

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

5,800

Open access books available

142,000

International authors and editors

180M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Chapter

Genetic Diversity and Evolution of Yunnan Chicken Breeds of China

Mohammed Alsoufi and Ge Changrong

Abstract

Chickens are the first type of bird that was domesticated and spread widely in the world to cover the growing demand for animal protein from meat and eggs, and it was cultivated from a wild ancestor known Red junglefowl (*Gallus gallus*). Yunnan Province is considered the most diverse in culture and biology among all the provinces of China. There are a total of more than 24 chicken breeds in Yunnan Province. These chickens are characterized by good quality of their meat and eggs, a good immune system against diseases, and the ability to adapt to various environmental and administrative conditions. Yunnan Province is one of the centers of domestication and evolutionary of chickens in the world. There are many studies that have been conducted to evaluate and study the genetic diversity and evolutionary relationship within and among chicken breeds in Yunnan Province and their relationship with wild chicken species and other chicken breeds using phenotypic markers, protein polymorphisms, SNPs marker, microsatellite marker, and mitochondrial DNA marker. However, there is no review that summarizes these studies, and most of these studies were authored in the Chinese language. Therefore, we have reviewed all studies that have been conducted on Yunnan chicken breeds diversity in Yunnan Province.

Keywords: genetic diversity, Yunnan chicken breeds, molecular studies, phenotypic studies

1. Introduction

Poultry at the present time is called the domesticated birds and is used in the production of meat and eggs, and includes the following—chicken, ostrich, duck, turkey, goose, quail, pheasant, peacocks, and guinea fowl [1, 2]. Chickens are the first type of bird that was domesticated and spread widely in the world to cover the growing demand for animal protein from meat and eggs and it was cultivated from a wild ancestor known Red junglefowl (*Gallus gallus*) regarding since more than eight thousand years [3, 4]. Currently, the scientific and technological advancement across the globe was reflected in the production and domestication of poultry, which led to the existence of many breeds resulting from breeding, genetic improvement programs, and natural selection. Moreover, the production system, modern chicken, and the focus of countries on obtaining the largest possible amount of animal protein with

the lowest possible loss led to loss of genetic diversity, a decrease of genetic variation, and disappearance of many local breeds, so that many research centers have sounded the alarm about the necessity of preserving local chicken breeds as an indispensable genetic resource [5].

During the last decades, commercial chicken breeds were imported into China, and then a crossbreeding process was carried out with local breeds to cover the growing demand for chicken products. The total number of chickens in China about 10 billion birds in 2015 representing all types of chicken, of which 44%, 37%, 9.5% and 9.5% broilers, yellow chicken, layer and hybrid broiler [6]. Although approximately 107 local chicken breeds have been registered in China by the research centers, most of them are raised in small groups and the rural area, and some of them are at risk, as there are about six breeds at risk of extinction and due to the hybridization process with commercial strains, the number of local breeds adapted to hard environmental conditions in Yunnan, like to the rest of China, is constantly declining, in addition to the decrease in genetic diversity, which will negatively affect the ability of local chickens to withstand harsh environments, resist diseases, and losing the characteristics of high-quality meat. From all the above, we note that it is needed to maintain the highest genetic variation of local breeds as a national genetic resource and globally, for the purpose of breeding and genetic improvement programs that we will need in the future [5, 7, 8]. In this article, we have reviewed all the studies that were conducted previously on the genetic variation of chicken breeds in Yunnan Province.

2. Yunnan Province as a center of animal domestication

Yunnan Province is located in Southern China, sharing borders with Myanmar, Laos, and Vietnam at (21°8'32"–29°15'8"N, 97°31'39"–106°11'47"E). Most of the Yunnan landscape is classed as a mountainous region with the Tropic of Cancer, which runs across the southern region. The province of Yunnan is an incredibly different geographical location that comprises mountains, valleys, lakes, and rivers. The climate in Yunnan ranges from the tropical oceanic monsoon in summers and dry interior monsoon in winters, combined with adequate sunshine, long frost-free periods, and abundant rainfall. In combination with these highly diversified geographic conditions, Yunnan exemplifies a vital biological diversity center of worldwide importance. Yunnan is the center of about half of China's varieties of greater vertebrate and plant types and various species of rare, widespread, and wild animals. Yunnan is also the territory for feral descendants of many species of livestock and has been suggested to be a center domesticated of prevalent animals, such as the pig, chicken, and the dog [3, 9]. Yunnan Province is considered the most diverse in culture and biology among all the provinces of China. Its varied environment, from snow-covered mountains to tropical environments, enabled it to possess many species of plants and animals that have no equivalent in the whole world. The wide range of topographical along with a tropical humidity has made Yunnan Province extremely diverse biology and with a high degree of endemism of species, as it has become one of the richest areas in the world in terms of plant and animal resources with 17 thousand species of plants and the equivalent of the northern hemisphere combined [10]. Although the area of Yunnan Province does not exceed 4% of the total area of China, it contains about 42.6% of plants species protected and 72.5% of wild animals protected that are found

throughout the country [11], and is also considered as a home of many animals, the most important of which is the South Asian Gorge, Indochina tiger, Asian elephant [12], box turtle, the Yunnan monkey [13], and red forest chickens species, in addition to it contains 11 national and nature reserves [14], moreover, Yunnan province has about 650 species of freshwater fish with 580 species are natives, this equates to 40% of freshwater fish in China [15]. Yunnan Province possesses many local poultry breeds with a large variety of various traits [16].

