

Full Length Research Paper

Seroprevalence of chlamydial infection in dairy goats in Shaanxi Province, Northwestern China

Guang-Hui Zhao^{1,2,3}, Chuan-Chuan Shang¹, Yan-Qing Zhao¹, Man Gao¹, Guo-Ying Fan⁴, Ting-Ting Tian¹, Yun-Liang Yao¹, De-Kun Chen^{1*} and Xing-Quan Zhu^{2,5*}

¹College of Veterinary Medicine, Northwest A & F University, Yangling, Shaanxi Province 712100, People's Republic of China.

²State Key Laboratory of Veterinary Etiological Biology, Lanzhou Veterinary Research Institute, Chinese Academy of Agricultural Sciences, Lanzhou, Gansu Province 730046, People's Republic of China.

³College of Veterinary Medicine, China Agricultural University, Beijing 100193, People's Republic of China.

⁴College of Animal Science, Henan Institute of Science and Technology, Xinxiang 453003, People's Republic of China.

⁵College of Animal Science and Veterinary Medicine, Heilongjiang Bayi Agricultural University, Daqing, Heilongjiang Province 163319, People's Republic of China.

Accepted 4 November, 2011

The prevalence of chlamydial infection in dairy goats in Shaanxi province, Northwestern China was determined by indirect hemagglutination antibody (IHA) on serum samples from 729 dairy goats (263 Saanen dairy goats and 466 Guanzhong dairy goats). Antibodies to *Chlamydomphila* sp. were detected in 21 (2.88%) serum samples, with antibody titers ranging from 1:16 to 1:64. Seropositive goats were found only in three (Zhuangli town, Wangliao town and Yangling district) of the nine locations/herds examined in six counties. The prevalence of chlamydial infection was significantly related with locations/herds ($\chi^2 = 54.36$, $P = 0.00$) and breeds ($\chi^2 = 56.50$, $P = 0.00$). Both Saanen and Guanzhong dairy goats were positive for chlamydial infection, with higher seroprevalence in Saanen dairy goats (5.70%, 15/263) than that in Guanzhong dairy goat (1.29%, 6/466). The results of the present study indicate that more integrated strategies should be carried out to prevent and control chlamydiosis in goats in Shaanxi province.

Key words: Seroprevalence, chlamydial infection, dairy goats, Shaanxi Province, Northwestern China.

INTRODUCTION

Chlamydiosis caused by the obligate intracellular gram-negative bacteria in the genus *Chlamydomphila* (*Cp.*), is one of the major abortion diseases in animals and humans (Donn et al., 1997; Szeredi and Bacsadi, 2002; Pantchev et al., 2010; Xu et al., 2010). According to current taxonomy based on morphological characters and 16S rRNA and 23S rRNA gene sequences, six species were identified in the genus *Chlamydomphila*, namely *Chlamydomphila psittaci*, *Chlamydomphila abortus*, *Chlamydomphila pecorum*, *Chlamydomphila felis*,

Chlamydomphila caviae and *Chlamydomphila pneumoniae* (Everett et al., 1999; Siarkou et al., 2002; Pantchev et al., 2010). Among these species, *C. abortus*, formerly known as "*Chlamydia psittaci*-serotype 1", is one of the most important causes of reproductive failure in sheep and goats, especially in the intensively managed farms (Perez-Martinez and Storz, 1985; Nietfeld, 2001). The disease caused by *C. abortus* usually presents ulceration of intra-caruncular areas of endometrial epithelium leading to placental infection and abortion in the last two to three weeks of gestation regardless of when the animal was infected, and also manifests epididymitis, pneumonia, arthritis and conjunctivitis (Rekiki et al., 2002; Amin, 2003; Zhong, 2009). *C. abortus* strains have also been isolated from faeces of healthy sheep and goats (Salinas et al., 1995; Siarkou et al., 2002).

*Corresponding author. E-mail: cdk@nwsuaf.edu.cn; xingquan.zhu1@hotmail.com. Tel: +86 931 8342837. Fax: +86 931 8340977.

Table 1. Prevalence of chlamydial infection in goats in People's Republic of China (PRC) examined by indirect hemagglutination test (IHA).

