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REVIEW

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A review on studies in forage in China

Abstract A review is made of the achievements in the collection, conservation, and genetic diversity of forage germplasm resources; methods and goals for forage breeding; and development and utilization of forage in China. The current problems based on the researches in forage are analyzed, and some suggestions are put forward.

Keywords forage, germplasm resource, breeding, application in production, study progress

1 Introduction

Forage, or forage plants, which is a broad concept, refers to all plants that are cultivated or grow wild, herbaceous, shrubby or arboreal, and can be grazed by phytophagy livestock. Their vegetative organs (mainly referring to the stems or leaves) are often taken as food by grazing or cradling (Jiang, 1993). China is the second largest country of grassland in the world, approximately 400 million hectares, accounting for 41.7% of the country's total land territory and which is nearly four times as large as the total area of farmland (Xu et al., 2000). But grassland resources in China are far from being reasonably and efficiently utilized so far; compared with those of countries whose animal husbandry are advanced, the livestock productivity per unit grassland in China is only 1/80 as much as New Zealand's, 1/20 as much as America's and 1/10 as much as Australia's (Huan et al., 2005). Therefore, there is great potential in China's grassland. In this article, a review is made of the achievements in forage germplasm resources, forage breeding, forage production and utilization.

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2 Forage germplasm resources

Forage germplasm resources refer to all the forage species and the sum of their genetic materials (Xu et al., 2000). It includes not only the wild forage resources naturally distributed on grasslands, but also the cultivated forages and fodder crop resources (Shi et al., 2005). It is the indispensable hereditary base for screening, improving and making fine cultivars, and the important materials for biodiversity study including classification, evolution and origin (Zhang et al., 2003). The main direction of forage germplasm resources research is "extensive collection, proper preservation, deep study, aggressive innovation and full utilization" (Wang, 1983).

2.1 Collection and preservation of forage germplasm resources

China began to study forage germplasm in the 1960s. Detailed stationing and sampling were carried out in 15 key provinces and regions, such as temperate zone, subtropical zone, tropical zone, frigid zone, Qinghai-Tibet Plateau and so on; specimens representing the whole country were collected (Xu et al., 2002). The main types and distribution of forage germplasm resources of Chinese land have been made clear by now. Some elite types of forage are mainly distributed in major temperate grasslands, subalpine meadow areas of Qinghai-Tibet Plateau, subtropical and tropical grazing lands. There are mainly herbs in these places, but semi-shrub forage plants also account for certain proportions. There are many special forage species in China, mainly distributed in such areas as Yunnan-Guizhou Plateau, Qinghai-Tibet Plateau, Hengduan Mountains, Hainan Island and arid desert. Moreover, fine cultivated forage species of the wild and wild relatives are also widely distributed in China. These forages belong to 6 704 species, 1 545 genera, 246 families and 5 divisions (including 29 sub-species, 296 varieties and 13 forms) (Shi et al., 2005).

Fruitful results of forage germplasm collection and investigation in China have been achieved. In Inner Mongolia Autonomous Region, there are 899 species of vascular plant forages, including 194 species of Gramineae, 134 species of