3. Yunnan chicken breeds and their phenotypic characteristics and location of domestication

According to the report of Yunnan provincial animal and poultry genetic resources committee [17], there are a total of more than 24 breeds, and these breeds are located and distributed across all regions of Yunnan Province (**Figure 1**), named Nixi chicken, Wuding chicken, Xishuangbanna game chicken, Chahua chicken, Dali chicken, Xichou black bone chicken, Yanjin black bone chicken, Daweishan mini chicken, Yunlong short led chicken, Yangbi Hang chicken, Dulong chicken, Lanping chicken, Taliu black bone chicken, Dehong chicken, Labai high leg chicken, Lanping silky chicken, Mengzi game chicken, Poya chicken, Tengchong white chicken, Wuliangshan black boned chicken (Puer feathered feet chicken, Nanjiang green and black boned chicken), Weixin chicken, Wenshan chicken, and Piao chicken. These chickens are characterized by the good quality of their meat, a good immune system against diseases, and the ability to adapt to various environmental and administrative conditions. Because of the introduction of commercial strains, the number of these local breeds is decreasing, therefore, measures must be created to conserve these genetic supplies [19]. Furthermore, there are many breeds living in villages and mountains in Yunnan Province that have not been recorded or unknown until now, according to Kun et al. [20], in their study, that has reported three new breeds; Frizzle chicken, Naked-neck chicken, and YN chicken (YN) in Nujiang Prefecture in Yunnan Province (**Table 1**). Moreover, these domestic breeds when compared to broiler or layer chicken breeds mostly still not yet extensively bred and selected and possess a poorer performance, therefore some of them are not financially useful as broilers and layer breeds. However, it will continue to be a resource of genetic materials for the reason that they have been synthetically selected and bred throughout a lengthy history of reproduction and breeding using standards and methods that are completely different from those used with commercial chickens breeding [29].

There are many breeds of chickens that have been formed during thousands of years in Yunnan Province, and they can be divided according to their production purpose into the following: Entertainment type, meat type, dual type, and eggs type [17, 18].

Entertainment type: These chicken breeds are similar to wild chicken breeds (Red Junglefowl) that still live wild in the forests of Yunnan Province and are characterized by their low production of eggs and meat and their small size **Figure 2**.

Xishuangbanna game chicken: Entertainment type, an ancient breed with history 2000 years. Large body size (2.5 kg male and 1.7 kg female), the annual production of eggs is 100–120 egg, white skin, variable plumage color (mostly grayish-green mixed with golden red) long neck, small walnut comb, and red earlobe [30]. This breed is distributed in Xishuangbanna prefecture (Southwest of Yunnan Province), (21°09'N–22°36'N and 90°56'E–101°50'E, ~2429 m above sea

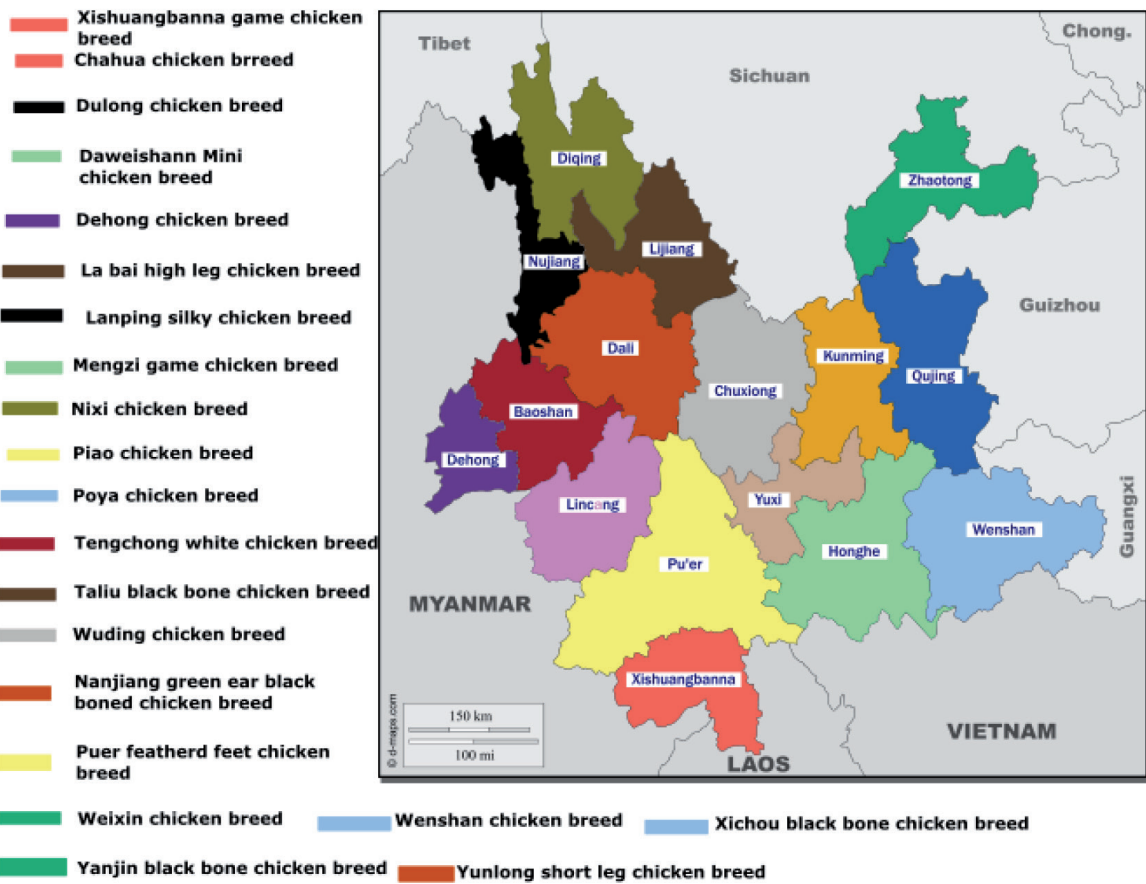


Figure 1. Map of China and Yunnan Province indicating the location of domestication and distribution of chicken breed in Yunnan Province, [17, 18].

level); yearly average temperature 18.6–21.9°C, rainfall of 1200 mm–1700 mm, and humidity of 81–85% [17, 31].

Breed Name	Number of studied Samples	Haplotype Diversity	Nucleotide Diversity	References
Yanjin black-bone chicken	8	0.535	0.00103	Zhu et al. [21]
Tengchong chicken	45	0.881	0.01515	Liu et al. [3]
Wuding chicken	7	0.810	0.00919	Liu et al. [3]
Frizzle chicken	56	0.947	0.01268	Kun et al. [20]
Naked-neck chicken	56	0.938	0.01434	Kun et al. [20]
YN chicken	56	0.596	0.00239	Kun et al. [20]
Daweishan Mini Chicken	30	0.685	0.00443	Jia et al. [22]
Chahua chicken	30	0.476	0.00301	LU et al. [23]
Taliu black bone chicken	54	0.855	0.017	Miao et al. [24]
Lanping silky chicken	47	0.545	0.0046	Miao et al. [24]
Piao Chicken	50	0.883	0.015 03	Gongpan et al. [25]
Xichou chickens	36	0.884	0.01452	Huang et al. [26]
Yunlong short-leg chickens	80	0.851	0.01342	Ouyang et al. [27]
Dulong chicken	59	0.911	0.016	Li et al. [28]
Labai high-leg chicken	80	0.784	0.011 66	Ouyang et al. [27]

Table 1.

