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Short Communication

Low colostrum immunoglobulin G concentration in Saanen dams with seropositive to caprine arthritis encephalitis virus infection without affecting kid growth rate

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Abstract

Caprine arthritis encephalitis (CAE) is one of the most pervasive diseases and causes economic damages both to health and milk production. Data on colostral quality and kids' growth rate of CAE-seropositive CAE dams is limited. The aims of the present study were, 1) to investigate the general components including insulin-like growth factor 1 (IGF-1), immunoglobulin G (IgG) and Vitamin A (Vit A) in colostrum and 2) to determine the effect of the separation of kids born from CAE-seropositive mothers and fed heat-processed colostrum and milk on the growth rate of the kids of Saanen goats. The colostrum of dams with CAE-seronegative (CONT) group (n = 5) and CAE-seropositive (CAE) group (n = 6) was collected within 3 hours of parturition for analysis. The results showed that protein and IgG concentrations in the colostrum of the CAE group was significantly lower than those of the CONT group. However, no differences were found in colostral IGF-1 and Vit A concentrations or in the body weights of kids at birth and at 28 days old between both groups. It is concluded that CAE-seropositive dams secreted colostrum of lower quality and immunity and feeding milk from other goats showed no negative effects on a kid's growth rate.

Keywords: Goat, Immunoglobulin G, Kid Growth, Caprine Arthritis Encephalitis

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Introduction

One of the most significant diseases in goats that causes economic loss is caprine arthritis encephalitis (CAE) caused by the lentivirus. The virus can be transmitted from infected dams to their offspring mainly via colostrum and milk consumption although serum CAE-positive newborn kids examined before colostral consumption have been implicated (Rodrigues *et al*., 2017). The CAE virus can cause multisystemic inflammatory diseases affecting lungs, central nervous system, joint and mammary glands (Kennedy-Stoskopf *et al*., 1985, DeVilbiss *et al*., 2013 Ravazzolo *et al*., 2006, Son et al., 2021). Goats with CAE-seropositive have a shorter lactation period, lower milk yield and altered milk composition compared to seronegative does (Martinez-Navalon *et al*., 2013).

Many factors in colostrum are essential for growth and development and the immunity of newborn kids. In particular, high concentrations of insulin-like growth factor 1 (IGF-1), immunoglobulin G (IgG) and vitamin A (Vit A) in colostrum have dramatically declined when colostrum is transitioned to milk (Buranakarl *et al*., 2021). However, limited data are available regarding the association between CAE viral infection and these bioactive components in colostrum.

The CAE virus may affect the kid's weight and growth rate although no negative effects have been found in kids born from positive serological does (Nalbert *et al*., 2019a, Nalbert *et al*., 2020). Moreover, immediate separation of kids from does and substitute milk products as performed in this study can also influence growth rate. Therefore, the objectives of this study were, 1) to determine the level of IgG in the colostrum at parturition, and 2) to determine the growth rate of kids, which were immediately separated from CAE-seropositive dams and were fed heated colostrum and milk from other goats. This information will be of benefit in terms of the management of CAE-seropositive dams and newborn kids in goat farming.

Materials and Methods

Animals, Housing and General Management: This study was conducted in eleven Saanen goats which were raised at the Chaipattana Foundation's Black Bengal Goat Domestication Project, Chiang Rai province in the north of Thailand from June 2018 to June 2019. The dams were assigned to two groups: the CAE-seropositive (CAE) group (n = 6) and the CAE-seronegative or healthy control (CONT) group (n = 5) based upon the results of the latest test when tests was routinely performed every year. The does were mated naturally with either Saanen or black Bengal bucks and gave birth with one parturition. The temperature and relative humidity inside the barn ranged from 14.6 - 32.8^{o} C (mean ± SD = 26.1 ± 4.5) and 42 - 91% (mean ± SD = 70.5 ± 13.1), respectively. The goats were fed twice daily at 07:00 and 18:00 with concentrate (17.6% crude protein, 4.5% fat, 14.8% crude fiber and digestible energy of 2,660.9 kcal/kg) approximately 200 g/head/day and 3 kg/head/day of roughage including chopped Napier grass and Pangola with a ratio 2:1, respectively, with free access to water.

