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Original article

Seroprevalence and risk factors of foot-and-mouth disease in sheep and goats in the Soudan-Sahelian and Guinean regions of Cameroon

Simon Dickmu Jumbo[1,2], Ranyl Nguena Guefack Noumedem[1], Abel Wade[1,3], Isaac Dah[3], Laurent God-Yang[1], Silas Lendzele Sevidzem[4*], Cyrille Mbu'u Mbanwi[5], Aziwo Tatanja Niba[2], Julius Awah-Ndukum[2]

1- National Veterinary Laboratory (LANAVET), Garoua, Cameroon
2- Department of Animal Production Technology, College of Technology, University of Bamenda, Bambili, Cameroon
3- National Veterinary Laboratory (LANAVET), Annex Yaoundé, Cameroon
4- Université Libreville Nord (ULN), Transmissible Diseases Laboratory (TDEL) Okala, Libreville, Gabon
5- Faculty of Sciences, University of Yaoundé I, Yaoundé, Cameroon

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ABSTRACT

Background: Information on the epidemiology of foot and mouth disease (FMD) in small ruminants in Cameroon and particularly in the northern regions is insufficient. Indeed, studies on the epidemiology of FMD in these areas were focused on cattle and pigs. Hence, the current cross-sectional study was conducted from January to July 2020 to determine the seroprevalence and risk factors of FMD in small ruminants and cattle mixed herds in the Soudan-Sahelian and Guinean agro-ecological zones (AEZs) of Cameroon. **Methods**: A total of 350 serum samples from 268 sheep and 82 goats were collected in the 3 regions (Adamawa (n=93), North (n=105), and Far North (n=152)). All samples were tested using indirect ELISA specific to antibodies against FMD virus Non-structural Protein (NSP) and seropositive samples were further serotyped using ELISA "PrioCHECK® FMDV Type A" and "ELISA PrioCHECK® FMDV Type O" kits. Moreover, a univariate analysis was performed to test the association between the potential risk factors and prevalence of FMD. Lastly, a multivariate logistic regression was used to build the final model. **Results**: The overall seroprevalence of antibodies to the non-structural protein of the FMD virus was 45.4% (95% CI: 40.3 – 50.7), that of serotype A was 4.6% (95% CI: 2.8 – 7.3) and that of serotype O was 17.4% (95% CI: 13.8 – 18.7). NSP antibodies seroprevalence was significantly higher in sheep, but anti-serotype O antibodies were higher in goats. The main risk factor independent of the species is region. In fact, small ruminants from the Sahelian region (OR: 7.3; P=0.003) had a higher seroprevalence than others. No intrinsic factor showed a significant influence on seroprevalence in goats. However, in sheep, age, sex and physiological status were significantly associated to seroprevalence. For both species, young animals (OR: 2.9; P=0.02) were more susceptible, females were 1.4 and 4.7 times respectively more likely to have NSP and type O antibodies than males. This study has shown that FMDV antibodies are present and the viruses could be circulating among small ruminant populations in the three regions of Cameroon. **Conclusion**: The present study highlights the probable circulation of FMD serotypes A and O in both sheep and goat populations for the first time in the major cattle rearing northern regions of Cameroon. In depth molecular studies on the serotypes circulating in these regions are

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* *Corresponding author:* Silas Lendzele Sevidzem
E-mail address: *sevidzem.lendze@gmail.com*

therefore needed to identify potential vaccine candidates and to design species-specific vaccines. Ultimately, the real burden and economic impact of this disease should be assessed nationwide.

Introduction

Foot-and-mouth disease (FMD) is a highly contagious viral disease of cloven-hoofed ungulates (*Artiodactyls*) of both domestic and wild animals affecting mostly bovine, ovine, caprine and porcine species [1]. Foot-and-mouth disease is caused by a positive-sense, single stranded RNA virus of the genus *Aphthovirus* within the family *Picornaviridae.* Seven serotypes of FMDV have already been reported (O, A, C, Asia-1, SAT1-3), with numerous antigenically distinct subtypes within each serotype [2,3]. These serotypes have further been classified into topotypes, which are based on geographic region as well as on the VP1 sequence-based phylogenetic analysis. There is no lasting cross-protection between serotypes and animals having an immune response against one serotype (by either vaccination or infection) might not be protected against the other serotypes [4]. Furthermore, vaccination programs require vaccines that match the circulating viral strains [5]. The clinical signs of FMD include fever, lameness, and salivation (ptyalism) associated with the appearance of characteristic vesicular lesions in the oral cavity as well as interdigital clefts and coronary bands of the feet. Though mortality rates are generally low among adult animals, production objectives such as weight gain, milk yield, and draught power are severely affected by the clinical disease [6].

Foot-and-mouth disease constitutes a menace to the livestock sector in many countries of the world due to its high contagiousness and the threat it poses to international trade of livestock and livestock products [5,7]. It is one of the most important economic diseases of cattle in the tropics limiting animal production and trade and contributes towards food insecurity in these regions [8]. Lack of infrastructure, economic resources and vaccines tailored to particular condition is rendering many developing countries vulnerable to the spread and devastating effects of the disease. In Africa, >75% of livestock are reared under communal smallholder systems [9] which are most negatively impacted by animal diseases including transboundary animal diseases (TADs) such as FMD.

The disease is enzootic in Cameroon and most parts of Africa. In Cameroon, high rates of serotypes O and A have been reported in the North West, Adamawa, North and Far North regions [10-13] and serotype SAT2 has been frequently detected in the Adamawa and Far North regions [11-13]. Serotypes SAT1 and SAT3 have also been reported at low levels in the country [13]. There is no formal FMD control program in Cameroon because international trade of livestock is not a priority. However, in March 2014, cattle vaccination against FMD was launched in the country using a commercially available trivalent inactivated FMDV vaccine against serotypes SAT2, A, and O [14]. Although the virus strains used in the vaccine were based on vaccine matching tests with field isolates, it is important to note that the vaccine prevented clinical manifestation and not the persistence of the infection [15].