Asteraceae, 83 species of Leguminosae, 58 species of Chenopodiaceae, 54 species of Cyperaceae and 35 species of cultivated forages (Li et al., 2004). Gramineous forages in Xinjiang Uygur Autonomous Region add up to 54 subspecies, 322 species and 71 genera, accounting for 26.8% and 37.3% in species and genera of gramineous plants, respectively (Feng et al., 2003). The valuable wild forages in Hubei province number 924 species, and nearly 500 of them can be grazed, and forages of Gramineae, Asteraceae, Cyperaceae, Labiatae, Scrophulariaceae, Leguminosae, Polygonaceae and so on are more important (Cai, 2004). In Hunan province, the natural grassland plants are attributed to 868 species and 137 families, which can be grazed and belong to 775 species and 137 families. Their proportions are as follows: gramineous forages 9.29%, asteraceous forages 9.17%, cyperaceous forages 5.16%, other 133 families of forages 59.35% (Zhang and Li, 2004). The natural forages in Gansu province are all involved in the 2 128 species, 706 genera and 154 families, which are from 242 species and 79 genera of Gramineae, 92 species and 28 genera of Leguminosae, 1 243 species and 369 genera of other families (Shi, 2003). Forage plants in Sichuan province are about 800 species, of which gramineous forages and leguminous forages add up to 400 species, about 200 species are highly nutritious for animals, with more than 300 cultivars introduced from abroad (Zhang et al., 2002). Some 2 020 forage germplasm resources samples have been conserved in Qinghai province. They are from 1 075 samples of Gramineae, 896 samples of Leguminosae, and 49 samples of other families (Wang, 2002). In the northwestern part of Yunnan province, the valuable forage germplasm resources of temperate forages are classified into 163 species and 15 genera. Forages worthy of thorough study are *Medicago sativa* Linn., *Medicago pubescens* (Edgew. ex Baker) Sirjaev, *Astragalus cicer* Linn., *Lotus corniculatus* Linn., *Dactylis glomerata* Linn. and *Elymus tangutorum* (Nevski) Handel-Mazzetti (Zhong and Kui, 2000). Natural germplasm resources available in Western Jilin province are attributed to 343 species, 127 genera and 29 families, belonging to 83 species and 45 genera of Gramineae, 41 species and 14 genera of Leguminosae, 36 species and 10 genera of Cyperaceae, 101 species and 35 genera of other families (Wang et al., 1996). In the forage surveyed areas of Western and Southern Yunnan province, Zhong Sheng et al. (1999) collected 187 samples of forage germplasm, 15 species of *Crotalaria* Linn., 14 species of *Desmodium* Desvaux, and 7 species of *Pueraria* de Candolle of Leguminosae, 7 species of *Pennisetum* Richard of Gramineae. In the survey of wild grass in Guizhou province, Tang Chengbin et al. (1997) collected 151 samples which are attributed to 87 species, 32 genera, and elite grasses are related to 67 species and 25 genera. In the survey of wild forage germplasm resources in Hainan province, Chen Dingru et al. (1981) gathered 175 species of forage plants, including 100 species of Gramineae and 28 species of Leguminosae. In Hainan province, fine forages are *Pennisetum purpureum* Schumacher, *Pennisetum polystachyon* (Linn.) Schultes, *Panicum maximum* Jacquin, *Leucaena leucocephala* (Lamarck) de Wit, *Centrosema pubescens* Bentham, etc. (Liu, 2000).

It can be seen that forage species are abundant in the Inner Mongolia and Xinjiang Uygur Autonomous Regions, and Jilin, Qinghai, Gansu, Sichuan, Hunan, Yunnan, Hainan provinces, etc. Most forage species are attributed to Gramineae, Leguminosae, Asteraceae and Cyperaceae, which are the main forage germplasm resources.

Meanwhile, China has established a number of institutions to collect and conserve the forage germplasm. From 1986 to 1992, the Ministry of Agriculture established a mid-term bank for forage germplasm resources at the Grassland Research Institute of the Chinese Academy of Agricultural Sciences, to conserve more than 3 500 copies of forage germplasm resources. The Livestock Forage Germplasm Preservation Center (LFGPC) was established in the National Animal Husbandry and Veterinary Station, and Chinese largest forage resource collection was founded based on the Grassland Research Institute of the Chinese Academy of Agricultural Sciences. Forage specimens collected by LFGPC counted 7 300, over 1 500 and more than 500 samples during the 7th, 8th and the 9th Chinese Five-Year Plan periods. Currently, the total specimens in LFGPC are more than 10 000. A number of natural reserves and national resource nurseries have been built, a remote conservation system of Forage Germplasm Resources Gene Banks and Resource Nurseries has also been founded, and part of the Forage Germplasm Resources are conserved in situ (Xu et al., 2000).

As to the aspect of collection and conservation of tropical forage Germplasm Resources, more than 1 400 tropical forage germplasm samples, which are from America, Africa, Colombian International Agricultural Tropical Center, Hawaii, Australia, etc., have been mainly introduced, collected and sorted out by the Tropical Forage Center of the Chinese Academy of Tropical Agriculture. Among these tropical forage Germplasm Resources, 557 fine forage germplasm samples are introduced from abroad, and over 200 samples have been submitted to National Germplasm Repository. On the basis of the full inspection of Chinese tropical crops, extensive local wild forage cultivars were gathered, and over 2 000 wild forage germplasm samples were collected. Books such as *China's Tropical Forage Plants, Hainan Flora* and so on (Liu, 2000; Liu and Luo, 1995) were also compiled. The Tropical and Subtropical Crops Research Institute of Yunnan's Academy of Agricultural Sciences introduced and collected 223 forage germplasm samples, and established the first cultivar resource conservation center and research base for forages in Hot Valley, Yunnan province (Huan et al., 2005).