The colostrum that was collected within 3 days postpartum and the milk from CAE-seronegative dams were kept in a refrigerator at -4^{o} C. Neonates born from CAE-seropositive dams were immediately separated from mothers and were given the reserved colostrum for 7 days after birth and milk later on. Before feeding, the heating process was conducted for colostrum (56 ^{o} C for 30 minutes) and for milk (boiling water for 30 minutes). Kids from CAE-seronegative dams stayed with their mothers and had colostrum and milk freely and the weaning time was at 13 weeks of age. The concentrate and roughage were started to the kids at about 1 month of age in both groups.

The test for antibodies against CAE: Detection of antibodies against CAE was performed using a Small Ruminant Lentivirus Antibody Test Kit, cELISA (Catalog #289-2, Veterinary Medical Research & Development, Pullman, WA, USA).

Colostrum collection and measurement of the kid's body weight: Approximately 15-20 ml of colostrum from each dam in both groups was collected within 3 hours after parturition by hand according to standard procedures into disposable plastic tubes. Immediately after collection, the sample tubes were kept in a -20°C freezer for later analysis of the nutrient composition, IGF-1, IgG and Vit A concentrations. All kids were weighed at birth before colostrum consumption and at day 28 postpartum (D28). The birth weight data of one kid in the CAE group that had died due to dystocia was included.

Analytical Procedure: The colostrum samples (kept at -20°C) were thawed in a water bath at 40 ^{o}C for 20 minutes before analysis of the microchemical composition. The samples of 3-folded dilution by distilled water were analyzed by infrared spectroscopy (MilkoScan FT2 instrument, Foss Milkoscan, Hillerød, Denmark).

For IGF-1 measurement, samples were extracted by acid as per the manufacturer's instructions. The concentrations of IGF-1 were analyzed using solid-phase enzyme-labeled chemiluminescent immunometric assay (Immulite 2000 IGF-1, Siemens-Healthcare GmbH, Erlangen, Germany). The concentrations of IgG were determined by a goat specific goat IgG ELISA kit (Cat. no. K3231053P, Koma Biotech Inc., Seoul, Korea). The Vit A concentrations in colostrum were measured using high performance liquid chromatography (HPLC) with UV detector (HPLC-Shimadzu, Kyoto, Japan) with reverse phase C18 µ-Bondapak (3.9x300 mm) column (Water Corp., Milford, MA, USA).

Statistical Analysis: All statistical analyses were performed using SigmaPlot® version 12.0 (Systat Software Inc, California, USA). The unpaired t-test or Mann-Whitney U-test were used to compare data between the CONT and CAE groups. The data are presented as mean ± standard error. Relationships between parameters were analyzed using Pearson correlation. A probability value of $P < 0.05$ was regarded as being statistically significant.

Results and Discussion

The body weight of CAE-seropositive dams was higher than that of CONT group (41.9 ± 1.1 vs. 36.1 ± 2.1 kgs, $P < 0.05$). The age and parity number of CONT were 73.2 ± 1.8 months and 5.0 ± 0.6 while those in CAE group were 72.2 ± 1.7 months and 4.0 ± 0.5, respectively with no differences between groups. The litter size of CONT was 1.6 ± 0.2 and was no different from CAE group (1.5 ± 0.2).

The colostrum from dams in the CAE group had significantly lower protein concentrations ($P < 0.05$) (Table 1) but that in the CONT group tended to have higher SNF ($P = 0.054$) and density ($P = 0.064$) than that in the CAE group. No differences were found in fat, lactose and TS concentrations. It was reported that milk from CAE-seropositive dams contained low protein, fat and lactose with or without affecting milk yield (Kaba *et al*., 2012; Martínez-Navalón *et al*., 2013).