Haplotype diversity and nucleotide diversity in some Yunnan chicken breeds from previous studies.

Chahua chicken: Primitive type, good for running and flying, small body size (1.27 kg male and 1.07 kg female), yielding 100–140 eggs per year, the color of plumage is mixed gray, green, black, and yellow, the wattle and comb are red, and the skin color is white with some chicken is yellow. This breed is domesticated and distributed in Xishuangbanna and Licang, Puer, Dehong prefecture (Southwestern and Western Yunnan), (21°09'N–22°36'N and 90°56'E–101°50'E, ~2429 m above sea level); yearly average temperature 18.6–21.9°C, rainfall of 1200 mm–1700 mm, and humidity of 81–85% [17, 23].

Dehong chicken: wild breed, small size (0.93 kg male and 0.67 kg female), the yielding eggs production is 8–12 eggs under natural conditions and 80 eggs per year in the farm. Single red comb, the skin color is white, the color of plumages is mainly mixed red with white, yellow with black, and black with white. This breed is mainly located and distributed in Mangshi, Longchun, and another county in Dehong prefecture (west of Yunnan Province), (23°50'N–25°20'N and 97°31'E–98°43'E, ~893 m–1200 m above sea level); rainfall of 1400 mm–1700 mm [17].

Mengzi game chicken: Entertainment type, large body size, tall, thick bones and strong (3 kg male and 2 kg female), the annual production of eggs is 50–80 egg, hard feeding, and strong resistance to diseases. White yellow skin color, red meat color, variable plumage color (mainly dark green, red with black, yellow with black) long neck, small walnut comb, and red earlobe. This breed is located and lived in Mengzi



Figure 2.
The morphology of entertainment type native breeds in Yunnan Province in China, [17, 18].

County, Honghe prefecture (Southeast of Yunnan Province), ($23^{\circ}01'N-23^{\circ}34'N$ and $103^{\circ}13'E-103^{\circ}49'E$, $\sim 200\text{ m}-2567\text{ m}$ above sea level); yearly average temperature $18.6^{\circ}C$, rainfall of $1200\text{ mm}-1700\text{ mm}$, and humidity of 72% [17].

Dulong chicken: Dual type with minimal production costs, hard feeding, and strong resistance to diseases. Small body size (0.97 kg male and 1.15 kg female), the yielding eggs production is $55-75$ eggs. The skin color is white, the color of plumages is mainly mixed red with white, yellow with black, and black with white. This breed is distributed in Gongshan County, Nujiang prefecture (Northwest Yunnan), ($27^{\circ}40'N-28^{\circ}45'N$ and $98^{\circ}45'E-98^{\circ}30'E$, $\sim 4964\text{ m}$ above sea level); yearly average temperature $16^{\circ}C$, rainfall of $2932\text{ mm}-4000\text{ mm}$, and humidity of 90% [32].

Daweishan mini chicken: This breed is a slow growing, small size (0.85 kg male and 0.68 kg female), aggressive, pectoral muscles, and thighs are combined with strong, thin bones, yielding about 60 eggs per year, The color of plumages are mainly white, yellow, red flowers, the comb is red and multiple [27]. This breed is distributed in Pingbian County, Honghe prefecture (Southeastern of Yunnan Province), ($22^{\circ}49'N-23^{\circ}23'N$ and $103^{\circ}24'E-103^{\circ}58'E$, $\sim 154\text{ m}-2590\text{ m}$ above sea level): yearly average temperature $16^{\circ}C$, rainfall of $1450\text{ mm}-1700\text{ mm}$, and humidity of $33.5-80.9\%$ [17, 22].

