Development of a new yak breed through utilization of wild yak genetic resource – serial technologies for the development of the Datong yak breed

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Summary
On the Datong Yak Breeding Farm of Qinghai Province (Datong farm), the scientists of the Lanzhou Institute of Animal Science and Veterinary Pharmaceutics of Chinese Academy of Agricultural Sciences, in collaboration with others, explored the possibility to cross wild yak bulls with domestic yak cows in the past 20 years and a new yak breed, the Datong yak, has been developed.
Keywords: Datong yak, wild yak, crossbreeding, heterosis

Background

Activities of crossing wild yak bulls with domestic yak cows, for the purpose of developing a new yak breed, namely the Datong yak, date back to 1950s. At that time, senior researchers (Lu B.Q. and Xu K.Z.) who worked in Northwest Institute of Animal and Veterinary Sciences (the predecessor of the Lanzhou Institute of Animal Sciences which was recently changed to the Lanzhou Institute of Animal Science and Veterinary Pharmaceutics) led a group of scientific workers to carry out experiments on the Datong farm to study biological characters, crossbreeding and management of the wild yak. And they explored the possibility of utilizing the wild yak to improve the domestic yak, which established the fundamental work for the development of the Datong yak.

Since the sixth five-year plan (1981-1985), taking consideration of developing the minority economy in western China to strengthen national unity, the Ministry of Agriculture started to pay more attention to research and development on yak as one of the special projects at ministerial level. With support from the Ministry, the Lanzhou Institute of Animal Sciences proposed a research project to develop a new yak breed. Scientists then rebuilt the experimental herds on the Datong farm with knowledge in traditional crossbreeding of large domestic animals and existing scientific technology practiced in livestock production in that period. Later on, more basic research on biological characters of the wild and domestic yak and methodology for the development of the Datong yak were initiated and completed. Through more than twenty years' hard working, A.I. has been adopted at a large scale in the field, wild yak blood is introduced successfully into domestic yak population, and selection intensity and culling rate are strengthened on the Datong farm. As a result, a new yak breed, the Datong yak, has been developed (Wiener et al., 2003). Liveweight, meat performance, stress resistance and adaptability of the Datong yak are approximately 18-27% higher than that of the domestic yak managed under the same conditions. And body conformation, appearance and coat color of the Datong yak are very similar within the population. These characters can be maintained up to 3-4 generations.

During the last two decades, the Lanzhou Institute of Animal Sciences persisted in the research and development of the new yak breed on the Datong farm. A few of wild yak bulls were caught and tamed for collection of semen, which was processed into frozen semen for use through A.I. in crossing the wild yak with the domestic yak cows to produce crosses with a significant heterosis in large numbers on the Datong farm and also in other yak production areas (Lu Zhonglin and Li Kongliang, 1994; Zhao Bingyao and Zhang Jianwen, 1994). A nuclear herd for closed-breeding was subsequently setup through selection of superiors at a high culling rate, which formed the fundamental herds of the new breed.

It has been strategically clear that research findings should be applied to yak production. Scientists of the institute and technical staff of the Datong farm took the comparative advantage of integrating scientific research findings with market economy during the process of experiments, demonstrations and extension. At the same time, they emphasized on the development of the new yak breed by not only altering the genetic structures but also improving the management and feeding conditions. This solved many problems in the process of selection, breeding, and continuous improvement of the performance of the new yak breed.

Comparative advantages of wild yak and development of the Datong yak

Domestic yak is a primitive animal species. During the process of its domestication, the impact of natural selection is believed to be greater than that of artificial selection. At present, 11 indigenous yak breeds are included in the *Catalogue of China Livestock and Poultry Genetic Resources*, they are indigenous populations evolved and developed under different ecological conditions and management systems, therefore making them not a typical breed in a strict sense. Utilization of genetic resources of wild relative animals to develop a new breed is an exploitive and creative work. This was the first time to artificially change gene frequency in a domestic yak population by using modern theory of animal breeding and A.I. technology to develop a new breed in the history of yak breeding. There were many different problems and challenges, not only on theoretical aspects but also in practice. Most of them have been solved with practical solutions, thus several 'first' cases of studies or applications have been accomplished as what are described in following examples:

- Wild yak bulls were firstly tamed to cross with domestic yak cows to improve and rejuvenate the genetic potential of the latter. Semen from the tamed and trained wild yak bulls were collected and processed into frozen semen in 1982 (Lu Zhonglin and Li Kongliang, 1994). Special diluents and thawing solutions applied to the frozen wild yak semen were also developed (QGSAHVM and Datong farm 1997).
- A.I. was adapted and widely used in yak breeding and notable achievements were made. Once 1080 domestic yak of nine herding groups kept in summer pastures were served by A.I. with the wild yak semen. From 1984 to 1989, the pregnancy rate of the A.I. served yak cows was about 82%.
- A project titled 'New technology for yak rejuvenation' was carried out since 1993 as part of the serial technologies to improve domestic yak performances by introducing the wild yak blood. The project was evaluated by the Ministry and approved to be applicable to larger yak production areas (Li Quan et al., 1997; Yang Rongzhen et al., 1997; Shoudong, 2002).
- The theory which accepts the crossbreeding at lower generations of crosses to develop a new breed was applied to yak breeding practice. The new yak breed was developed by crossing the F1 individuals and the positive impact of inbreeding was optimally explored. There was no obvious phenotypic segregation in F2 generation, liveweight, growth rate, body size, appearance and coat color were very similar to the F1 individuals (Wang Minqiang et al. 1998).
- Through systematic research of the mechanism of rejuvenation of the domestic yak by introducing the wild yak blood, the breeding value and potential of the wild yak are well recognized (Yan Ping et al., 1998). Because of the strong natural selection and long-term closed-breeding in their isolated natural habitats, genetics of the wild yak seems to be relatively pure. Their liveweight, body size, growth rate, survival ability and resistance are better than that of the domestic yak, therefore a significant heterosis is expected in the crossbreeds. Relevant studies successfully demonstrated that the wild yak have the following advantages compared to their domestic relatives:
  (1) Activity of the LDH in the wild yak is higher (Xu Yude et al., 1994).
  (2) Proportion of γ-globin to total globin in the wild yak is higher, possibly linked to their stronger stress

resistance (Xu Yude et al., 1997).

(3) Content of free amino acids in serum of the wild yak is four times that of the domestic yak, a positive indicator of their better absorption and conversion for nutrients (Xu Yude et al., 1997).

(4) In the wild yak, F1 and higher generations, the liver, lung, kidney and heart have a low level of respiratory metabolism and consume less oxygen, which make the wild yak easier to acclimate the environment lacking oxygen (Yan Ping et al., 1998).

(5) Wild yak has a better reproduction performance with larger volume of ejaculation, higher mobility, density, lifespan, proportion of acrosome integrity and activities of enzymes, but lower abnormality of the sperms (Pan Heping and Yan Ping 1997; Yan Ping et al., 1997).

(6) Skin and fur properties confirmed that the wild yak adapt well to cold environment (Yan Ping et al. 1994). Characteristics of skin and fur of the new yak breed at ages of three and 12 months old also maintained their good adaptability to cold environment (Yang Bohui et al., 1998).

(7) Bodyweight of the wild yak keeps increasing instead of decreasing in winter (Minqiang et al., 2002). Quantity, diameter, and bulk of red cells in the wild yak are larger than that in the domestic yak. Four blood protein and allozyme loci in the wild yak are monomorphic. All these provide proof for a purer genetics of the wild yak (Wei Yaping et al., 1997; Zhang Caijun et al., 1997).

(8) Milk performance of the Datong yak was evaluated (Bo Jialin et al. 1998c; Jialin et al. 1998a).

(9) Microsatellite DNA loci were used to study the genetic relationship of the Datong yak to the wild yak and the results verified their high genetic similarity (Wang Minqiang, 2000; Wang Minqiang et al., 2003).

(10) Distribution, classification and application of Chinese wild yak demonstrated the breeding value of the wild yak (Lu Zhonglin and Li Kongliang, 1994; Yan Ping et al., 1998).