Table 1 The composition of colostrum in colostrum of dams in CONT (CAE-seronegative) and CAE (CAE-seropositive) groups

Parameters	CONT group (5)	CAE group (6)
Fat (%)	6.8 ± 1.2	8.0 ± 1.1
Protein (%)	12.2 ± 0.8	9.7 ± 0.6*
Lactose (%)	3.5 ± 0.1	3.8 ± 0.2
Total solid (%)	23.3 ± 1.0	22.6 ± 1.1
Solid not fat (%)	16.8 ± 0.7	14.8 ± 0.6
Density (g/L)	1056.3 ± 3.5	1047.5 ± 2.5
IGF-1 (ng/ml)	413.2 ± 51.1(0.175)	275.3 ± 73.8
IgG (mg/ml)	12.81 ± 1.37 (0.012)	7.25 ± 1.13*
Vit A (µg/100gm)	508.2 ±145.0	600 ± 138.4

Data are expressed as mean ± SE, * indicates $P < 0.05$ compared with CONT group.

The present study is the first report showing that IgG concentrations in the colostrum of the CAE group was significantly lower than those in the CONT group ($P < 0.05$) (Table 1). The ingested IgG is absorbed from the jejunum epithelium of newborn kids regardless of source from either goats or lyophilized bovine colostrum (Nordi *et al*., 2012). One explanation for the lower level of IgG in the CAE group may be due to colostrum volume. This is because an inverse relationship was reported in cattle between colostral weight and IgG concentration (Conneely *et al*., 2013). Unfortunately, colostral weight was not measured in the present study. However, the higher milk yield during the early phase of lactogenesis and the dilution effect for analysis could not explain the lower IgG in colostrum in the CAE-seropositive dams because the concentrations of fat and lactose were not different between groups. Other factors including the parity number and litter size, had no effect in this study. It was reported in daily cow that colostrum IgG levels were affected by factors such as month of calving, parity number, and time interval from calving to milking (Conneely *et al*., 2013) and also in goats (Buranakarl *et al*., 2021) with no effect of level of energy diet in cows (Nowak *et al*., 2012).

In cows, the month of calving in a year was reported to be associated with IgG concentration in colostrum, that is, the lowest IgG concentration was seen in April to May while the highest was in spring and autumn (Conneely *et al*., 2013). They suggested that it was related to fertility, and body condition at different stages of lactation. In the present study, although the dams delivered the kids between winter and summer, this may not affect the health of dams since the ADG of kids during hot and cool conditions was higher than that during the rainy season (Nuntapaitoon *et al*., 2021).

Because CAE virus belongs to the retroviridae which does not infect lymphocytes and has a minor effect on normal immune function as reviewed earlier (Patel *et al*., 2012), the lower IgG in colostrum from CAE-seropositive dams can be explained by the direct inhibition of normal mechanism of IgG translocation during colostrogenesis as previously identified (Rojas and Apodaca., 2002). With this hypothesis, CAE virus may influence either IgG fluid phase endocytosis or IgG vesicle transportation.

The relationships among constituents in colostrum are shown in Table 2. The IgG had a significant relationship with protein, SNF and density ($P < 0.01$). Vit A, a fat-soluble vitamin, was correlated with fat ($P < 0.001$) as demonstrated previously (Torsein *et al*., 2018) and with TS ($P < 0.01$) while solids not fat was correlated with protein ($P < 0.001$) and IgG ($P < 0.05$).

In the present study, the total number of kids in the CONT and CAE groups was 8 and 9, respectively (Table 3). Does in the CONT group delivered 2 male singletons, 2 twins of male and females and a twin of both females. Does in CAE delivered 3 male singletons, 2 twins of male and female and a twin of both males. Although the kid breeds in this study were pure SA or crossbred BBSA, the weight is comparable since F1-BBSA crossbred had similar birth growth and a rate of growth compared to SA until 13 weeks of age (Nuntapaitoon *et al*., 2021). No differences in kids' birth weight of singleton males, twin males, twin females or total kids' weight/litter between two groups were found. These results were supported by previous studies in which birth weight and growth rate of kids were not affected by the serological status of the doe (Nalbert *et al*., 2019a; Nalbert *et al*., 2020).

When considering growth rate of kids, the ADG at 28 days was different between groups. The growth rate of kids in the CAE group with separated feeding was higher than CONT. Previous study showed that kids weaned immediately after birth had similar weight at 4 months compared with kids kept with their mothers (Nalbert *et al*., 2019b). Careful management by supplying adequate colostrum for kids born from CAE-seropositive dams may be a reason for the higher growth rate.

