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Original Article

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Abstract

To determine the seroprevalence of caprine arthritis-encephalitis virus infection (CAEV) in goats in the Western part of Thailand, a cross-sectional serological survey was conducted in three provinces, Ratchaburi, Petchaburi and Kanchanaburi, situated in the western part of the country along the border area. A total of 1,129 serum samples from 74 randomly selected goat farms containing different breeds of goats were collected during the period from November 2009 to January 2011. Seroprevalence of CAEV antibodies was determined using competitive enzyme-linked immunosorbent assay (cELISA) test. To investigate the risk factors associated with the seroprevalence of CAEV antibodies, semi-structural questionnaires were developed and presented to farm owners to get necessary information. Univariable analysis using chi-square test was employed to find out an association between seropositivity of CAEV and each hypothesized risk factor on both herd and individual levels. A total of 67 goats were found seropositive with overall prevalence of 5.9% and true prevalence of 5.52% respectively. On herd level, 23 farms out of 74 were found seropositive with the prevalence of 31%. Multivariable logistic regression model revealed herd type (p=0.034; OR=5.026; 95% CI=1.130-22.360), herd size (p=0.006; OR=24.065; 95% CI=2.466-234.788), contact with goats from other herds (p=0.008; OR=8.526; 95% CI=1.762-41.25), and addition of new goats into herd (p=0.044, OR=4.396; 95% CI=1.044-18.51) as risk factors for CAEV seropositivity on herd level analysis. On individual level, age of 3 years and above (p=0.001, OR=4.288, 95% CI=1.809-10.163), herd size (p<0.001, OR=17.971, 95% CI= 7.787-41.475), and addition of new goats into herd were found to be risk factors associated with seroprevalence of CAEV antibodies. The results showed that CAEV infection existed in goat herds in the Western part of Thailand, with some risk factors to be aware of in order to minimize the occurrence of, and economic losses due to, CAEV infection in the coming future.

Keywords: Caprine arthritis-encephalitis virus (CAEV), cELISA, goats, risk factors, seroprevalence

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บทคัดย่อ

ความชุกและปัจจัยเสี่ยงที่เกี่ยวพันกับการติดเชื้อไวรัสข้ออักเสบและสมองอักเสบในแพะในภาคตะวันตกของประเทศไทย

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การศึกษานี้เพื่อยืนยันความชุกและปัจจัยเสี่ยงต่อโรคไวรัสข้ออักเสบและสมองอักเสบในแพะในภาคตะวันตกของประเทศไทย ทำการสำรวจข้อมูลทางซีรั่มวิทยาในจังหวัดราชบุรี เพชรบุรี และกาญจนบุรี จำนวนทั้งหมด 1,129 ตัวอย่าง จากฟาร์มแพะที่มีพันธุ์แตกต่างกัน และถูกเลือกมาแบบสุ่มจำนวน 74 ฟาร์ม ตั้งแต่เดือนพฤศจิกายน 2552 ถึงมกราคม 2554 ตรวจหาแอนติบอดี้จากซีรั่มของโรคไวรัสข้ออักเสบและสมองอักเสบในแพะโดยใช้วิธี cELISA นอกจากนี้ยังสำรวจปัจจัยเสี่ยงที่ส่งผลต่อการติดเชื้อโรคไวรัสข้ออักเสบและสมองอักเสบในแพะ โดยใช้แบบสำรวจความคิดเห็นเพื่อเก็บข้อมูลที่จำเป็นจากเจ้าของฟาร์ม ทำการวิเคราะห์ทีละตัวแปร โดยใช้ไคสแควร์เพื่อหาความเกี่ยวเนื่องระหว่างผลบวกของโรคไวรัสข้ออักเสบและสมองอักเสบในแพะในน้ำเหลืองกับปัจจัยเสี่ยงที่เป็นสมมติฐานทั้งแบบฝูงและแยกรายตัว การศึกษาพบว่าจำนวนแพะที่ให้ผลบวกต่อการตรวจหาความชุกมีจำนวน 67 ตัว คิดเป็นร้อยละ 5.9 ในระดับฝูง ในจำนวน 74 ฟาร์ม ตรวจพบหลักฐานการติดเชื้อที่ 23 ฟาร์ม คิดเป็นร้อยละ 31 ในการวิเคราะห์แบบถดถอยพหุลอจิสติกแสดงให้เห็นว่าความชุกดังกล่าวสัมพันธ์กับปัจจัยความเสี่ยงต่าง ๆ ในระดับฝูง พบว่าชนิดของฝูง (p=0.034; OR=5.026; 95% CI=1.130-22.360) ขนาดของฝูง (p=0.006; OR= 24.065; 95% CI= 2.466-234.788) การติดต่อจากแพะจากฝูงอื่น (p=0.008; OR= 8.526; 95% CI= 1.762-41.25) การเพิ่มแพะใหม่ในฝูง (p= 0.044, OR= 4.396; 95% CI= 1.044-18.51) เป็นปัจจัยเสี่ยงในการติดเชื้อโรคไวรัสข้ออักเสบและสมองอักเสบในแพะ ในการวิเคราะห์แบบแยกเป็นรายตัว แพะอายุตั้งแต่ 3 ปีขึ้นไป (p=0.001, OR=4.288, 95% CI=1.809-10.163) ขนาดฝูง (p< 0.001, OR= 17.971, 95% CI=7.787-41.475) และการเพิ่มแพะใหม่ในฝูงเป็นปัจจัยเสี่ยงที่สัมพันธ์กับความชุกของโรคไวรัสข้ออักเสบและสมองอักเสบในแพะ ผลการทดลองแสดงให้เห็นว่าฝูงแพะในภาคตะวันตกของประเทศไทยมีการติดเชื้อไวรัสข้ออักเสบและสมองอักเสบ และมีปัจจัยเสี่ยงที่ควรจะต้องตระหนักเพื่อลดการเกิดโรคและความสูญเสียทางเศรษฐกิจ