Province	Usage	No. tested	Prevalence (%)	Time tested (year)	Reference
Qinghai	Down	100	26.00	Unknown	Shi, 2009
Guangxi	Meat	2168	1.98	1996 - 1998	Wu et al., 2000
Henan	Meat	211	4.48	2003 - 2004	Wang et al., 2004
Shaanxi	Dairy	308	1.90	2001	Yang et al., 2002
	Dairy or meat	965	2.2	2001	Yang et al., 2002

Chlamydial infection of goats have been reported in many countries such as Poland, Tobago and Hungary (Donn et al., 1997; Wang et al., 2001; Borde et al., 2006; Szeredi et al., 2006; Czopowicz et al., 2010), as well as China. Table 1 summarize surveys of chlamydial infection in goats in some provinces of the People's Republic of China (PRC) which were published in the Chinese language in local journals and are not readily accessible to international readers. In recent years, much interest in rearing of dairy goats was observed among many countries including China, since consumption of goat milk is elevated in children with allergy to cow milk and also because of its similar composition to human milk (Figueiredo et al., 2001; Zhao et al., 2011). Therefore, the objectives of the present survey were to investigate the seroprevalence and associated factors of chlamydial infection in dairy goats in Shaanxi province, Northwestern China.

MATERIALS AND METHODS

Experimental animals

Blood samples were obtained from 729 dairy goats between September and October 2010, from nine randomly selected farms in six counties in Shaanxi Province. Details of locations/herds and breeds of goats, and other characteristics are listed in Table 2. Animals were farmed in extensive production systems for meat and milk and were generally kept in small herds of 20 to 200 animals. Natural breeding was the sole means of reproduction and goats from outside breeding stocks was rarely purchased. Goats were fed in-house with no grazing. In local practice, both Guanzhong and Saanen dairy goats were crossed with Saanen male goats, therefore, our study included only male goats for the Saanen breed.

Blood sampling and serological examination

Approximately 3 ml of blood were obtained via a jugular vein, centrifuged at 2000 *g* for 5 min and stored at -20°C. Antibodies to chlamydial infection were determined in sera using an indirect hemagglutination antibody (IHA) test with a commercially available kit (Lanzhou Veterinary Research Institute, Chinese Academy of Agricultural Sciences, Lanzhou, Gansu Province, China) according to the manufacturer's instructions and the method of Xu et al. (2010). In brief, 75 μ L of IHA dilution solution was transferred into 96 well V bottomed polystyrene plates with 25 μ L of sera added and diluted in a four-fold series from 1:4 to 1:64. The plates were shaken for 2 min and then incubated at 37°C for 2 h without shaking. The test was considered positive when a layer of agglutinated erythrocytes was formed in wells at dilutions of 1:16 or

higher, and positive and negative controls were included in each test.

Statistical analysis

Differences in seroprevalence of infected goats between the two breeds and among associated factors (location/herd, gender and age) were analyzed using the binary logistic regression in SPSS for Windows (Release 17.0 standard version, SPSS Inc., Chicago, IL, USA), and 95% confidence intervals (CI) was given (Zhao et al., 2011). The differences between levels within factors and interactions were considered to be statistically significant and highly significant when $P < 0.05$ and $P < 0.01$, respectively.

RESULTS AND DISCUSSION

In the present study, of the nine locations/herds in the six counties examined, only three locations/herds (one for Saanen dairy goats and two for Guanzhong dairy goats) were positive for antibodies to chlamydial infection, giving farm prevalence of 66.7% (Table 2). A total of 729 dairy goats (263 for Saanen dairy goats and 466 for Guanzhong dairy goats) were investigated. Of these, 67 were male, while 662 were female (Table 2). The binary logistic regression showed that location ($\chi^2 = 54.36$, $P = 0.00$) and breed ($\chi^2 = 56.50$, $P = 0.00$) were highly significantly associated with prevalence of infection in dairy goats. Prevalence of individual locations/herds ranged from 0 to 14.29%, with an overall seroprevalence of 2.88% (21/728). The antibody titers were 1:16 to 1:64, with 1:16 in 14 dairy goats and 1:64 in 7 dairy goats.

