



Reproductive Characteristics of Dazu Black Goats, a Newly Discovered Chinese Indigenous Breed Resource with High Litter Sizes

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ABSTRACT

The reproductive characteristics of Dazu black goats (1056 kidding, 584 adult does and 224 adult bucks) have been researched in this study. The results showed that the age of puberty, sex maturity and breeding for male and female kids were 102.0±4.2 days vs. 117.0±8.7 days; 216.0±28.5 days vs. 195.0±22.4 days; 490.0±38.5 days vs. 355.0±27.5 days, respectively. Estrous cycle was 20.1±0.5 days. The duration of the natural estrous period of Dazu black goat (41.4±8.6 h) was longer than these reported goat breeds and was not significant difference among the different litter sizes does in the breed. The semen quality was high in different seasons. Dazu black goats might have shorter gestation period (147.9±1.7 days) and have longer kidding interval (237.8±4.6 days). The percentages of singletons, twins, triplets and quadruplets born were 1.98, 47.27, 40.02 and 10.29 %, respectively. The mean litter sizes (2.60±0.72) were the highest among the reported meat goat breeds in China. Dazu black goat reached the highest litter sizes (2.74±0.71) in the fourth kidding.

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Authors' Contribution

ZQZ and TYY designed research, performed research, analyzed data, and wrote the paper. All authors were involved in writing and revisions the manuscript.

Key words

Dazu black goats, Reproductive characteristics, Litter sizes, Age of puberty, Sex maturity.

INTRODUCTION

The level of reproductive performance of the goats is dependent on genetic and environmental factors, and this performance is particularly sensitive to the latter. For example, the management system, which includes the nutritional requirement and rearing environment, can affect reproductive performance considerably (Haniza *et al.*, 2017). Reproduction efficiency is determined by many different processes (Delgado, 2011) and these processes include age at first kidding, kidding interval, birth type and litter sizes at birth and weaning rate (Rhone *et al.*, 2013).

Dazu black goats live in Dazu county of Chongqing in China. This breed has absolutely black color pattern, high litter sizes, good meat quality and efficient disease resistance. They can live in humid heat environment and can rear coarse breeding. What we want to stress is that the mean litter sizes of Dazu black goats are particularly prominent. We compared the mean litter sizes of Dazu black goats with Matou goats, Korean local goats, Boer goats and improved Boer goats and the results showed that the mean litter sizes of Dazu black goats was significantly higher than others.

This population had been affirmed as a Chinese national livestock resource in 2009 and had been a

protected goat breed since 2014.

This paper reports the reproductive characteristics of Dazu black goats maintained under natural photoperiod and nutrition. The significance of this paper is to provide basic data for the effective protection of Dazu black goat as well as for further study on the mechanism of high reproduction of Dazu black goat.

MATERIALS AND METHODS

Study site

The data for this study were obtained from the flocks raised on Dazu black goat central breeding farm in Dazu County. The farm is at an elevation of 564 m, with a subtropical humid monsoon climate type, an annual mean atmospheric temperature of 17.3°C (ranging from -2°C to 39°C), an annual mean precipitation of 1004 mm, an annual mean sunlight length of 1279 h, mean relative humidity of 85% and an annual mean frost-free period of 323 days.

Animals and management

Records of 1056 kidding, 584 adult does and 224 adult bucks from 2003 to 2016, were used in this study. All goats were kept in housing, provided with a motion yard and fed thrice a day. Diet was mainly composed of fresh grass, dried hay and supplement concentrates which comprised of maize (75%), oil cake (10%), yeast powder (10%) and premix (5%). All goats were fed with mineral

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salt and water *ad libitum*. Animals were vaccinated in spring and autumn against epidemic diseases. All kids were kept with does until weaning at the age of 2 months.

This study was carried out in strict accordance with the recommendations in the Guide for the International Cooperation Committee of Animal Welfare (ICCAW), which is responsible for animal care and use in China. The experimental conditions were approved by the Committee on the Ethics of Animal Experiments of Southwest University (No. 2017-7) and the Animal Protection Law in China, and all efforts were made to minimize suffering.

Data analysis

All reproductive performance records were kept including puberty and sex maturity, estrous cycle, kidding interval, litter sizes and semen quality. Puberty of female kids which was considered as the age at which female kids expressed behavior of estrus (Gallego-Calvo *et al.*, 2015) in a mixed herd and for this purpose herd was observed by technical staff for 1 h twice a day *i.e.* in the morning and in the evening (584 female kids). Sex maturity was considered as the age at which kids have attained 60-75% of its mature bodyweight (Smith, 1980). Whereas, estrus cycle was taken as the time between the beginning of the previous estrus and the beginning of the subsequent estrus. Estrus duration was taken as from the onset of estrus symptoms to the disappearance of estrus symptoms in one estrus. The sperm motility was evaluated by 10-grade visual test. The sperm smears were fixed and the teratospermia rate, acrosome integrity and semen concentration were calculated by 1000 times microscopic examination after Coomassie blue staining.