คำสำคัญ: ไวรัสข้ออักเสบและสมองอักเสบในแพะ cELISA แพะ ปัจจัยเสี่ยงความชุกทางน้ำเหลือง

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Introduction

Caprine arthritis encephalitis (CAE) is an important viral disease of goats caused by caprine arthritis-encephalitis virus (CAEV), a lentivirus of the family Retroviridae (Al-Ani and Vestweber, 1984). CAEV produces an insidious, chronic, and slowly progressive systemic inflammatory infection (Lamara et al., 2002; de Andrés et al., 2005; Ceciliani et al., 2009), mainly characterized by polyarthritis, interstitial pneumonia, indurative mastitis, and progressive weight loss in adult goats and encephalitis in kids (Al-Ani and Vestweber, 1984; Rodriguez et al., 2005). Having a long incubation period followed by a persistent clinical course (Nord et al., 1998a), CAEV will infect its host for life once the infection is established, despite the presence of humoral and cell mediated immune response (Karanikolaou et al., 2005; Elfahal et al., 2010). All infected animals become potential transmitters of virus, nevertheless most of which are usually asymptomatic sub-clinical carriers (Archambault et al., 1988; Plaza et al., 2009). Transmission primarily takes place via ingestion of virus-infected colostrums or goat milk (deMaar et al., 1995), regardless of the presence of maternal antibody (Knight and Jokinen, 1982), and less commonly by other routes such as direct contact, bodily secretions, and excretions (East et al., 1993; Leitner et al., 2010). However, unlike other lentiviruses, sexual transmission has not yet been well defined for CAEV (Travassos et al., 1999; Ali Al Ahmad et al., 2008[b]).

CAEV is worldwide in distribution (Gufler et al., 2007a). It has been detected in many parts of the

world since its first documentation in goats in 1974 (Kusza et al., 2004; Peterhans et al., 2004). Prevalence of CAE around the world has passed over a wide range of variation among different countries, which may be as low as 1.9% in Turkey and 3.6% in Mexico, or even up to as high as 73% in USA and 82% in Australia (Al-Qudah et al., 2006). In Thailand, prevalence of CAEV was reported to be 12.4% (Ratanapob et al., 2009).

To date, no treatment has come out yet for the relief of CAEV infection (Reina et al., 2009); therefore early detection of infection using serological diagnostic methods (Kwang et al., 1995; Cortez-Moreira et al., 2005) is still a vital approach for prevention, control and eradication of CAEV infection (Eltahir et al., 2006; Brinkhof et al., 2009; Reina et al., 2009).