2.2 Genetic diversity of germplasm resources

Genetic diversity refers to the hereditary variation of different populations or different individuals of the same species. Genetic diversity is directly reflected by the hereditary variation (Wang, 1983). Genetic diversity is a critical component of biodiversity and the basis of species and ecosystem diversity. There are rich genetic diversity, characteristics of wildness (China's Agricultural Genetic Resources Society, 1994), aggressiveness and resistance in wild forages, so they are usually used as valuable original materials for forage breeding and natural gene banks for new fine cultivated cultivars. Therefore, the collecting, analyzing and identifying of wild forage germplasm, and finding out the characteristics of population genetic structure, can enrich forage germplasm resources and lay a foundation for the development and utilization of forage germplasm resources (Wang, 1983).

From the following aspects such as morphological characteristic, cytological level, molecular level and so on, genetic diversity is studied. Anatomy research is the study of biological hereditary variation in accord with forage external characteristics and the differences in structure. It is direct, easy and convenient. By observing the nutrition structures (such as roots, stems and leaves) of 7 *Aneurolepidium chinense* (Trinius) Kitagawa populations under different soil conditions by optical microscope and SEM, the genetic differences among them were pointed out (Hu et al., 2001).

The study of cytological level is to make chromosome markers, including karyotype analysis, chromosome banding pattern analysis, variation of number and structure of chromosome analysis, genome analysis, etc. Some chromosome karyotype analysis has been reported about wild or cultivated forages, which are mainly attributable to Gramineae. After studying the chromosome karyotype of Yunnan's *Dactylis glomerata* Linn., Zhou Ziwei et al. (2000) pointed out that *Dactylis glomerata* Linn. is diploid ($2n = 14$) and has two types such as 2A and 2B. The work of karyotype analysis of *Psathyrostachys perennis* Keng cv. Shandan by Yang Qijian et al. (2001), indicates that the number of chromosomes of *Psathyrostachys perennis* is $2n = 14$, and karyotype formula is as the following: $2n = 2x = 12m + 2sm$ (2SAT).

Studies of molecular level are mainly carried out with the methods Isozyme Analysis, Storage Protein Electrophoresis, Restriction Fragment Length Polymorphism (RFLP), DNA Fingerprinting, Site-specific Analysis of Small Satellites and Simple Sequence Repeat (SSR), Random Amplified Polymorphic DNA (RAPD) and so on; they are all widely used in the research of biological genetic diversity. Allozyme Analysis is an effective genetic diversity detection technology in Isozyme Analysis and is generally applied in recent years. Genetic diversity of 6 natural populations and 2 cultivars of *Agropyron mongolicum* Keng from the central and eastern areas of Inner Mongolia Autonomous Region was analyzed by means of Allozyme Analysis Technology, and results indicated that there was much greater genetic diversity among them (Xie et al., 2001). After measuring the Hydrogen Peroxidase and Isoenzyme of 4 materials of *Trifolium repens* Linn. in different growing stages, Qi Guang et al. (2002) proved that they were of the same ancestry but still with variations.

Plant Seed Storage Protein is more and more widely used as genetic markers and applied to the study of plant Germplasm Resources, which has higher polymorphism compared with Isozyme. Li Ruifen et al. (2001) studied different cultivars of *Astragalus adsurgens* Pallas with Plant Seed Storage Protein Technology, and pointed out that local samples of *Astragalus adsurgens* Pallas were rich in genetic diversity. Li Yongjun (1998), Yu Linqing et al. (2001), and Wang Zhaolan et al. (2004) respectively studied Seed Storage Protein Polymorphism of different clover cultivars and illustrated that there was genetic diversity in different alfalfa seeds.