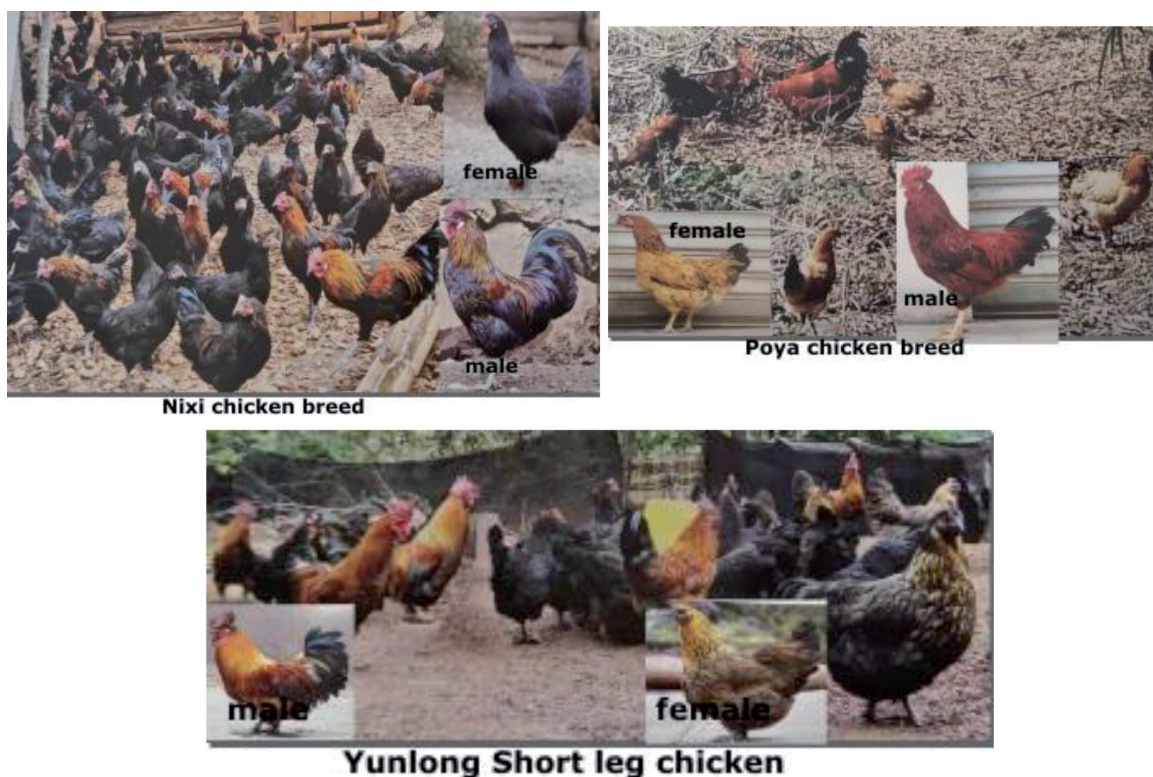


Figure 3.
The morphology of eggs production type native breeds in Yunnan Province in China, [17, 18].

Egg production type: These breeds are mostly characterized by their small size and producing many eggs in year **Figure 3**, which are the following:

Nixi chicken: Egg production type, its egg production reaches 156–221 eggs annually, the body size is small (1.6 kg male and 1.2 kg female), single red comb, long tail, gray shank, most of them white skin and some are black, variable plumage (mixed red and yellow and black for male and most of the black color with some white color for female and mixed yellow with black color). The regions of domestication and distribution of this breed are lives and are Shangri La County, Diqing prefecture county (Northwestern Yunnan), (26°52'N–28°52'N and 99°23'E–100°19'E, ~2800 m above sea level); yearly average temperature 7.4–13.5°C, rainfall of 270 mm–500 mm [16, 17].

Yunlong short-leg chicken: Yunlong chicken is a type of eggs production (160–190 eggs per year), small size (1.9 kg male and 1.6 kg female), good meat quality, unique flavor features, strong adaptability, the skin color is black or white and the color of plumages are mainly red and yellow. This breed is located and lives in Yunlong County, Dali prefecture (Central Yunnan plateau), (25°28'N–26°23'N and 99°52'E–99°46'E, ~730 m–3663 m above sea level); yearly average temperature 15.9°C, rainfall of 730 mm [17, 27].

Poya chicken: This breed is a type of eggs production (150–210 eggs per year), small size (1.4 kg male and 1.3 kg female). This breed has a red and single type of comb, the plumage color is red, white, black, and yellow. The skin color is white. Funingxian County, Wenshan prefecture (Southeast of Yunnan province), is the location of domesticated of this breed, (23°41'N–23°52'N and 105°53'E–106°10'E, ~823 m above sea level); yearly average temperature 19.3°C, rainfall of 1200 mm [17].

Dual type: These breeds are of medium size, and their production of eggs and meat is acceptable (**Figure 4**), and the most important of them are the following:



Figure 4. The morphology of dual production types native breeds in Yunnan Province in China, [17, 18].

Xichou black bone chicken: Dual-type, aggressive and vigilant, bodyweight is medium (2 kg and 1.7 kg for female), the number of eggs produced is about 100–130 annually, the shank, skin, and bone are black, a varied plumage color, comb, wattle, earlobe, and beak are red and black. This breed has domesticated and distributed in Xichou County, Wenshan prefecture (Southeastern of Yunnan Province), (23°05'N–23°37'N and 104°22'E–104°58'E, ~667–1962.9 m above sea level); yearly average temperature 15.5°C, rainfall of 1100 mm–1600 mm, and humidity of 78% [16, 17].

Wuding chicken: Dual type (meat and eggs production). The body size of this chicken breed has small and large types (3 kg for male large type, 2.1 for male small type, and 1.7 kg for female), the number of eggs produced reaches 90–130 eggs per year. The color of plumages, skin, and bone is varied, the comb is red and single. Some of these breed chickens have feathered feet. This breed is located in Wuding

County, Chuxiong prefecture (Central Yunnan plateau), (25°19'N–26°11'N and 101°56'E–102°29'E, ~862 m–2956 m above sea level); yearly average temperature 15.1°C, rainfall of 959 mm [16, 17].

Piao chicken: The common name is Piao chicken, this breed has no pygo-style, tail bones, tail fat gland, tail feathers, caudal vertebra, and uropygial gland. Medium size, the bodyweight is reached to 2 kg for male and 1.7 kg for female, the number of eggs produced reaches 100–130 eggs per year, the skin, meat, and shank color mostly black and some skin is white, a varied plumage color (reddish-brown, black, white, yellow with flower color, single red comb). The location and distributions of this breed are Zhenyuan County, Puer prefecture (Southwestern of Yunnan), (23°24'N–24°22'N and 100°21'E–101°31'E, ~774 m–3137 m above sea level); yearly average temperature 18.5°C, rainfall of 1284 mm, and humidity of 78% [17, 33].

Taliu black bone chicken: Dual type (meat and eggs production). Large size (2.4 kg male and 2 kg female), the yielding eggs production is 90–120 eggs, with strong black skin, black bones, black meat, good meat quality, plumages colors are two types, red mixed with yellow, black color and white color. The location of this breed is Yongsheng County, Lijiang prefecture (Northwestern Yunnan), (25°59'N–27°04'N and 100°22'E–101°11'E, ~2890 m above sea level); yearly average temperature 13.5°C, rainfall of 936 mm [17, 24].

Lanping silky chicken: Dual type (meat and eggs production), medium size (1.9 kg male and 1.6 kg female), the production of eggs is about 110–120 eggs annually, the meat flavor is superior and unique, the tail is very short, the colors are mainly red meat, white skin, black shank, the plumage color is yellow with black tail and wings. This breed is located and lives in Lanping County, Nujiang prefecture (Northwestern Yunnan), (26°06'N–27°04'N and 98°58'E–99°38'E, ~1350 m–4435 m above sea level); yearly average temperature 13.7°C, rainfall of 1002 mm [17, 24].