The objective of this study was to determine the seroprevalence of CAEV antibodies and to investigate potential risk factors associated with the prevalence of CAEV infection in the population of goats raised in the Western part of Thailand.

Materials and Methods

Study design and study area: During the period between November 2009 to January 2011, a cross-sectional study with two stage sampling design was carried out to find out the seroprevalence and risk factors associated with CAEV infection among the goat herds in the western part of Thailand. This study region included three Western provinces, namely Kanchanaburi, Ratchaburi, and Petchaburi, situated along the border, adjacent to Tanintharyi division of Myanmar on their west.

Sample size determination: Total population of goats in the studied area, three provinces as a whole Western part, was approximately 40,000 heads. Sample size of 1,044, taken as 1,100, was calculated using the expected prevalence of 12.40% (Ratanapob et al., 2009), with allowable error of 0.02 at 95% confidence interval. Then, the number of animals to be sampled from each herd was determined using expected within herd prevalence of 15% and confidence interval of 95% with the herd size of 200. Number of animals to be sampled from each herd was:

$$n=[1-(1-p\_1)^{(1/d)}][N-d/2]+1 = 18$$

where n is the number of animals to be sampled from each herd, p1 is the probability of detecting at least one seropositive animal from a herd, and d represents expected prevalence of disease within a herd (Thrusfield, 2005).

Herd size in this study region ranged from 5 to 200, and it was separated into 3 categories; small (1-50 goats), medium (51-100 goats) and large (more than 100 goats).

Sampling: A total of 74 goat farms (56 meat goat farms and 18 dairy goat farms) were randomly selected from the total population in the study region. From each selected farm, 18 goats were sampled for blood. With those farms having less than 18 animals, all animals were sampled. All animals in the herds were randomly selected, regardless of age and sex. Five ml of blood samples were collected from the jugular vein of each goat, using vacutainer tubes and disposable needles. Afterwards, all sera were centrifuged and stored at -20°C until analysis.

Questionnaires: Semi-structural questionnaires were developed, farmers were asked to participate in the interview focusing on general information of the farm, including health status of animals, history of diseases and farm management practice.

Analysis of serum samples: Collected sera were then analysed for the presence of CAEV antibodies using commercially available competitive ELISA (cELISA) test kits (VMRD Inc., Pullman, WA, USA), which comes with microtiter plates containing 96 CAEV antigen-coated wells. Test kit includes both positive and negative controls. The sensitivity and specificity of cELISA test kit is 100 and 99.6% according to manufacturer. All laboratory procedures were carried out in accordance with manufacturer's instruction. Optical density (OD) values obtained from plate reader were calculated to obtain percent inhibition (%I) as follows:

%I= 100 - [Sample OD x 100], in which samples producing more than 35% inhibition were defined positive, while those producing less than 35% were defined negative.

Statistical analysis: Analysis of data was carried out using Microsoft office excel 2007 and statistical package for social science (SPSS for windows, version 16.0, SPSS Inc., Chicago, USA). Seroprevalence of CAEV antibodies was calculated both on herd and individual level prevalence. True prevalence was estimated from apparent prevalence using sensitivity and specificity of the test.

$$TP= (Ap+Sp-1)/(Se+Sp-1)$$

Where TP represents true prevalence, AP is the apparent prevalence, and Se stands for sensitivity of the test (Thrusfield, 2005).

Associations between seropositivity of CAEV infection and hypothesized risk factors, on both individual and herd level prevalence, were primarily checked out in case-control design, where seropositive and seronegative groups were compared in terms of exposure to hypothesized risk factors (Abo-Shehada and Abu-Halaweh, 2010), and analysed by univariate analysis using chi-square test. Variables that showed significant association with p value less than 0.05 (two-sided) at univariate analysis were then advanced to multivariable logistic regression model analysis. Hosmer and Lemeshow's goodness of fit statistic test was applied, and backward-stepwise method was performed to filter the variables.