- The breeding system for genetic rejuvenation of the domestic yak was established. This system takes the structure of a pyramid, which includes the wild yak breeding station, the nuclear herds (also called crossbreeding populations among F3 and F4 generations) and the multiple herds maintained on the Datong farm to provide breeding animals to other yak production areas for extension. The number of breeding animals of the new breed was up to 2200, of which there were 120 superior breeding bulls by 2003. Beef performance has been improved by more than 20% compared to the domestic yak (Bo Jialin et al. 1998a, b; Jialin et al., 1998b). The selection and breeding of the new yak breed continued for the last two decades and the F3 and F4 generations of crossbreeding were maintained for genetic fixation. 3000 breeding bulls and 130 thousand pellets of frozen semen have been introduced to other yak production areas.
- A comprehensive technique to produce high quality yak veal from six months old calves was established to cooperate with the intensive selection and high cull rate in the process of the new breed development. These include utilization of heterosis of wild × domestic yak and improvement of management and feeding conditions e.g. full suckling by the newborns and supplementary forage from the warm season pasture to ensure a rapid growth of the calves before the cold season. The culled male calves were slaughtered after weaning. This speeded up the breeding process. Production of the high quality yak veal also improved the economic return of the Datong farm. Meanwhile, weaning in time is helpful to the onset of estrus of the cows and eventually to the efficient improvement of the reproduction. Also the total number of yak population in winter is controlled, which reduced grazing pressure to the pasture.
- Semen of the wild yak has been introduced to other counties like Mongolia and India (Amarsanna et al., 2002).

Demand of the breeding bulls of the Datong yak

Because of the stable genetic characters of the Datong yak, that is, improved beef performance, resistance to adverse environments and adaptation to the high, cold or even extremely hibernal rangelands, the new breed is warmly welcomed by other yak production areas and plays a very important part in genetic improvement and rejuvenation of the domestic yak in those areas. At present, demand for breeding animals of the Datong yak is high, although the Datong farm can only produce 1000 breeding bulls every year. In 2002, the Livestock Department of the Qinghai Province assigned a mission to the Datong farm and requested the farm to provide 1000 head of breeding bulls every year for other pastoral areas in the province. A contract was signed by the Bayingolin Mongolian Autonomous Prefecture of Xinjiang Province and the Datong farm to provide the breeding bulls of the new breed to the prefecture for five years. The pastoral areas of Tibet, Gansu and Sichuan would also like to purchase hundreds of breeding bulls in the coming years.

Challenges in developing and improving the Datong yak

Accuracy of determined productive performances of the yak

The yak graze all the year round in the natural pastures. The climates of the pastoral areas vary from place to place a factor that influences the growth of grasses, nutrients availability to the yak and eventually the stability of yak performances. All the measurements of yak performances need to be determined continuously year after year in the process of breeding, however, it is relatively difficult to collect such data regularly. Generally, all the body measurements are not as accurate as expected because of the hardy and uncontrolled field conditions. Though the trait of liveweight is objective, the equipment used to weigh the yak is crude. For yak at one and half of a year old and onwards, a weighbridge is needed to weight them and the animals have to be fixed properly, therefore it is not an easy job. Genetic parameters of important economic traits in yak are still not available.

Maintenance of genetic diversity in the Datong yak

Generally, the yak has a relatively low productivity compared to other bovines. It is very difficult to select and breed a new population of the yak. To maintain and improve the quality of the Datong yak, different strains (e.g. beef-purpose and milk-purpose) will have to be developed within the breed to maximize the diversity of the new breed.

Changes in economy and policy

With rapid change and significant reform of economic systems in pastoral areas, herds of livestock have been contracted out to individual families. As a result, it is more and more difficult to control the herds for the purpose to sustain the breeding program of the yak. The economy of high and cold pastoral areas is still relatively poor, and the level of education of local herdsmen is comparatively low. The human resources in livestock production sectors are relatively limited. In conclusion, the software and hardware required implement a sound genetic improvement program in yak remain to be strengthened.

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