DNA markers can best grasp the vital and the most essential materials, for they are of accuracy and visibility, without insubjection to environmental constraints and limitation of the number of molecular makers. RFLP and RAPD have been applied for molecular markers, germplasm identifications and genetic diversities, they have become the most available and mature technologies. For instance, in 1992, Echt et al. (1992) applied RAPD for analyzing genetic Polymorphisms of DNA of alfalfa diploid, found out that 13 pairs of random primers among 19 pairs amplified 37 polymorphic fragments, 28 polymorphic fragments of which (76%) accorded with Mendelian Heredity Law. So it fully supports that RAPD could be better used for analysis and study of alfalfa's hereditary variation. Hu Baozhong et al. (2003), and Wei Zhenwu (2004) analyzed the genetic diversities of representative cultivars and genomes of the basic germplasm sources of alfalfa with RAPD markers. In the aspects of the genetic diversity study of other forages, after analyzing the genetic relationships among 8 cultivars and lines in Pennisetum with RAPD by Xie Xinming et al., (2005) results showed that there was much greater genetic diversity and certain genetic differentiation among the 8 cultivars (or strains). After analyzing the genome DNA of *Astragalus adsurgens* Pallas by RAPD, Li Ruifen et al. (2001) indicated that the proportion of DNA polymorphic loci, average gene diversity and total gene diversity of bred varieties of *Astragalus adsurgens* Pallas were lower than those of local materials and wild materials. Jiang Changshun et al. (2004) analyzed the genetic diversities of 4 strains of *Stylosanthes guianensis* (Aublet) Swartz with 18 microsatellite DNA, and confirmed that the genetic variability of resistant accessions was greater than that of the susceptible.

3 Forage breeding

Forage breeding is the foundation work for the development of the grass industry. China is one of the countries that have the richest forage germplasm resources in the world. With these rich germplasm resources, it is entirely possible to find all the necessary genes and make great achievements in grass industries. However, there are few fine breeding cultivars suitable for planting in China, thus 80% of forage seeds is relied on imports (Wang et al., 2002).

The modern sense of forage breeding began in the 1950s. For example, new alfalfa cultivars named Gongnong No.1

and Gongnong No.2 have been cultivated by the Institute of Jilin Academy of Agricultural Sciences (Su, 2001). From 1986 to 2005, 337 cultivars used as forages, fodder crops, green manure crops, plants specialized for soil and water conservation, and turf grasses, including 134 newly-bred cultivars, 41 local cultivars, 109 introduced cultivars from foreign countries, and 54 domesticated wild cultivars were checked, appraised and licensed by the Chinese Herbage Cultivar Registration Broad (CHCRB) (Su and Zhang, 2002; China Herbage Cultivar Registration Board, 2003; China Herbage Cultivar Registration Board, 2004; Notice the People's Republic of China Ministry of Agriculture, NO. 477. March 17th, 2005).

Hybridization is the main breeding process apart from introducing a fine wild variety and domestication, sorting local varieties, introducing superior breeds from abroad, and selective breeding. Meanwhile, radiation-induced breeding and polyploidy breeding are also widely used. Many alfalfa varieties, such as Caoyuan No.1, No.2, No.3, Gannong No.1, No.2, No.3, Xinmu No.1, No.2, No.3, and Longmu 801, 802, 803 were cultivated respectively by the Inner Mongolia Agricultural University, Gansu Agricultural University, Xinjiang Agricultural University and Heilongjiang Animal Husbandry Institute (Yu and Yun, 2005). By means of ray- and laser-induced mutation, early-maturing *Astragalus adsurgens* Heifu 214 and Heifu 2 were cultured (Li, 1997). Forage seeds of Leguminosae and Gramineae were irradiated in penetration by heavy ion beams by Xie Hongmei et al. (2004), and superior varieties were successfully cultured after being radiated with different intensities and heavy ion beam. Other researchers cultured bromegrass (*Bromus inermis* Leyss.) Xinque No.1, triticale (Triticosecale Wittmack) Zhongxin 1881, triticale Zhongsi 237, annual ryegrass (*Lolium multiflorum* Lam.) Ganxuan No.1 and Shangnong Tetraploidy annual ryegrass (Su, 2001; Xiao et al., 1998). Besides, cell engineering and genetic engineering breeding have been developed in China since the 1970s, mainly in the breeding of Leguminosae and Gramineae. For instance, in tissue culture, some regenerated plants were harvested from different explants (hypocotyls of aseptic seedlings and so on) of *Medicago sativa* Linn. (Wei et al., 1992; Xiao et al., 2003). Luo Ximing et al. (1991) cultured regeneration from protoplast of *Astragalus adsurgens* Pallas. Some other technologies, such as Agrobacterium-mediated transformation, protoplast transformation, microinjection, electorporator transformation and so on, could introduce exogenous genes into forage and improve its performance and resistance (Jiang and Cao, 1998). In the late 1980s, transgenic plants were cultured by introducing exogenous genes into *Lolium perenne* Linnaeus and *Pennisetum alopecuroides* (Linnaeus) Sprendel (He and Yu, 1997). Weng Pin et al. (2002) introduced chimeric gene of *Arabidopsis thaliana* (Linn.) Heynhold containing promoter sag12 and *ipt* gene to sugarcane-grass 42 mediated by Agrobacterium, established an optimum protocol of transformation and obtained the seedling regenerated from transformants. Recently, alfalfa cultivar Zhongmu No.1 was transformed with *Dscbr* gene from *Dunaliella Salina* via Agrobacterium-mediated process and regenerated alfalfa plants with *Dscbr* gene were obtained (Chen et al., 2005).