Table 1 Results of univariable analysis showing association between serological status of individual goat and different exposed factors

Factor	Category	Number	Positive (%)	Negative (%)	*p* value
Age	< 1 year	218	7 (3.2)	211 (96.8)	0.001*
	1 to 2 years	319	11 (3.4)	308 (96.6)	
	2 to 3 years	256	15 (5.9)	241 (94.1)	
	3 years and above	336	34 (10.1)	302 (89.9)	
Sex	Female	958	51 (5.3)	907 (94.7)	0.04*
	Male	171	16 (9.4)	155 (90.6)	
Herd type	Meat	838	40 (4.8)	798 (95.2)	0.005*
	Dairy	291	27 (9.3)	264 (90.7)	
Herd size	Small (0-50)	787	22 (2.8)	765 (97.2)	0.000*
	Medium	234	28 (12.0)	206 (88.0)	
	Large	108	17 (15.7)	91 (84.3)	
Breed	Native breed	69	1 (1.4)	68 (98.6)	0.003*
	Crossbreed	777	38 (4.9)	739 (95.1)	
	Saanen crossbreed	283	28 (9.9)	255 (90.1)	
Rearing system	Semi-intensive	895	46 (5.1)	849 (94.9)	0.027*
	Intensive	234	21 (9.0)	213 (91.0)	
Use of pasture	No	662	48 (7.3)	614 (92.7)	0.026*
	Yes	467	19 (4.1)	448 (95.9)	
Contact with other goats from other herds	No	875	53 (6.1)	822 (93.9)	0.746
	Yes	254	14 (5.5)	240 (94.5)	
Presence of other goat herds within 1 km distance	No	686	47 (6.9)	639 (93.1)	0.105
	Yes	443	20 (4.5)	423 (95.5)	
Male- female separation	No	773	52 (6.7)	721 (93.3)	0.097
	Yes	356	15 (4.2)	341 (95.8)	
Addition of new goats into herd	No	805	40 (5.0)	765 (95.0)	0.036*
	Yes	324	27 (8.3)	297 (91.7)	
Replacement policy	All-in-all-out	60	1 (1.7)	59 (98.3)	0.254
	Not all-in-all-out	1069	66 (6.2)	1003 (93.8)	
Use of disinfectants	No	206	11 (5.3)	195 (94.7)	0.686
	Yes	923	56 (6.1)	867 (93.9)	
Practice of FMD	No	403	21 (5.2)	382 (94.8)	0.443
	Yes	726	46 (6.3)	680 (93.7)	
Veterinary service	No	823	47 (5.7)	776 (94.3)	0.602
	Yes	306	20 (6.5)	286 (93.5)	
Presence of sheep in the	No	1079	67 (6.2)	1012 (93.8)	0.069
	Yes	50	0	50	
Presence of cattle in the	No	725	49 (6.8)	676 (93.2)	0.116
	Yes	404	18 (4.5)	386 (95.5)	
Breeding method	AI	121	3 (2.5)	118 (97.5)	0.089
	Natural mating	1008	64 (6.3)	944 (93.7)	
Previous case of CAE	No	767	38.0 (5.0)	729 (95.0)	0.042*
	Yes	362	29 (8.0)	333 (92.0)	
Knowledge of owner about	Without knowledge	810	51 (6.3)	759 (93.7)	0.412
	With knowledge	319	16 (5.0)	303 (95.0)	

** p value significant*

Results

Individual and herd seroprevalence: Of 1,129 samples tested, 67 were found seropositve to CAEV antibodies, showing apparent prevalence of 5.9% and true prevalence of 5.52%. At herd level, seroprevalence stood at 31%, where 23 farms out of 74 were found seropositive to CAEV antibodies.

Univariate analysis: On individual level prevalence, age, sex, herd type, herd size, breed, rearing system, use of pasture, addition of new animals, and previous outbreak of CAE showed significant associations (p<0.05) with the seropositivity of CAEV and were therefore advanced to multivariable logistic regression model (Table 1).

On herd level prevalence, herd type, herd size, breed, contact with goats from other herds, addition of new animals into herd, and previous outbreak of CAE were significantly associated (p<0.05) with the prevalence of CAEV infection and they were further analysed using multivariable logistic regression model (Table 2).

Multivariable analysis: Nine significant variables from individual level prevalence and six from herd level prevalence, with $p(\chi 2)$<0.05, on univariate analysis were accordingly transferred to multivariable logistic regression model for further evaluation of risk factors on both levels.