In the present study, two kids from CAE-positive dams died within 28 days postpartum. One died on the day of parturition, due to dystocia (the birth weight was 3.3 kg) while the second died on day 23 due to a gastrointestinal problem. It is unlikely that the cause of death was related to IgG or Vit A concentrations in colostrum, although lower serum α-tocopherol concentration in calves has been reported to be related to high mortality (Torsein *et al.*, 2018).

In conclusion, the colostrum from CAE-seropositive dams had lower IgG and protein concentrations than that from CAE-seronegative dams without negative effects on the kid's body weight in the early stage. The separation of kids from seropositive mothers at parturition and substitution with other goat's milk could be implemented in farms without a negative effect on kids' growth rate.

Table 2 The relationships among constituents in colostrum of all dams (n = 11).

		IgG	Vit A	Fat	Protein	Lactose	TS	SNF	Density
IGF-1	r	0.540	-0.517	-0.446	0.512	0.234	-0.075	0.595	0.671
	P	0.086	0.103	0.170	0.107	0.488	0.826	0.054	0.024
IgG	r		-0.144	-0.341	0.740	-0.405	0.121	0.734	0.719
	P		0.672	0.304	0.009	0.217	0.723	0.010	0.013
Vit A	r			0.944	-0.358	0.140	0.822	-0.316	-0.570
	P			<0.0001	0.280	0.682	0.002	0.344	0.067
Fat	r				-0.523	0.376	0.793	-0.456	-0.685
	P				0.099	0.254	0.004	0.158	0.020
Protein	r					-0.606	0.091	0.984	0.955
	P					0.048	0.789	<0.0001	<0.0001
Lactose	r						0.115	-0.464	-0.448
	P						0.736	0.150	0.167
TS	r							0.180	-0.101
	P							0.597	0.768
SNF	r								0.956
	P								<0.001

Abbreviations: IGF-1- Insulin like growth factor 1; IgG- Immunoglobulin G; Vit A- Vitamin A; r- Correlation coefficient; *P*- *P*-value; TS- Total solid; SNF- Solids not fat

Table 3 The general characteristics of kids born from dams in CONT (CAE-seronegative) and CAE (CAE-seropositive) groups.

Characteristics	CONT group	CAE group
Kid breeds	SA (3)/BBSA (5)	SA (1)/BBSA (8)
Kid BW male singleton (kg)	3.05 ± 0.64 (2)	2.90 ± 0.21 (3)
Kid BW male (twin) (kg)	2.40 ± 0.30 (2)	2.40 ± 0.13 (4)
Kid BW female (twin)(kg)	1.63 ± 0.23 (4)	1.95 ± 0.05 (2)
Kid Total BW/Litter (kg)	3.48 ± 0.45 (5)	3.68 ± 0.39 (6)
Kid ADG D28 (kg)	2.18 ± 0.34 (8)	3.00 ± 0.20 (7)*
Number of delivery kids/dead kids	8/0	9/2

Data are expressed as mean ± SE, * indicates $P < 0.05$ compared with CONT group, number in parentheses indicated the number of animals

SA- Saanen; BBSA- 100% Male Black Bengal x 100% Female Saanen; BW: Birth weight, ADG D28: Average daily weight gain measured at day 28.

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References

Buranakarl C, Thammacharoen S, Semsirmboon S, Sutayatram S, Nauntapaitoon M, Dissayabutra T and Katoh K 2021. Effects of litter size and parity number on mammary secretions including, insulin-like growth factor-1, immunoglobulin G and vitamin A of Black Bengal, Saanen and their crossbred goats in Thailand. Vet Sci. 8: 95.

Conneely M, Berry DP, Sayers R, Murphy JP, Lorenz I, Doherty ML and Kennedy E 2013. Factors associated with the concentration of immunoglobulin G in the colostrum of dairy cows. Animal. 7: 1824–1832.