Tengchong white chicken: Dual type (meat and eggs production), the body size is a medium (2.1 kg male and 1.7 kg female). The production of eggs reaches 100–150 eggs per year. This breed has a red and single type of comb, the plumage color is white. The color of shanks, skin, bone is black. This breed is distributed in Tenchong County, Baoshan prefecture (western Yunnan), (24°38'N–25°52'N and 98°05'E–98°46'E, ~930 m–3780 m above sea level); yearly average temperature 14.8°C, rainfall of 1469 mm, and humidity of 81.7% [16, 17].

Nanjiang black-boned chicken: Dual type (meat and eggs production), the body size is a medium (2.9 kg male and 2.2 kg female). Small head, green ear, the color of skin, meat, and bone is black. This breed has a red and single type of comb, the plumage male color is red, in addition to whit color, the female color mainly is yellow and some chicken color is white. This breed is located and lives in Wuliangshan County, Dali prefecture (Western Yunnan province), (24°32'N–25°10'N and 100°06'E–100°41'E, ~994 m–3061 m above sea level); yearly average temperature 19.2°C, rainfall of 770 mm, and humidity of 68% [17].

Meat production type: These breeds are mostly characterized by their large size and high efficiency in the production of meat **Figure 5**, which are the following:

Yanjin black bone chicken: Meat production type, large body size (3.1 kg male and 2.4 kg female), yielding 120–160 eggs per year. The skin, eyes wattle, face, ear, and comb are black, also the beak, toes, and shanks are black, a variable plumage color (mostly white or black), the location and distribution of this breed are Yanjin County, Zhaotong prefecture county (Northeast of Yunnan Province), (26°34'N–28°40'N



Figure 5. The morphology of meat production types native breeds in Yunnan Province in China, [17, 18].

and 102°52'E–105°19'E, ~267 m–4040 m above sea level); yearly average temperature 6.2–21°C, rainfall of 1100 mm [16, 30].

Labai high leg chicken: Meat production type, the meat is tender and unique, tall body, long greenshank, large size (2.7 kg male and 2.3 kg female), the yielding eggs production is 90–120 eggs, the skin color is white, and the color of male plumages are mainly yellow, with black wings and tail and yellow and black for female. Ninglang County, Lijiang prefecture (Northwestern Yunnan), is the region of domestication and distribution of this breed, (26°36'N–27°56'N and 100°22'E–101°15'E, ~1350 m–4510 m above sea level); yearly average temperature 12.7°C, rainfall of 918 mm, and humidity of 69% [17, 27].

Puer feathered feet chicken: Meat production type, this breed has a feather on feet, large size (3 kg male and 2.4 kg female), the production of eggs reaches 90–130 eggs per year. The skin color is mostly black and some of them are white, the plumage

color is reddish-brown or yellowish-brown, and the color of the tail is black, in addition to some females is white or black. This breed is located and distributed in Puer County, Puer prefecture (Southwestern of Yunnan), (23°56'N–24°29'N and 100°22'E–101°15'E, ~795 m–3371 m above sea level); yearly average temperature 18.3°C, rainfall of 1086 mm, and humidity of 77% [17].

Weixin chicken: Meat production type, the bodyweight is large (4.3 kg for male and 3.5 kg for female), The production of eggs reaches 128 eggs per year. The legs are tall and thick, this breed has a red and single type of comb, white skin, the plumage color mostly is a black female and red or red with black for male. Weixin County, Zhaotong prefecture (Northeast of Yunnan Province), is the location and distributions of this breed, (27°42'30"N–28°07'30"N and 104°41'15"E–105°18'45"E, ~480 m–1902 m above sea level); yearly average temperature 13.3°C, rainfall of 1060 mm, and humidity of 84–89% [17].

Wenshan chicken: Meat production type, large size (2.6 kg male and 2 kg female). The production of eggs reaches 90–120 eggs per year. This breed has a red and single type of comb, the plumage color is brown for female and reddish-brown for male. This breed is located and has domesticated in Wenshan city and Maguan County, Wenshan prefecture (Southeastern of Yunnan Province), (22°34'N–24°28'N and 103°30'E–106°11'E, ~123 m–2991 m above sea level); yearly average temperature 15.8–19.3°C, rainfall of 1224 mm, and humidity of 76.7–86% [17, 18].

4. Genetic diversity molecular studies of Yunnan chicken breeds

Yunnan Chicken breeds are mainly reared in remote mountainous areas. But what is disturbing is that these breeds are less affected by the outside world, but it is being bred in a traditional selection by farmers, nevertheless, in recent periods, the genetic resources of poultry have received strong support from the Ministry of Agriculture and the provincial government to preserve these genetic resources and expand production for many breeds [34].

During the past 30 years and assuming that Yunnan Province is one of the centers of domestication and evolutionary of chickens in the world, there are many studies that have been conducted to evaluate and study the genetic diversity and evolutionary relationship within and among chicken breeds in Yunnan province and their relationship with wild chicken species and other chicken breeds using phenotypic markers [35], protein polymorphisms [36], and mitochondrial DNA marker [20, 22–24, 27, 31, 37].

4.1 Mitochondrial DNA marker studies

Jia et al. [22] studied the origin and genetic variation of 30 Daweishan Mini chickens breed and compared them with five species of red jungle fowl (*G.g. bankiva*, *G.g. gallus*, *G.g. murghi*, *G.g. jabouill*, and *G.g. spadiceus*) sequence that downloads from previously published data (GenBank) using mtDNA. They identified 18 variable sites and observed six haplotypes. Their conclusion has indicated multiple origins for the Daweishan breed and the subspecies *G.g. spadiceus* is more contributed of Daweishan Mini chickens breed evolution. Similarly, the conclusion has obtained by LU et al. [23] revealed that multiple origins for Chahua chicken and Daweishan breed, and the subspecies *G.g. spadiceus* is more contributed of Daweishan Mini chicken breed and Chahua chicken breed evolution. This study has conducted on 30 Daweishan Mini

and 30 Chahua chicken breeds to assess the origin and genetic variety of these breeds using mtDNA marker.