From multivariate analysis, on individual level, it was found that age of 3 years and above, herd size, and addition of new animals into herd were

significant (p<0.05) risk factors associated with the prevalence of CAEV infection (Table 3). On herd level, herd type, herd size, addition of new animals, and contact with goats from other herds were found as significant risk factors (p<0.05) related with the prevalence of CAEV infection among goat herds (Table 4).

Table 2 Results of univariable analysis showing association between serological status of goat herds and different exposed factors

Factor	Category	Number	Positive (%)	Negative (%)	*p* value
Herd type	Meat	56	13 (23.2)	43 (76.8)	0.01*
	Dairy	18	10 (55.6)	8 (44.4)	
Herd size	Small (0-50)	55	13 (23.6)	42 (76.4)	0.039*
	Medium	13	6 (46.2)	7 (53.8)	
	Large	6	4 (66.7)	2 (33.3)	
Breeds	Native breed	8	1 (12.5)	7 (87.5)	0.003*
	Crossbreed	49	11 (22.4)	38 (77.6)	
	Saanen crossbreed	17	11 (64.7)	6 (35.3)	
Rearing system	Semi-intensive	61	18 (29.5)	43 (70.5)	0.527
	Intensive	13	5 (38.5)	8 (61.5)	
Use of pasture	No	47	13 (27.7)	34 (72.3)	0.401
	Yes	27	10 (37.0)	17 (63.0)	
Contact with other goats from other herds	No	59	15 (25.4)	44 (74.6)	0.037*
	Yes	15	8 (53.3)	7 (46.7)	
Presence of other goat herds within 1 km distance	No	45	13 (28.9)	32 (71.1)	0.612
	Yes	29	10 (34.5)	19 (65.5)	
Male- female separation	No	53	17 (32.1)	36 (67.9)	0.769
	Yes	21	6 (28.6)	15 (71.4)	
Addition of new goats into herd	No	51	12 (23.5)	39 (76.5)	0.037*
	Yes	23	11 (47.8)	12 (52.2)	
Replacement policy	All-in-all-out	4	1 (25.0)	3 (75.0)	0.787
	Not all-in-all-out	70	22 (31.4)	48 (68.6)	
Use of disinfectants	No	18	6 (33.3)	12 (66.7)	0.812
	Yes	56	17 (30.4)	39 (69.6)	
Practice of FMD vaccination	No	31	10 (32.3)	21 (67.7)	0.853
	Yes	43	13 (30.2)	30 (69.8)	
Veterinary service	No	56	19 (33.9)	37 (66.1)	0.351
	Yes	18	4 (22.2)	14 (77.8)	
Presence of sheep in the herd	No	71	23 (32.4)	48 (67.6)	0.235
	Yes	3	0	3	
Presence of cattle in the herd	No	48	15 (31.2)	33 (68.8)	0.966
	Yes	26	8 (30.8)	18 (69.2)	
Breeding method	AI	7	2 (28.6)	5 (71.4)	0.879
	Natural mating	67	21 (31.3)	46 (68.7)	
Previous case of CAE	No	51	12 (23.5)	39 (76.5)	0.037*
	Yes	23	11 (47.8)	12 (52.2)	
Knowledge of owner about	Without knowledge	56	18 (32.1)	38 (67.9)	0.728
	With knowledge	18	5 (27.8)	13 (72.2)	

Table 3 Results from final logistic regression model showing risk factors associated with seroprevalence of CAEV antibodies in goats on individual level analysis

Risk factor	β	SE	Wald	95% CI	Odds	*P* value
Age (3 years and above)	1.456	0.440	10.935	1.809-10.163	4.288	0.001
Herd size						
Small (1-50)					1	
Medium (51-100)	2.153	0.337	40.814	4.448-16.671	8.612	< 0.001
Large (> 100)	2.889	0.427	45.832	7.787-41.475	17.971	< 0.001
Addition of new goats	1.715	0.337	25.935	2.873-10.758	5.559	< 0.001

β: Regression coefficient, SE: Standard error, Wald: Wald's statistical value

Discussion

In this study, overall seroprevalence of CAEV antibodies in the Western part of Thailand was 5.9%. It was relatively low, compared to a previous report on seroprevalence of CAEV infection in Thailand (Ratanapob et al., 2009) that stood at 12.4%. This can be either due to the achievement of CAE eradication program carried out by DLD (Department of Livestock Development, Thailand) or, also, probably due to the achievement of success in taking control measures against animal smuggling and live animal movement, which have been considered as an important cause of the spread of CAE between countries (Torres-Acosta et al., 2003; Blacklaws et al., 2004).