In order to widen the planting area and improve the forage productivity, much more varieties, which not only are suitable to different climates, soils and other environmental conditions, but also have characteristics of precocity, cold resistance, drought resistance and salty-tolerance were cultured. For instance, many varieties suitable for tropical climates, were cultured in the Chinese Academy of Tropical Agriculture Sciences, including *Stylosanthes guianensis* Reyan No.2, No5, No.7 and No.10, *Leucaena leucocephal* Reyan No.1, king grass Reyan No.4, *Brachiaria Brizantha* cv. Reyan No.6, *Panicum maximum* cv.Reyan No.8 and No.9, *Puspalum atratum* Bra. cv. Reyan No.11, *Arachis pintoi* cv. Amarillo Reyan No.12, *Bachiaria ruziziensis* Reyan No.13 and *Desmodium ovalifolium* Wall. cv. Reyan No. 16 and so on (Zou and Jiang, 2002), (Tropical Crops Genetic Resources Institute of Chinese Academy of Tropical Agriculture. The introduction of Tropical Crops Genetic Resources Institute. http://www.scuta.cn/pzs/js.htm, cited on January 6th, 2006). Moreover, other varieties were also successfully cultured in other institutes, such as precocious species of *Astragalus adsurgen*, *Medicago sativa* with cold resistance Longmu No.801 and No.803, *Medicago sativa* with downy mildew resistance Zhonglan No.1, white alfalfa with drought resistance and heat tolerance Emu No.1, whose survival rate in summer was 15% higher than that of the original and the productivity was improved by 11% (Su, 2001).

4 Studies on forage utilization

4.1 Development and utilization of husbandry product

Animal husbandry is the source of meat, milk and other necessaries for human life; its development is of great significance for the improvement of people's living standards. And the forage of animal husbandry is mainly from forage in addition to a part from grain. According to some specialists and overseas practices, forage products take up 60% in cattle and sheep feeding, 10%–15% in pig feeding and 3%–5% in chicken feeding (Wu et al., 2001). So, the development and utilization of forage product is of great significance.

Some forage products have been developed in China, such as forage bundle, forage lump, forage powder, forage grain and leaf protein. Forage bundles are now the most widely used of all because of its low cost and simple technology for processing; the other forage products are mainly further finished by forage bundle. Forage powder is an important forage and industry material; it can balance the content of amino acid and supply abundant vitamins and high-quality cellulose. With the development of the forage industry, the shortage of forage materials (especially for protein from forage materials) becomes more and more serious. So it is an important way to improve the quality of livestock products to supplement a section of materials with forage powder (Zhang et al., 2004).

Leaf protein, also called leaf protein concentrate (LPC), is coarse protein concentrated from the juice of fresh forage or other green plants (Jin, 2005), which supplies people with a cheap and high-quality protein source. The obtaining of animal protein product is based on abundant protein forage, in other words, the essence of the grass animal husbandry is to obtain animal protein, for instance, meat, milk, fur and so on are all special existing forms of protein. Many experiments at home and abroad have proved that LPC can increase body weight of animals, improve the quality of fish and eggs, reduce forage consumption rate and improve its transformation rate (Olvera et al., 1990; Tartari et al., 1992). *Medicago sativa* is the main forage in China and many researches on its LPC have been carried out. Zhou Zhiyu et al. (1999) extracted the leaf protein of *Medicago sativa* in 6 different methods, and analyzed relative elements and amino acids in protein, fiber and syrup products. The results showed that protein content was higher than 50% in protein products and 20% in fiber products. Liu Xiaoying et al. (1994) extracted the LPC from *Medicago sativa* and studied its characteristics; the study showed that extracting LPC using the method of acid sedimentation proved very useful in the food and forage industry.

