 1980s, the number of Angora rabbits in China occupied 90% of the world's total population and 95% of the world's Angora output (Ma, 2011; Zhao *et al.*, 2012). In the 1980s, the annual average wool yield of main Chinese Angora rabbit was only 370 g per rabbit (Chinese Domestic Animal Genetic Resources Committee, 2012; Wei, 2011). However, the long-term lack of high wool-yielding rabbit breed has severely restricted the development of Angora industry in China. During the 1970s and 1980s, China started to introduce German Angora rabbits and found that these rabbits showed lower adaptability and resistance than Chinese Angora rabbits (Kong *et al.*, 1986; Gao *et al.*, 1983; Li, 1986). Therefore, these rabbits were cross-bred with other Angora rabbits for genetic improvement. Subsequently, the Chinese researchers found that German Angora rabbits and their hybrid progeny had higher individual and annual wool yields than Chinese Angora rabbits; whereas some hybrid progeny had lower wool yields than German Angora rabbits and some hybrids had similar wool yields to German Angora rabbits (Kong *et al.*, 1986; Gao *et al.*, 1983; Li, 1986; Ye *et al.*, 1982). Based on these findings, Zhejiang has carried out the breeding of a new high wool yield breed: Zhexi Angora rabbits, which were accredited by the Chinese Domestic Animal Genetic Resources Committee in March 2010.

During the breeding process, the National Rabbit Breeding Committee organized nearly 20 domestic well-known rabbit breeding experts to measure production traits of 1,000 Zhenhai giant Angora rabbits (800 females and 200 males) with a hair growth period of 73 days (Zhenhai line of Zhexi Angora rabbits) in Zhenhai District of Ningbo City from October to December 2000. The results showed that the average wool yield for the male rabbit was 343g, the estimated annual average wool yield was 1,715g, and the average body weight was 5,111g. The results for the female rabbits were 388g, 1,940g, and 5,197g, respectively.

## MATERIALS AND METHODS

### Breeding process

The basic breeding population was selected and established from local Angora rabbits and German Angora rabbits. The local rabbits were Chinese Angora rabbits, which had the bloodline of Japanese white big-ear rabbits. In 1984, Zhejiang Livestock Products Import and Export Co., Ltd. introduced 200 German Angora rabbits from Germany (50 males and 150 females) and conducted the pure breeding in the Huaxing Rabbit Plant of Zhejiang Baizhongwang Angora Corp. which was formerly known as Shengzhou City Animal By-Product Co., Ltd. In the mid and late 1980s, rabbit plants in Zhejiang such as Shengzhou, Xinchang, Zhenhai, and Pingyang carried out hybrid and back-crossing of German Angora rabbits with the local Angora rabbits. After genetic selection, a hybrid population with high wool yield, giant body size, and high-quality Angora was generated.

In the early 1990s, Zhejiang Baizhongwang Angora Corp., Ningbo Zhenhai Rabbit Plant, and Pingyang Quansheng Rabbit Co., Ltd. selected 2,340 (390 males and 1950 females) from the hybrid population combining German Angora rabbits and local Angora rabbits according to their breeding goals and set up three breeding populations for generation breeding. The line selection and breeding focused on wool yield, adult weight, and percentage of loosened angora and referred to breeding performance indicators such as litter size and weaning weight, and characteristics such as fiber length, average wool yield rate and percentage of coarse angora. Average wool yield rate is calculated as the ratio between annual wool yield (g) to body weight (g). The early selection focused on growth and density of fleece, and the final choice was based on wool yield performance and breeding results. While strict elimination (more than 50% elimination rate for female rabbits and more than 70% for male rabbits) was performed, excellent individuals from the production group were allowed to be included in the core breeding group. After the genetic selection for four generations, Zhexi Angora rabbits, which included the Shengzhou, Zhenhai, and Pingyang lines, had been successfully established according to the initial breeding goals in relation to the body, appearance, and main production performance, and had genetic stability (Ma *et al.*, 2011).

## RESULTS AND DISCUSSION

### Body characteristics and appearance

Zhexi Angora rabbits had long and giant bodies with wide shoulders, long backs, deep chests, round and large hips, strong limbs, obvious wattle in the neck, moderate head size with a mouse or lion shape, and red eyes. Their ears were fully or half covered by fur or with a handful of fur. The hair of the entire body was white, glossy, thick, and dense, with obvious staple structure. The hair behind neck, on the abdomen, and on the feet was especially dense.

### Body weight and size

The average weights for adult male and female Zhexi Angora rabbits were 5.28 kg (4.9 ~ 5.4 kg) and 5.4 kg (5.1 ~ 5.1 kg), respectively. The body lengths of male and female rabbits were 54.2 cm and 55.5 cm, respectively. The heart girths for male and female rabbits were 36.5 cm and 37.2 cm, respectively. The average weight of adult Zhexi Angora rabbits was greater than German Angora rabbits and French Angora rabbits (Chinese Domestic Animal Genetic Resources Committee, 2012; Rafat *et al.*, 2008).

### Angora yield performance

The estimated annual average wool yield of male and female Zhexi Angora rabbits aged 11 months with a hair growth period of 73 days is 1,957g and 2,178g, respectively (Table 1). According to the field investigation results of new breed in December 2009, the estimated annual average wool yield of 150 male and female Zhexi Angora rabbits aged 10 months with a hair growth period of 90 days was 1,864g and 1,832g, respectively.