More also, both Saanen and Guanzhong dairy goats were positive for chlamydial infection, with higher seroprevalence in Saanen dairy goats (5.70%, 15/263) than in Guanzhong dairy goats (1.29%, 6/466). The seroprevalence in male goats (4.48%) was higher than that in females (2.72%), but the difference was not statistically significant ($P > 0.05$) (Table 2). Seroprevalence in goats was different with age, and prevalence in older goats (>1 year old) was higher than that in animals below 1 year old, but the highest prevalence (10.17%) of chlamydial infection was found in the goats between 1 and 2 years old. This investigation showed that location/herd and breed were the main factors to affect seroprevalence of chlamydial infection in dairy goats. The prevalence of dairy goats in Shaanxi province reported in the present study was lower than that in Qinghai (Shi,

Table 2. Factors associated with seroprevalence of chlamydial infection in dairy goats in Shaanxi Province, Northwestern China.

Factor	Category	No. examined	No. positive	Prevalence (%)
Breed	Saanen dairy goat	263	15	5.70
	Guanzhong dairy goat	466	6	1.29
Sex	Male	67	3	4.48
	Female	662	18	2.72
Age	<1 year	160	3	1.88
	1 - 2 years	59	6	10.17
	>2 years	510	12	2.35
Location/Herd	Zhuangli town, Fuping county	88	6	6.82
	Wangliao town, Fuping county	117	1	0.85
	Dongshangguan, Fuping county	126	0	0.00
	Mizi town, Fuping county	160	0	0.00
	Yangling district	98	14	14.29
	Qianyang county	39	0	0.00
	Fengxiang county	29	0	0.00
	Baishui county	29	0	0.00
Chunhua county	43	0	0.00	
Total		729	21	2.88

2009) and Henan provinces (Wang et al., 2004) in PRC, but higher than that in Guangxi (Wu et al., 2000) (Table 1), which further indicated that goats in different locations were different in susceptibility to chlamydial infection.

Seroprevalence of chlamydial infection in dairy goats in the present study was higher than that reported in 2002 by Yang et al. (2002) (Table 1), thus suggesting that prevalence of chlamydial infection may be elevating in this province. The seroprevalence in Guanzhong dairy goats was lower than that in Saanen dairy goats. The possible explanation was that Guanzhong dairy goat is a native breed in Shaanxi province crossed with Saanen goats and may therefore get much more resistance to chlamydial infection than the pure breed of Saanen dairy goat.

In conclusion, the antibodies to *Chlamydomphila* were found in both Guanzhong and Saanen dairy goats, and the seroprevalence were highly associated with breed and geographical locations/herds. The seroprevalence of chlamydial infection in dairy goats in Shaanxi province is increasing with years. These results would have important implications for the prevention and control of chlamydiosis in dairy goats in this province.

ACKNOWLEDGEMENTS

Project support was provided in part by grants from the special fund for Agro-scientific Research in the Public Interest (Grant No. 201103038) to JL, the State Key

Laboratory of Veterinary Etiological Biology, Lanzhou Veterinary Research Institute, Chinese Academy of Agricultural Sciences (Grant No. SKLVEB2011KFKT011), and the special funds for Talents in Northwest Agriculture and Forestry University (Grant nos. Z109021107 and 2010BSJJ015) to GHZ.

REFERENCES

- Amin AS (2003). Application of touchdown enzyme time release (TETR)-PCR for diagnosis of *Chlamydomphila abortus* infection. Res. Vet. Sci. 74: 213-217.
- Borde G, Lowhar G, Adesiyun AA (2006). *Toxoplasma gondii* and *Chlamydomphila abortus* in caprine abortions in Tobago: a sero-epidemiological study. J. Vet. Med. B Infect. Dis. Vet. Public Health, 53: 188-193.
- Czopowicz M, Kaba J, Szalu-Jordanow O, Nowicki M, Witkowski L, Nowicka D, Frymus T (2010). Prevalence of antibodies against *Chlamydomphila abortus* and *Coxiella burnetii* in goat herds in Poland. Pol. J. Vet. Sci. 13: 175-179.
- Donn A, Jones GE, Ruiu A, Ladu M, Machell J, Stancanelli A (1997). Serological diagnosis of chlamydial abortion in sheep and goats: comparison of the complement fixation test and an enzyme-linked immunosorbent assay employing solubilised proteins as antigen. Vet. Microbiol. 59: 27-36.
- Everett KDE, Bush RM, Andersen AA (1999). Emended description of the order Chlamydiales, proposal of *Parachlamydiaceae* fam. nov. and *Simkaniaceae* fam. nov., each containing one monotypic genus, revised taxonomy of the family Chlamydiaceae, including a new genus and five new species, and standards for the identification of organisms. Int. J. Syst. Evol. Microbiol. 49: 415-440.
- Figueiredo JF, Silva DA, Cabral DD, Mineo JR (2001) Seroprevalence of *Toxoplasma gondii* infection in goats by the indirect haemagglutination, immunofluorescence and immunoenzymatic tests in the region of Uberlândia, Brazil. Mem. Inst. Oswaldo. Cruz. 96:

- 687-692.
- Nietfeld JC (2001). Chlamydial infections in small ruminants. *Vet. Clin. North Am. Food Anim. Pract.* 17: 301-314.
- Pantchev A, Sting R, Bauerfeind R, Tyczka J, Sachse K (2010). Detection of all *Chlamydomphila* and *Chlamydia* spp. of veterinary interest using species-specific real-time PCR assays. *Comp. Immunol. Microbiol. Infect. Dis.* 33: 473-484.
- Perez-Martinez JA, Storz J (1985). Antigenic diversity of *Chlamydia psittaci* of mammalian origin determined by microimmunofluorescence. *Infect. Immun.* 50: 905-910.
- Rekiki A, Sidi-Boumedine K, Souriau A, Jemli J, Hammami S, Rodolakis A (2002). Isolation and characterisation of local strains of *Chlamydomphila abortus* (*Chlamydia psittaci* serotype 1) from Tunisia. *Vet. Res.* 33: 215-222.
- Salinas J, Souriau A, Cuello F, Rodolakis A (1995). Antigenic diversity of ruminant *Chlamydomphila psittaci* strains demonstrated by the indirect microimmunofluorescence test with monoclonal antibodies. *Vet. Microbiol.* 43: 219-226.
- Shi SJ (2009). Serological investigation of chlamydiosis in down producing goats in Delingha city, China. *Qinghai J. Anim. Vet. Sci.* 39: p. 24.
- Siarkou V, Lambropoulos AF, Chrisafi S, Kotsis A, Papadopoulos O (2002). Subspecies variation in Greek strains of *Chlamydomphila abortus*. *Vet. Microbiol.* 85: 145-157.
- Szeredi L, Bacsadi A (2002). Detection of *Chlamydomphila* (*Chlamydia*) *abortus* and *Toxoplasma gondii* in smears from cases of ovine and caprine abortion by the streptavidin-biotin method. *J. Comp. Pathol.* 127: 257-263.
- Szeredi L, Jánosi S, Tenk M, Tekes L, Bozsó M, Deim Z, Molnár T (2006). Epidemiological and pathological study on the causes of abortion in sheep and goats in Hungary (1998-2005). *Acta Vet. Hung.* 54: 503-515.
- Wang FI, Shieh H, Liao YK (2001). Prevalence of *Chlamydomphila abortus* infection in domesticated ruminants in Taiwan. *J. Vet. Med. Sci.* 63: 1215-1220.
- Wang YZ, Yan MX, Li XL, Xu GC, Zhu H, Wang D, Zhang L, Ye BH (2004). Serological investigation of chlamydiosis in goats in several regions of Henan province. *Prog. Vet. Med.* 25: p. 133.
- Wu LJ, Liu Q, Zheng LF, Chen ZX, Teng BZ (2000). Serological investigation of chlamydiosis in goats in Guangxi. *Chinese J. Vet. Sci. Technol.* 30: 41.
- Xu MJ, He Y, Liang R, Zhou DH, Lin RQ, Yin CC, He XH, Liang M, Zhu XQ (2010). Seroprevalence of *Chlamydia* infection in pigs from intensive farms in southern China. *J. Anim. Vet. Adv.* 9: 1143-1145.
- Yang ZQ, Zhang SX, Du EQ, Jin LF, Zhao YF, Cao GR, Yan SC (2002). Serological investigation of brucellosis, bluetongue, and chlamydiosis in goats. *Chinese J. Vet. Sci. Technol.* 32: 38-39.
- Zhao GH, Zhang MT, Lei LH, Shang CC, Cao DY, Tian TT, Li J, Xu JY, Yao YL, Chen DK, Zhu XQ (2011). Seroprevalence of *Toxoplasma gondii* infection in dairy goats in Shaanxi Province, Northwestern China. *Parasit. Vet.* 4: p. 47.
- Zhong G (2009). Killing me softly: chlamydial use of proteolysis for evading host defenses. *Trend Microbiol.* 17: 467-474.