Furthermore, Gongpan et al. [25] in their study that conducted on 50 chickens of Piao chicken breed to evaluate the genetic diversity. The results revealed that the genetic variation of this breed is high and has multiple origins for the Piao chicken breed. However, a study has been conducted to investigate the relationship of Dulong chicken breed with Chinese chicken breeds (Pengxian chickens, Jinyang chickens, Emei chickens, Jiuyuan chickens, Muchuan chickens, Miyi chickens, Shimian chickens, and Tianfu chickens) by using mtDNA analysis. The results have revealed the close relationship between Dulong chickens and studied chicken breeds and have suggested that Dulong chickens have a single matrilineal lineage [28].

Ouyang et al. [27] studied the genetic variation of 257 individuals from three chicken breeds (Labai high-leg chicken breed, Daweishan mini chicken breed, and Yunlong short-leg chicken breed) and using mtDNA D-loop sequences. Based on genetic diversity results, they have suggested that there is a rich genetic diversity in these studied breeds and all of these breeds have a multiple maternal lineage, which supports the concept of various maternal ancestry of chicken. Wang et al. [38] used the mtDNA D-loop sequence to explore the origin and genetic variation of 30 individuals from the Labai high-leg chicken breed. Haplotype diversity and nucleotide diversity were 0.763 and 0.031, respectively. The findings showed that this breed kept a wealthy genetic variety and multiple origins for the Labai high-leg chicken breed.

4.2 Microsatellite's markers studies

There are many of studies have been done by using microsatellites markers and most of these studies indicated to increase of genetic diversity within population of Yunnan chicken breed. Huo et al. [16] examined the genetic diversity and association between seven native breeds in Yunnan Province (Tengchong chicken, Banna chicken, Nixi chicken, Chahua chicken, Wuding chicken, Yanjin chicken, and Xichou chicken,) and Red Junglefowl chicken by utilizing 28 microsatellite markers. The numbers of alleles that were identified 342, 121 of them were specific, the heterozygosity among the population was high (0.663) and the FIS was low ($-0.098-0.005$) indicating the weakness of inbreeding between population, the FST, and the distance of genetic were high (0.1757–0.3015) and (0.4232–0.6950) respectively, indicating the high diversity among populations. Li et al. [39] also have used 30 microsatellite markers to study the genetic diversity of six Yunnan chicken breeds (Chahua, Xishuangbanna game, Wuding, Yunlong short-legged, Yanjin silky, and Tengchong chicken). The results have demonstrated the lowest value of heterozygosity was in Wuding chicken, and the highest value was in the Tengchong breed. In addition to the Yunlong chicken, Yanjin and Wuding chicken were grouped together, while Tengchong chicken and Xishuangbanna chicken were grouped together, however, Chahua chicken had grouped alone.

Ye et al. [40] used 33 microsatellites to evaluate the population structure and genetic diversity of 30 individuals from the Chahua chicken breed. The results showed an increased average value of heterozygosity (0.6129) and the polymorphism information content (0.5276) for all experimented microsatellites. LangThui et al. [41] used 33 microsatellites to assess the level of genetic diversity of 50 individuals from the Nixi chicken breed. The results have indicated to increase in the genetic diversity of this breed with average heterozygosity of 0.63 and 0.551 for polymorphic information content. Jia et al. [42] used 33 microsatellites to evaluate the population

structure and genetic variability of 30 individuals from the Daweishan Mini chicken breed. The results have indicated to decrease in the heterozygosity (0.1737) and the polymorphism information content (0.3279) with increased homozygosity. Qian et al. [43] investigated the genetic diversity and genetic structure of 53 unrelated individuals from the Wuding chicken breed by using 25 microsatellite markers. The results indicated that the genetic diversity of this breed is high with average heterozygosity of 0.6957 and 0.6382 for the polymorphism information content of 25 microsatellites that have been studied. Chen et al. [44] examined the genetic diversity of 53 individuals from the Yanjin black-bone chicken breed, the findings revealed that the Yanjin black-bone chicken breed was rich in genetic variation with average heterozygosity of 0.6232 and 0.5712 for polymorphism information content.

4.3 Microsatellite's markers studies

Wang et al. [45] have done an experiment on 10 chickens of Dulong Chicken breed to study the population structure and genes selection in the period of chicken domestication based on whole-genome resequencing using single nucleotide polymorphisms marker and the approach of fixation index. The results have identified 18,262,807 SNPs from the 10 genomes of Dulong Chickens and five genomes of Red Jungle Fowls that have been downloaded from the NCBI. The findings also have obtained 469 candidate genes, these genes may be related to small size, aggressiveness, and disease resistance in Dulong Chickens. Moreover, Guo et al. [46] used two methods (heterozygosity and fixation index) based on whole-genome resequencing to investigate selection signatures between eight individuals of Xishuangbanna chicken breed genome and six of Red Jungle Fowl genome that have been downloaded from the EMBL-EBI database. The results have identified more than 16 million SNPs from all individual's genomes and identified 413 candidate genes that are related to energy metabolism, disease resistance, aggressive behavior, immunity, and growth.

In addition, many studies have included some of Yunnan chicken breeds as a reference breed or experimented breed, particularly, chicken breeds that still preserve their morphological characteristics (Chahua chicken breed, Xishuangbanna game chicken breed, Dehong chicken breed, Mengzi chicken breed, Daweishan mini chicken breed, and Dulong chicken breed) which are similar to chicken species that wildly living in south Asia, including Yunnan Province to understand evolutionary of chicken, genetic variation and genetic relationship between them and other Chinese domesticated breeds, global domesticated chicken breeds, wild species chicken, commercial chicken breeds using SNPs marker [47–51], copy number variants [52], microsatellites marker [53], and mtDNA marker [54, 55].

5. Conclusions

The ecological and topographical diversity of Yunnan Province in China has been reflected in the biological diversity, as this region is considered one of the centers of genetic resources for living organisms. Including chicken, as it is one of the centers of domestication of chickens in the world where it contains all types of chicken breeds—fancy breeds, meat breeds, and eggs breeds. Research centers have begun to conduct many studies on the genetic variation and evolution of chickens using molecular methods. As many breeds are still discovered in succession to this day, it is necessary

to make more efforts to enumerate and describe all the chicken breeds that exist in Yunnan Province.

Conflict of interest

The authors declare no conflict of interest.