The estimated annual average wool yield of male and female Zhexi Angora rabbits was much higher than that of German Angora rabbits and significantly higher than that of Chinese Angora rabbits

(Chinese Domestic Animal Genetic Resources Committee, 2012). The estimated annual average hair yield of German Angora rabbits and Chinese Angora rabbits was 60.8% ~ 64.16% and 12.8% ~ 16.1% of that of Zhexi Angora rabbits (Table 2). The average wool yield rate of Zhexi Angora rabbits was much higher than that of German Angora rabbits and Chinese Angora rabbits (80.1% ~ 83.2% and 24.5% ~ 29.5% of that of Zhexi Angora rabbits). The wool yield of Zhexi Angora rabbits was obviously higher than that of French Angora rabbits with a hair growth period of 14 weeks (Rafat *et al.*, 2008).

**Table 1.** The estimated annual wool yield of Zhexi Angora rabbits

Gender	Estimated annual wool yield (g)			Average wool yield rate (%)
	Average	Shengzhou line	Zhenhai line	
♂	1,957	2,102	1,963	37.1
♀	2,178	2,355	2,185	39.9

**Table 2.** Wool yield performance comparison between Zhexi Angora rabbits and other Angora rabbits

Breed	Gender	No.	Estimated annual wool yield		Adult weight (g)		Wool yield rate (%)	
			Value	Compared with Zhexi Angora rabbits (%)	Value	Compared with Zhexi Angora rabbits (%)	Value	Compared with Zhexi Angora rabbits (%)
Zhexi Angora rabbits	♂	420	1,957	100	5,282	100	37.1	100
	♀	2,100	2,178	100	5,459	100	39.9	100
German Angora rabbits	♂	50	1,190	60.8	4,012	76.0	29.7	80.1
	♀	150	1,406	64.6	4,235	77.6	33.2	83.2
Chinese Angora rabbits	♂	390	250	12.8	2,750	52.1	9.1	24.5
	♀	1,950	350	16.1	2,950	54.0	11.9	29.5

**Notes:** the data for the production performance of German Angora rabbits are the data from 1984 when they were introduced.

The percentage of angora coarse performance for male and female Zhexi Angora rabbits was as follows: 4.3% and 5.0% for Shengzhou line, 7.3% and 8.1% for Zhenhai line, and 24.8% and 26.3% for Pingyang line, respectively.

The percentage of loose wool for male and female Zhexi Angora rabbits aged 11 months was 98.7% and 99.2%, respectively. The hair length, diameter, tensile strength and stretching extend for male and female rabbits were 4.6 cm and 4.8 cm, 13.1  $\mu$ m and 13.9  $\mu$ m, 4.2cN and 4.3 cN, and 42.2% and 42.2%, respectively. Their down hair length was close to or slightly lower than that of German Angora rabbits and French Angora rabbits, which may have been attributed to the shorter growth hair period than that of German Angora rabbits and French Angora rabbits, and hair diameter was almost the same as that of German Angora rabbits and French Angora rabbits (Chinese Domestic Animal Genetic Resources Committee, 2012; Rafat *et al.*, 2008).

### Reproductive performance

The average litter size of Zhexi Angora rabbits was  $6.8 \pm 1.7$ , with the average litter weight of those aged 3 weeks reaching  $2,511 \pm 165$  g and those aged 6 weeks reaching  $1,579 \pm 78$  g. The average litter size of Zhexi Angora rabbits was almost the same as that of German Angora rabbits and French Angora rabbits (Animal Genetic Resources in China Other Animals, 2012).

### Application of Zhexi Angora rabbits and their influence on development of the Chinese Angora rabbit industry

Before and after the 1980s, the introduced German Angora rabbits were mainly crossed with Chinese Angora rabbits for improvement. The hybrids were much better than the local Angora rabbits in terms of production performance and, thus, have replaced German Angora rabbits and the local Angora rabbits. The performance competition of Angora rabbit hair is held every one- to three-years at various sites in the Zhejiang Province, which have largely promoted the mass selection and breeding of Zhexi Angora

rabbits and improved the production of Angora rabbits. It is also helpful to rapidly increase the Angora rabbit population size. The breeding of Zhexi Angora rabbits would reduce the long-term dependence on excellent foreign breeds and greatly increase the production of rabbits for commercial use. These Angora rabbits have been widely distributed to other provinces, providing breeding breeds for those in Xiping of Henan Province, Yingjing of Sichuan Province, Shizhu of Chongqing Municipality, and some new breeds in Shandong Province.

On this basis, the Angora rabbit breeding enterprises in Zhejiang Province have established the basic breeding population by selecting ideal individuals from the high-yield hybrid rabbits and carrying out effective selection of Zhexi Angora rabbits. Moreover, Zhexi Angora rabbit is also the first new breed of Chinese Angora rabbit with independent intellectual property rights and world-leading wool yield performance. More than three million Zhexi Angora rabbits have been distributed to over 20 provinces and cities in China, propelling the sustainable development of the Chinese Angora rabbit industry.

## CONCLUSIONS

Zhexi Angora rabbits have been established by the effective selection in China with excellent performances, including the giant body, high wool yield and quality, great adaptability, and genetic stability. Zhexi Angora rabbit is the first new breed of Chinese Angora rabbit and are competitive with similar Chinese and international Angora rabbits. Its world-leading performance is able to meet Chinese production demands, reduce dependence on foreign Angora rabbits, increase, and stabilize the production of Chinese Angora rabbits. Zhexi Angora rabbits are expected to make great contributions to the Chinese and worldwide Angora rabbit industry

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