True prevalence, adjusted from the apparent prevalence of 5.9% in this study, 5.52%, was lower

than those reported in Somalia (6.0%) (Ghanem et al., 2009), Jordan (8.9%) (Al-Qudah et al., 2006), Brazil (14.1% and 8.2% respectively) (Lilenbaum et al., 2007; Bandeira et al., 2009), America (31%) (Cutlip et al., 1992), and Norway 42% (Nord et al., 1998[b]). However, on the other hand, it was higher than those reported in Mexico (0.4%) (Torres-Acosta et al., 2003), Saudi Arabia (0.8%) (Alluwaimi et al., 1990), Turkey (1.9%) (1994; Aslantas et al., 2005), and Italy (4.0%) (Gufler and Baumgartner, 2007[b]).

On herd level, seroprevalence of this study (31%) was relatively high, compared to that of 3.6% in Mexico (Torres-Acosta et al., 2003), 10.3% in Great Britain (Dawson and Wilesmith, 1985), and 23.2% in Jordan (Al-Qudah et al., 2006). However, on the contrary, it was much lower than those reported in Somalia (71%) (Ghanem et al., 2009), USA (73%) (Cutlip et al., 1992), and Norway (86%) (Nord et al., 1998[b]).

From this study, it was observed that seroprevalence of CAEV antibodies tended to increase with age; seroprevalence gradually increased in goats from less than one year (3.2%) to 3 years (5.9%) of age. However, from the age of 3 years onwards, seroprevalence jumped to almost double (10.1%), and it was significantly higher (p=0.001; OR=4.288; CI 95%=1.809-10.163) than that of others less than 3 years of age. This finding was similar to a previous report from Somalia (Ghanem et al., 2009) which described that goats of 3 years and older were more likely to be seropositive. Another study also indicated that seroprevalence of CAEV increased with age (Cutlip et al., 1992), and one suggested that the prevalence was significantly higher in goats older than 3 years of age (Al-Qudah et al., 2006). This can be explained by the fact that CAEV infection is prone to infect any age of goats (Al-Ani and Vestweber, 1984) and older animals, with higher possibility to be exposed to risk factors, are therefore more likely to be at risk, get infected and remain infected for life since CAEV is persistent and can produce lifelong infection in host (Knight and Jokinen, 1982). However, this finding was opposed to one study (Dawson and Wilesmith, 1985) that said the prevalence was highest in yearlings.

With reference to sex, seroprevalence was noticeably higher in male, which has also been reported in some other studies (Aslantas et al., 2005; Bandeira et al., 2009). However, the difference was sometimes not significant (Gufler et al., 2007[a]). For example, in the previous study in Thailand, higher seroprevalence was observed in female (Ratanapob et al., 2009). In this study, higher seroprevalence in male might reflected by the male-female ratio in the herds, from which comparatively few numbers of male were available to be included.

Herd size, which exceeds 50 animals, were found to be a risk factor, having a prominent effect on the seropositivity of CAEV in goats on both herd and individual levels. It was also seen that an increase in herd size was directly proportional to an increase in odds ratio. A similar finding was also reported in a previous study (Ghanem et al., 2009). This can be mainly due to the stocking density of the herd, which could increase the likelihood of transmission within herd (Greenwood et al., 1995[b]; Aslantas et al., 2005). However, there has also been a report stating that herd size has no effect on serological status of the herd (Al-Qudah et al., 2006). In this study, most of the farmers were small-holders and the majority of the farms were of small size containing less than 50 animals. Yet, relatively low seroprevalence was observed in those small farms, which was purely in contrast to a previous study saying that seroprevalence was higher in small-sized farms (Cutlip et al., 1992).