Variance analysis and multiple-comparison of reproductive data were undertaken by SAS 9.0 software (SAS, 1997).

RESULTS

Puberty and sex maturity

The male and female goat kids attained puberty between 102.0±4.2 days (n=508) and 117.0±8.7 days (n=548), respectively. The mean body weight at puberty of Dazu black goats was 18.78±2.41 kg (n=508) about male and 15.44±2.12 kg (n=548) about female, respectively.

The age of sex maturity was 216.0±28.5 days (n=495) about male and 195.0±22.4 days (n=532) about female, respectively. Although Dazu black goats had early sex maturity, the age of breeding was 490.0±38.5 days (n=495) about male and 355.0±27.5 days (n=532) about female, respectively.

Estrous cycle

Estrous cycle of Dazu black goats was 20.1±0.5 days

(n=495). The time of estrous cycle in different seasons were not significant difference ($P>0.05$) (Table I), which indicated that the occurrence of estrous was almost the same in different seasons.

The duration of the natural estrous period in the mature Dazu black goats was 41.4±8.6 h (n=495), with a variation of 28-65 h among the individuals. The duration of estrous period was not significant difference among multiparous, biparous or primiparous does (49.5 versus 44.0 versus 48.3 h, respectively) ($P>0.05$).

Table I.- The time of estrous cycle in different seasons in Dazu black goat.

	Spring	Summer	Autumn	Winter
No. of does	501	468	577	424
Time of estrous cycle (days)	20.2±0.6	19.9±0.2	20.1±0.4	20.4±0.6

Kidding interval

The mean gestation period for Dazu black goats was 147.9±1.7 days (n=584). The does bearing singletons had a longer gestation period, compared with does bearing twins, triplets and quadruplets ($P<0.05$) (Table II). It indicated that the length of gestation would be shortened for does bearing multipllets.

The season of mating and nutrition on fetal development would scarcely affect the gestation length. Lactation period of Dazu black goats was 60 days. Does can rut about 10.2±3.5 days after weaning (n=2060). So the kidding interval for Dazu black goats was 237.8±4.6 days (n=584).

Table II.- The length of gestation period in does bearing different litter sizes.

	Number of kids per litter				Mean
	1	2	3	4	
No. of does	41	978	828	213	2060
Gestation period (days)	149.3±1.6 ^a	148.1±1.5 ^b	147.6±1.4 ^{bc}	146.7±1.4 ^c	147.9±1.7

Letters (a-c) with different superscripts means significant difference ($P<0.05$). Values having the same letters (b or c) mean no significant different ($P>0.05$).

Litter size

The percentages of singletons, twins, triplets and quadruplets born were 1.98, 47.27, 40.02 and 10.29 %, respectively. The mean litter size was 2.60±0.72 (n=584) (Table III). Dazu black goats had the lowest litter sizes in the first kidding (2.14±0.58) and came to the highest litter sizes (2.74±0.71) in the fourth kidding.

Table III.- Number and percentage (in brackets) of does kidding 1 to 5 kids per litter at parity 1 to 6.

Parity	No. of does	Number of kids per litter					Average
		1	2	3	4	5	
1	384	29(7.55)	287(74.74)	55(14.32)	13(3.39)	-	2.14±0.58
2	345	8(2.32)	142(41.16)	156(45.22)	39(11.30)	-	2.66±0.70
3	340	2(0.59)	140(41.18)	155(45.59)	40(11.76)	3 (0.88)	2.71±0.71
4	340	-	136(40.00)	158(46.47)	43(12.65)	3(0.88)	2.74±0.71
5	336	-	138(41.07)	156(46.43)	40(11.90)	2(0.60)	2.72±0.69
6	324	2(0.62)	135(41.67)	148(45.68)	38(11.73)	1(0.30)	2.69±0.69
Total	2069	41(1.98)	978(47.27)	828(40.02)	213(10.29)	9(0.44)	2.60±0.72

Table IV.- Seasonal variation of sperm characteristics in bucks.