DeVilbiss B, Neelis D, Ochoa J, Ziegler J, Barrington G and Allen A 2013. Computed tomography findings in a 5-year-old Australian Cashmere goat (Capra hircus) suffering leukoencephalomyelitis due to caprine arthritis encephalitis virus. Can Vet J. 54: 960-964.

Kaba J, Strzalkowska N, Jozwik A, Krzyzewski J and Bagnicka E 2012. Twelve-year cohort study on the influence of caprine arthritis-encephalitis virus infection on milk yield and composition. J Dairy Sci. 95: 1617–1622.

Kennedy-Stoskopf S, Narayan O and Strandberg JD 1985. The mammary gland as a target organ for infection with caprine arthritis-encephalitis virus. J Comp Pathol. 95: 609-617.

Martínez-Navalón B, Peris C, Gómez EA, Peris B, Roche ML, Caballero C, Goyena E and Berriatua E 2013. Quantitative estimation of the impact of caprine arthritis encephalitis virus infection on milk production by dairy goats. Vet J. 197: 311–317.

Nalbert T, Czopowicz M, Szaluś-Jordanow O, Moroz A, Mickiewicz M, Witkowski L, Markowska-Daniel I, Puchała R, Bagnicka E and Kaba J 2019b. Effect of immediately-after-birth weaning on the development of goat kids born to small ruminant Lentivirus-positive dams. Animals. 9: 822.

Nalbert T, Czopowicz M, Szaluś-Jordanow O, Witkowski L, Moroz A, Mickiewicz M, Markowska-Daniel I, Słoniewska D, Bagnicka E and Kaba J 2020. The effect of the subclinical small ruminant lentivirus infection of female goats on the growth of kids. PLoS ONE. 15: e0230617.

Nalbert T, Czopowicz M, Szaluś-Jordanow O, Witkowski M, Witkowski L, Słoniewska D, Reczyńska D, Bagnicka E and Kaba J 2019a. Impact of the subclinical small ruminant lentivirus infection of female goats on the litter size and the birth body weight of kids. Prev Vet Med. 165: 71-75.

Nordi WM, Moretti DB, Lima AL, Pauletti P, Susin I and Machado-Neto R 2012. Intestinal IgG uptake by small intestine of goat kid fed goat or lyophilized bovine colostrum. Livest Sci. 144: 205-210.

Nowak W, Mikuła R, Zachwieja A, Paczyńska K, Pecka E, Drzazga K and Ślósarz P 2012. The impact of cow nutrition in the dry period on colostrum quality and immune status of calves. Pol J Vet Sci. 15: 77-82.

Nuntapaitoon M, Buranakarl C, Thammacharoen S and Katoh K 2021. Growth performance of Black Bengal, Saanen and their crossbred F1 as affected by sex, litter size and season of kidding. Anim Sci J. 92: e13571.

Patel JR, Heldens JGM, Bakonyi T and Rusvai M 2012. Important mammalian veterinary viral immunodiseases and their control. Vaccine. 30: 1767-1781.

Ravazzolo AP, Nenci C, Vogt HR, Waldvogel A, Obexer-Ruff G, Peterhans E and Bertoni G 2006. Viral load, organ distribution, histopathological lesions, and cytokine mRNA expression in goats infected with a molecular clone of the caprine arthritis encephalitis virus. Virology. 350:116-127.

Rodrigues AS, Pinheiro RR, Brito RLL, Oliveira LS, Oliveira EL, Santos VWS, Andrioli A, Souza TS, Dias RP and Teixeira MFS 2017. Evaluation of caprine arthritis-encephalitis virus transmission in newborn goat kids. Arq Inst Biol. 84: e0542016.

Rojas R and Apodaca G 2002. Immunoglobulin transport across polarized epithelial cells. Nat Rev Mol Cell Biol. 3: 944-955.

Son GI, Hong EJ and Shin HJ 2021. Case Report: A case of caprine arthritis encephalitis in dairy goat farms in South Korea. Front Vet Sci. 8: 773039.

Torsein M, Lindberg A, Svensson C, Jensen SK, Berg C and Waller KP 2018. α-Tocopherol and β-carotene concentrations in feed, colostrum, cow and calf serum in Swedish dairy herds with high or low calf mortality. Acta Vet Scand. 60: 7.