Author details


Mohammed Alsoufi^{1,2*} and Ge Changrong¹

1 College of Animal Science and Technology, Yunnan Agricultural University, Kunming, Yunnan Province, People's Republic of China

2 Faculty of Agriculture, Department of Animal Production, Sana'a University, Sana'a, Yemen

*Address all correspondence to: m-alsofy@hotmail.com

IntechOpen

© 2022 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Aho PW. The world's commercial chicken meat and egg industries. In: *Commercial Chicken Meat and Egg Production*. Boston, MA: Springer; 2002. pp. 3-17
- [2] Roenigk WP. Muscle growth and development. Keynote address: World poultry consumption. *Poultry Science*. 1999;**78**:722-728
- [3] Liu Y-P, Wu G-S, Yao Y-G, Miao Y-W, Luikart G, et al. Multiple maternal origins of chickens: Out of the Asian jungles. *Molecular Phylogenetics and Evolution*. 2006;**38**:12-19
- [4] Aho P. Challenges and opportunities for marketing poultry products in developed and developing countries. Presented on behalf of The American Soybean Association in Romania and Turkey; 2004
- [5] Chang C-S, Chen C, Berthouly-Salazar C, Chazara O, Lee Y, et al. A global analysis of molecular markers and phenotypic traits in local chicken breeds in Taiwan. *Animal Genetics*. 2012;**43**:172-182
- [6] Zheng MQ, Gong GF, Gao HJ. The monitoring report of poultry industry development in 2015. *China Poultry Science*. 2016;**38**:67-70
- [7] Chen. *Animal Genetics Resources in China*. China Agricultural Press; 2012
- [8] Vaarst M, Steinfeldt S, Horsted K. Sustainable development perspectives of poultry production. *World's Poultry Science Journal*. 2015;**71**:609-620
- [9] Pang J-F, Kluetsch C, Zou X-J, A-b Z, Luo L-Y, et al. mtDNA data indicate a single origin for dogs south of Yangtze River, less than 16,300 years ago, from numerous wolves. *Molecular Biology and Evolution*. 2009;**26**:2849-2864
- [10] Liang L. Biodiversity in China's Yunnan province. *Biodiversity and Conservation*. 2011;**23**:2012
- [11] Yang Y, Tian K, Hao J, Pei S, Yang Y. Biodiversity and biodiversity conservation in Yunnan, China. *Biodiversity and Conservation*. 2004;**13**:813-826
- [12] Smith AT, Xie Y, Hoffmann RS, Lunde D, MacKinnon J, et al. *A Guide to the Mammals of China*. Princeton University Press; 2010
- [13] Blanck T, Zhou T, McCord W. The Yunnan box turtle, *Cuora yunnanensis* (Boulenger, 1906); historical background and an update on the morphology, distribution and vulnerabilities of the only known living specimens. *Sacalia*. 2006;**13**:14-35
- [14] Grueter CC, Jiang X, Konrad R, Fan P, Guan Z, Geissmann T. Are *Hylobates lar* extirpated from China? *International Journal of Primatology*. 2009;**30**:553-567
- [15] Chen X-Y. Checklist of fishes of Yunnan. *Dongwuxue Yanjiu*. 2013;**34**(4):281-343
- [16] Huo J, Wu G, Chen T, Huo H, Yuan F, et al. Genetic diversity of local Yunnan chicken breeds and their relationships with Red Junglefowl. *Genetics and Molecular Research*. 2014;**13**:3371-3383
- [17] YPAPGRC. *Yunnan provincial animal and poultry genetic resources committee, Animal genetic resources in yunnan*. Kunming: Yunnan science and technology press; 2015

- [18] NAPGRC. National Animal and Poultry Genetic Resources Committee, China's livestock and poultry genetic resources. Beijing: China Agriculture Press; 2011
- [19] Chen G-H, Wang K-H, Wang J-Y, Ding C, Yang N, et al. Poultry genetic resources in China. Shanghai, China: Shanghai Scientific and Technological Press; 2004
- [20] Kun W, Tengfei D, Qihua L, Mingzheng L, Fengyun L, et al. Genetic Diversity analysis of three newly discovered native chicken breeds in Yunnan using mtDNA D-loop region sequences. *China Animal Husbandry and Veterinary Medicine*. 2020;**47**:3232-3241
- [21] Zhu W, Li H, Wang J, Shu J, Zhu C, et al. Molecular genetic diversity and maternal origin of Chinese black-bone chicken breeds. *Genetics and Molecular Research*. 2014;**13**:3275-3282
- [22] Jia X, Tang X, Lu J, Gu R, Ge Q, et al. The investigation of genetic diversity and evolution of Daweishan mini chicken based on complete mitochondrial DNA D-loop region sequence. *Journal of Nanjing Agricultural University*. 2015;**38**:656-660
- [23] Lu J, Jia X, Tang X, Fan Y, Tang M, et al. Genetic diversity of two local Yunnan chicken breeds and their relationships with red jungle fowl. *Journal of Zhejiang University (Agriculture and Life Sciences)*. 2016;**42**:385-390
- [24] Miao Y, Sun L, Wang S, Ouyang Y, Zhang Y, et al. Genetic diversity analysis of three indigenous chicken populations in Yunnan using mtDNA D-loop sequences. *Journal of Yunnan Agricultural University*. 2015;**30**:395-401
- [25] Gongpan P, Liu L, Li D, Yuan Y, Sun L, et al. The investigation of genetic diversity of Piao chicken based on mitochondrial DNA D-loop region sequence. *Journal of Yunnan Agricultural University*. 2011;**26**:211-223
- [26] Huang D, Li D, Yuan F, Lin C, Li H, Su S. Genetic diversity of mitochondrial DNA D-loop region of Xichou black-bone chicken. *Journal of Yunnan Agricultural University*. 2010;**25**:373-376
- [27] Ouyang Y, Ruan Q, Qian L, Sun L, Zhang Y, et al. Genetic diversity of Daweishan mini, Yunlong short leg and La-bai high leg chickens in Yunnan based on mitochondrial DNA D-loop sequences. *Journal of Yunnan Agricultural University*. 2017;**32**:70-77
- [28] Li Q, Zhang P, Li M, Li L, Hu Y, et al. Genetic diversity and relationship of Dulong chickens using mitochondrial DNA control region. *Mitochondrial DNA Part B*. 2020;**5**:275-280
- [29] Tadano R, Sekino M, Nishibori M, Tsudzuki M. Microsatellite marker analysis for the genetic relationships among Japanese long-tailed chicken breeds. *Poultry Science*. 2007;**86**:460-469
- [30] Luo Q, Wen JK, Wang X, Li ZS. *The Breeds of Domestic Animals in Yunnan*. Kunming: Yunnan Science and Technology Press; 1987
- [31] Yan M-L, Ding S-P, Ye S-H, Wang C-G, He B-L, et al. The complete mitochondrial genome sequence of the Daweishan Mini chicken. *Mitochondrial DNA Part A*. 2016;**27**:138-139
- [32] Weng Z, Xu Y, Li W, Chen J, Zhong M, et al. Genomic Variations and Signatures of Selection in Wuhua Yellow Chicken. *PLoS One*. 2020;**15**(10):e0241137