Indexes	Spring	Summer	Autumn	Winter
No. of bucks	224	224	224	224
Ejaculate volume (ml)	0.98±0.22	0.92±0.29	1.02±0.17	0.94±0.22
Motility rate (%)	84.32±10.47	75.83±15.05	88.28±9.58	76.23±14.87
Teratospermia rate (%)	12.33±4.21	15.81±5.59	11.24±3.42	14.25±4.82
Acrosome integrity (%)	92.35±2.87	89.23±3.38	93.45±2.65	90.15±2.24
Concentration (10 ⁹ /ml)	2.26±0.57	1.92±0.36	2.33±0.48	1.98±0.45

Semen quality

The fresh semen of normal adult Dazu black bucks was collected by artificial vagina method. The semen quality in moderate climatic conditions (spring and autumn) was significantly higher, compared with hot-wet periods (summer) ($P<0.05$) (Table IV). There were not significant differences between summer and winter ($P>0.05$). But the semen quality in hot-wet periods can also come to normal level. So semen quality showed a marked and significant seasonal effect.

DISCUSSION

Puberty

The age at puberty of the female about Dazu black goats was somewhat earlier than the Saanen (217.9 days), the Angora (240 days), Black Bengal (196.5 days), Barbari nannies (213 days), Boer goats (157.2 days) and North Moroccan goats (278 days) (Notter, 2012; Ince, 2010; Snyman, 2004; Menezes *et al.*, 2016; Chentoufa *et al.*, 2011). But live weight in puberty was comparable to North Moroccan indigenous goats (Chentoufa *et al.*, 2011), Saanen goats (Freitas *et al.*, 2004) and the Payoya goats (Zarazaga *et al.*, 2009). It displayed Dazu black goats had the potentiality of advanced utilization.

Estrus

Many goat breeds display significant characteristics of seasonal estrus, but some goat breeds are non-seasonal in estrus, such as Boer goats (Lehloeny *et al.*, 2008) and Jining grey goats (Shi *et al.*, 2015). Non-seasonal estrus of Dazu black goats might be concerned with their living

geographical environment and climatic condition.

Angora goats and Mossi goats were known to have a short estrus lasting only 22 h and 20 h, respectively (McGregor, 2018; Montaldo *et al.*, 2010). Creole goats exhibited 27 h of estrous behavior and French Alpine goats were reported to experience a 31 h estrus (Eyduran *et al.*, 2017). In Boer goats, the mean duration of estrous period was about 37 h (Menezes *et al.*, 2016) and it was of about 58 h in Chinese Matou goats (Moaeeen-ud-Din *et al.*, 2008). The mean duration of estrous period in Dazu black goats was longer than these goat breeds, which might be one of reasons for highly reproductive ability of Dazu black goats.

Litter sizes and gestation

The percentages of singletons, twins, triplets and quadruplets born in different goat breeds have been some reports. Matou goats were 27.4, 45.4, 16.3 and 10.9%, respectively (Moaeeen-ud-Din *et al.*, 2008). Korean native goats were 40.6, 50.4, 8.0 and 1.0% under the extensive and 33.8, 54.4, 11.4 and 0.4% under the intensive environments, respectively (Song *et al.*, 2006). Boer goats were 24.5, 59.2, 15.3 and 1.0%, respectively (Duricic *et al.*, 2012), and fecundity of improved Boer goats was 210% (Mbuku *et al.*, 2015). The mean litter sizes of Dazu black goats were the highest among reported goat breeds (Oliveira *et al.*, 2017; Ince, 2010; Ceyhan and Karadag, 2009; Bingöl *et al.*, 2012; Duricic *et al.*, 2012; Song *et al.*, 2006; Moaeeen-ud-Din *et al.*, 2008).

The result about the effect of the litter size on the gestation was consistent with the previous researches in other goat breeds (Sousa *et al.*, 1999; Lehloeny *et al.*,

2005; Khanum *et al.*, 2006). It seems that the mean gestation length of Dazu black goats is shorter than Murciano-granadina goats (Roca *et al.*, 1992), Boer goats (Menezes *et al.*, 2016), Chinese Matou goats (Moaeen-ud-Din *et al.*, 2008) and North Moroccan indigenous goats (Chentoufa *et al.*, 2011). This may be also one of the reasons for highly reproductive ability of Dazu black goats.

Seasonal effect of semen quality

Semen quality showed a marked and significant seasonal effect in Murciano-granadina goats (López-Fernández *et al.*, 2011), Alpine, Saanen and Damascus (Karagiannidis *et al.*, 2000), Damascus goat (Al-Ghalban *et al.*, 2004), Zairi goats (Barkawi *et al.*, 2006), Rayini goats (Zamiri and Heidari, 2006) and Payoya goats (Zarazaga *et al.*, 2009). Although semen quality of Dazu black goats showed marked seasonal effect, semen in different seasons can both come to normal level. So it reflected the male had high reproductive ability.

CONCLUSION

Dazu black goats have earlier puberty and sex maturity, longer duration of estrous period, shorter gestation and high semen quality in different seasons. These factors decide Dazu black goats have high litter sizes. Dazu black goats are excellent goat breeds and can be used to research the hereditary basis of high fecundity about goats.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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