4.2 Utilization of forage in environmental protection

Forage can be used in the protection of the ecological environment by controlling water loss and soil erosion, improving soil structure and soil fertility. Forages can cover the earth's surface and play an important role in soil and water conservation and sands fixation. In some studies, a two-year-old grassland could retain 54% of surface runoff, while forestland of 3 to 8 years old could only retain 34% of surface runoff. The capacity of grassland and woodland to reduce sediment runoff was 70.3% and 37.3%, respectively. For instance, on a 25° gradient hilly land with 340 mm rainfall, water and soil erosion weight on bare lands, cultivated lands and forestlands were 6 750 kg/ha, 3 570 kg/ha and 600 kg/ha, respectively, while that was only 93 kg/ha on grasslands (Wen et al., 2004). Xu Minggang's study showed that forage could reduce the surface runoff and soil erosion on hills with red soil (Xu et al., 2001). Zhang Qimin et al. (1998) compared the soil retention effect of 7 forages in the Loess Plateau Area of Western Shanxi province. The results showed that all the 7 forage species could retain soil effectively, while the results were better under mixture sowing of Leguminosae and Gramineae. Coverage rate was the main factor in preventing water and soil erosion, and the coverage rate of artificial grassland should be higher than 66%.

Forages can improve soil fertility and structure. Nodules in Leguminosae can fix nitrogen in the air and transform it into organic matter. The study conducted by Wang Xin (2003) indicated that total N accumulated at a depth of 20 cm soil under the culture of alfalfa for 5–12 years was 15.5%–47.0% higher than that under the continuous culture of wheat, and organic matter increased by 12.9%–119.8%, which showed that alfalfa could improve soil fertility effectively. Green manure is another measure for soil fertility management. Common forages for green manure are Leguminosae (alfalfa) and Gramineae (*Sorghum sudanense* [Piper] Stapf). Alfalfa was of great fertilizer efficiency; the content of nitrogen, phosphoric acid and K_2O was 0.5%, 0.18%, 0.31%, respectively (Zhang, 2005). Li Guoqiang and Bao Fenglan (1993) described that green manure was an organic fertilizer with great activity, which could promote the decomposition of organic matter, enhance the soil performance, and increase the number of soil microorganisms and the activity of enzyme. Using alfalfa as green manure could accumulate abundant nitrogen, which is good for the subsequent crops.

4.3 Utilization of forage as food and healthy food

Forage contains rich proteins, fibers, vitamins and mineral elements, which can be used as food and healthy products for human consumption after treatment and processing. Studies showed that in alfalfa leaf protein, the vegetable protein content was 57.8%, proportioned with 12.7% of dietary fiber, 7.9% of water, 8.5% of fat, 5.4% of ash, and 9.6% of carbohydrate. Each 100 g alfalfa leaf protein, as food, could supply 1.66 MJ calorific capacity, 60 g protein, 800 mg calcium, 50 mg iron and 0.4 μg β-carotene (Chen and Mao, 2002). In America, alfalfa is made into Nulife concentrated capsules, which can neutralize toxins in the human body and improve blood circulation. Also, they can resist oxidization, treat canker sore and prevent the reproduction of bacteria. Besides, alfalfa pellet has been made up in America to reduce weight. In China, some alfalfa products have been developed, such as vegetable salad, hamburger and spring rolls. In Sichuan province, alfalfa bud was added into wheat flour to make noodles and steamed bread (Zhang, 2005). Gu Yanxiang and Wang Daijun (2002) reported that alfalfa could be developed into food additives, medical products, cosmetics, drinks and so on. Recently, *Leucaena leucocephala* calcium healthy tea has been developed in Japan (The Xinyuan International Center for Economic and Technical Exchanges of Fujian Province. The Third Fujian Project and Fair exhibition outside borders. Fujian International Investment Promotion Network, http://www.fjfdi.com/fjfdi/tzxx/web/618/2005item/c152.html, cited on January 6th, 2006).

5 Conclusions

There have been many achievements in forage studies in China, but there are still many problems to be solved such as the forage genetic diversity, the processing of forage products and how to make the breed satisfy the production need in further studies. Therefore, continually developing biotechnologies is suggested in forage identification, screening, and breeding, and a greater contribution should be made to the study, the development and the utilization of forage production for the purpose of better improvement of economical benefits.

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