On herd level prevalence, herd type was found to be a risk factor to CAEV infection (p= 0.034; OR=5.026; CI 95%= 1.130-22.360), whereas on individual level, it was not a risk factor, but produced a significant association with the seropositivity of CAEV infection on univariate analysis. Although it has been generally accepted that infection rate is higher in dairy goats (deMaar et al., 1995), findings from this study suggested that farm management practice and replacement policy could also be a reason for the higher seroprevalence of CAEV infection in dairy goats since a vast population of meat goats are seasonally sold out while dairy goats are usually kept for long-term purposes, which increases the chance of transmission within herd. Moreover, the fact that most of the dairy goat farms in this study practiced intensive rearing system, previously reported as a risk factor, more commonly than meat goat farms is also one thing deemed related to higher seroprevalence in dairy goats.

Though not a risk factor, breeds of goat produced significant associations with seropositivity of CAEV infection on univariate analysis and it was clearly seen that seroprevalence was remarkably higher in crossbreeds than in native breeds. In this study, most of the dairy goat farms raised Saanen crossbreed while the majority of native breeds were kept under meat purposes. Therefore, it can be said that higher prevalence of CAEV infection in dairy farms was partly due to the breeds they raised.

Not similar to previous reports that described intensive rearing as a risk factor (Aslantas et al., 2005; Gufler et al., 2007[a]), rearing system did not show any significant association with seropositivity of CAEV infection on risk factor analysis. However, though not a risk factor, higher seroprevalence was detected in goats raised on intensive management on both herd and individual levels, with a significant association produced on individual level univariate analysis. Therefore, intensive rearing should be taken into account in the consideration of farm management practice against CAEV infection.

Addition of new goats into herd was observed as a risk factor to CAEV infection. A similar finding was reported in other studies (Al-Qudah et al., 2006; Bandeira et al., 2009) which also indicated addition of new goats into herd as a risk factor. However, it can be vague in saying that addition of new goat, any kind of addition, is always a potential risk factor to CAEV infection since lower seroprevalence was detected in young kids, majority

of which were newborn, being added to the number of animals in the herd. Therefore, it is more appropriate to say that addition of purchased animals into herd is a risk factor to CAEV infection.

Contact with goats from other herds, which had been described as a risk factor in some previous studies (Torres-Acosta et al., 2003; Al-Qudah et al., 2006), was discovered as a risk factor only on herd level analysis (p=0.008; OR=8.526; CI 95%=1.762-41.250). This can be because of the farm management system in which most of the farms in close proximity used a common grazing ground and, sometimes, sharing of a common buck was also practiced in some adjacent farms.

In this study, relationships between seropositivity of CAEV and feeding system, drinking system, deworming practice, and rearing on pasteurized milk, which were evaluated in some studies conducted in other countries (Rowe et al., 1991; Sanchez et al., 2001), were unable to be analyzed since all farms practiced shared feeding, shared drinking and regular deworming while rearing on pasteurized milk was not practiced in any of them.

Furthermore, presence of sheep in the farms, previously mentioned as a risk factor (Ghanem et al., 2009), did not show any significant association with seroprevalence of CAEV antibodies. This may be partly due to very few numbers of farms, altogether three, that raised sheep and goats together were included in this study. To obtain more precise relationship between sheep and goat towards CAEV infection, more in-depth studies on mixed farming should be conducted.

Other management practices such as male-female separation, replacement policy, use of disinfectants, practice of vaccination, presence of veterinary service, method of breeding, as well as knowledge of farm owners towards CAE did not show any significant association with serological status of the goats. Though not a risk factor, it was interesting that seroprevalence was significantly higher in those farms in which CAEV infection had taken place in the past. This suggested that infection could be recurrent, as it might be persistent in the herds, unless a proper eradication program is introduced.

This study tried to depict an overview of seroprevalence and risk factors associated with the prevalence of CAEV infection in goat herds raised in the western part of Thailand. However, due to some constraints and unfavorable situations, some farms in the studied area had not been explored into details. Therefore, further studies in the epidemiological aspects of CAE are desirable to elucidate the seroprevalence of, and risk factors associated with, CAEV infection and also for a better understanding of the nature and effect of CAEV infection in goats for the development of goat farming in the years to come.

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