- [33] Wang Y-M, Khederzadeh S, Li S-R, Otecko NO, Irwin DM, Thakur M, et al. Integrating Genomic and Transcriptomic Data to Reveal Genetic Mechanisms Underlying Piao Chicken Rumpless Trait. *Genomics, Proteomics & Bioinformatics*. 2021. DOI: 10.1016/j.gpb.2020.06.019
- [34] Li L, Li Y. Research on the Status and Problems of Local Chicken Development in Yunnan Province. *Rural Economy and Technology*, in Chinese. 2017;28:64-65
- [35] Wen-Ping H. Genetic diversity of Yunnan local chicken breeds and its relationship with origin of Chinese domestic chicken. *Biodiversity Science*. 1999;7:285
- [36] Okamoto S, Inafuku K, Ting Z, Maeda Y, Hou D, et al. Blood protein polymorphisms in native chicken breeds in Yunnan province of China. *Animal Science Journal*. 2003;74:471-476
- [37] Yina O, Qian R, Lindong Q, Limin S, Yongyun Z, et al. mtDNA D-loop genetic diversity analysis of Daweishan miniature chicken, Yunlong bantam chicken and Rabo tall chicken. *Journal of Yunnan Agricultural University: Natural Science Edition*. 2017;32:70-77
- [38] Wang X, Luo C, Tao Q, Sun L, Li Q, et al. Sequence variation of mtDNA D-loop and origin of Labai High-leg chicken. *China Poultry*. 2016;38:14-18
- [39] Li H-F, Chen K-W, Tang Q-P, Shen J-C, Zhang S-J. Analysis of Genetic Diversity of Microsatellite Marker of Chicken Breeds Indigenous to Yunnan Province of China. *Journal of Jiangsu Agricultural Sciences*. 2006;38:33-37, in Chinese
- [40] Ye L, Miao Y, Huo J. Genetic diversity of Chahua chicken based on microsatellite markers. *Chinese Journal of Zoology-Peking*. 2006;41:37
- [41] Lang Thui Y, Jin Tlong H, Yong Twang M, Sheng Tquan Z, Tao C, et al. Genetic Diversity Analysis of Nixi Chicken Using Microsatellite DNA Markers. *Zoological Research*. 2006;27:68-74
- [42] Jia J, Wen S, Xiong B, Ma Z, Miao Y, et al. Genetic diversity of Daweishan Mini chickens based on microsatellite markers. *Journal of Yunnan Agricultural University*. 2009;24:654-660
- [43] Qian L, Chen T, Huo J. Microsatellite DNA Variation within the Wuding Chicken Breed. *Journal-Yunnan Agricultural University*. 2006;21:651
- [44] Chen T, Y-w M, Huo J-l, Z-y YANG, Z-x LUO, et al. Genetic polymorphism of microsatellite DNA in the population of yanjin black-bone chicken. *Journal-Yunnan Agricultural University*. 2007;22:543
- [45] Wang Q, Li D, Guo A, Li M, Li L, et al. Whole-genome resequencing of Dulong Chicken reveal signatures of selection. *British Poultry Science*. 2020;61:624-631
- [46] Guo X, Fang Q, Ma C, Zhou B, Wan Y, Jiang R. Whole-genome resequencing of Xishuangbanna fighting chicken to identify signatures of selection. *Genetics Selection Evolution*. 2016;48:62
- [47] Liu R, Xing S, Wang J, Zheng M, Cui H, et al. A new chicken 55K SNP genotyping array. *BMC Genomics*. 2019;20:1-12
- [48] Wang M-S, Thakur M, Peng M-S, Jiang Y, Frantz LAF, et al. 863 genomes reveal the origin and domestication of chicken. *Cell Research*. 2020;30:693-701
- [49] Li D, Che T, Chen B, Tian S, Zhou X, et al. Genomic data for 78 chickens

from 14 populations. *Giga Science*. 2017;**6**:gix026

[50] Zhang C, Lin D, Wang Y, Peng D, Li H, et al. Widespread introgression in Chinese indigenous chicken breeds from commercial broiler. *Evolutionary Applications*. 2019;**12**:610-621

[51] Luo W, Luo C, Wang M, Guo L, Chen X, et al. Genome diversity of Chinese indigenous chicken and the selective signatures in Chinese gamecock chicken. *Scientific Reports*. 2020;**10**:1-14

[52] Tian M, Wang Y, Gu X, Feng C, Fang S, et al. Copy number variants in locally raised Chinese chicken genomes determined using array comparative genomic hybridization. *BMC Genomics*. 2013;**14**:262

[53] Qu L, Li X, Xu G, Chen K, Yang H, et al. Evaluation of genetic diversity in Chinese indigenous chicken breeds using microsatellite markers. *Science in China Series C: Life Sciences*. 2006;**49**:332-341

[54] Zhang T, Du W, Lu H, Wang L. Genetic Diversity of Mitochondrial DNA of Chinese Black-bone Chicken. *Brazilian Journal of Poultry Science*. 2018;**20**:565-572

[55] Miao Y, Peng M-S, Wu G-S, Ouyang Y, Yang Z, et al. Chicken domestication: an updated perspective based on mitochondrial genomes. *Heredity*. 2013;**110**:277-282