Despite several FMD research in livestock [10-13, 16-18], the virus ecology and maintenance during inter-epidemics is not well understood [13] and there is dearth of information of the disease in small ruminants in Cameroon. Chepkwony et al. [19] reported that small ruminants function as silent repository for FMD virus, and are responsible for inter-epidemic survival of FMD virus and spill over to large ruminants or other susceptible animal species and could cause repeated FMD outbreaks.

Though small ruminants and cattle usually occupy the same microenvironments and are grazed together [13], in Cameroon, the epidemiology of FMD is focused on cattle and pigs [20-22].There is no study on the epidemiology of FMD in small ruminants in the North region of Cameroon. Given that small ruminants do not frequently present symptoms, which make the clinical detection of the disease difficult [23], it is important to investigate on the role of small ruminants in FMD epidemiology. Non-structural proteins are formed during replication of the virus and antibodies to these proteins are only present in animals infected with the live virus [24]. In this context, the present study was conducted to determine the seroprevalence and associated risks factors of FMD

in domestic small ruminants reared with large ruminants in the Northern regions of Cameroon.

Materials and methods

Study area

A cross-sectional study was carried out in Adamawa (7°09' – 7°70'N and 13°52' - 13°70'E), North (8° – 10° N and 12°27' - 15°62' E) and Far North (10° - 12° N and 14° - 15° E) regions of Cameroon **(Figure 1)**. The Adamawa region is a Savannah-Guinean highland while the North and Far North regions are typical Sudan-Sahelian agro-ecological zones located in the mid to high altitude zones of Cameroon. The Adamawa region has an annual precipitation of 1200 – 1600 mm, rainy season from about mid-March to October and temperatures of 14° C– 26°C while the North and Far North regions has annual precipitations of 400 – 900mm, rainy season from July to October and temperatures of 21°C – 36°C [25]. These three northern regions represent the major centers of small ruminants farming in Cameroon [26]. The Adamawa region is a Carrefour between the northern and southern parts of Cameroon and provides the only road access to the North and Far North regions from the southern regions and vice-versa for many socioeconomic ventures [26]. The major livestock rearing regions of Cameroon are the Far North, Adamawa, North and North West. The livestock population of Cameroon includes 31 million poultry, 6 million cattle, 7 million small ruminants, one million pigs, 150,000 donkeys and 15,000 horses. The proportion of cattle by administrative region of Cameroon is as follows: 37.5% in the Far North, 33.9% in Adamawa, 11.6% in the North, 8% in the North West, 6.3% in the East and 2.7% in the West [14]. Most small ruminants are produced in the three regions of the North, Far North and Adamawa (>70% for sheep and approximately 60% for goats). The livestock population in the Northern regions of Cameroon is a mixture of sedentary (village) and mobile (seasonally transhumant) animals [26]. In general, the sedentary herds are smaller but more numerous and may contain sheep, goats, cattle and pigs, while the mobile herds are larger but fewer in number and contain cattle, sheep and goats. These two production systems share pasture and water resources as well as trade networks (markets) and veterinary services. In addition, livestock is the main source of income for about 30% of the rural population in northern Cameroon. The insecurity situation in neighbouring countries (Nigeria, Chad and CAR) has led to the massive displacement of livestock farmers and their livestock mainly to the North and Adamawa regions, constituting to a high risk for the introduction and spread of diseases. Thus, the northern region constitutes a hub for livestock breeding in the Central African Sub-region.

Sample size determination

The small and large ruminant samples were collected from the three study regions (North, Far North and Adamawa) and this sample number depended on the small ruminant population in these regions. 43.4% small ruminants were sampled in the Far North region, 30% in the North region and 26.6% in Adamawa region. The selection of herds was conducted by using the random-number generation method of known ruminant owners and locations of herds listed at the regional delegations of the Ministry of Livestock, Fisheries and Animal Industries (MINEPIA). Farms where cattle and small ruminants were reared together in areas where FMD has previously been reported were sampled. A total of 51 farms fitting the criteria and willing to participate in the study were surveyed with the help of MINEPIA field staff. Based on the 27.84% prevalence obtained by Lazarus et al. [27], a minimum number of 373 small ruminants to be sampled was calculated according to Thrusfield [28] with a significance threshold of 95% and required precision of 5%. Selection of small ruminants within chosen herds was based on a systematic random sampling technique and the willingness of the owner. The sample size was rounded up to 350 samples for the 51 farms to avoid sampling bias.

Blood collection, processing and storage

Blood was collected in 5ml vacutainer tubes via the jugular vein puncture of small ruminants used in the study. Information on the animals selected (age, sex, body condition score, breed and physiological status) were registered on the identification sheets and each sample was identified with a unique code. Serum was extracted, identified with the same sample code from tube with whole blood and transported in ice-boxes, fitted with icepacks, and transported to the National Veterinary Laboratory (LANAVET), Garoua-Cameroon and stored at -20°C prior to ELISA testing.

Ethics and approval

Prior to sampling, the research approval for this study was obtained from the Ministry of Livestock, Fisheries and Animal Industries

(MINEPIA) and the National Veterinary Laboratory (LANAVET). Other administrative approvals required for the study were obtained from the Services of Livestock, Fisheries and Animal Industries at the regional and district levels. Each owner of a herd selected for sampling provided verbal consent, once the objectives of the study were clearly explained in a language they best understood and all their questions and doubts addressed accordingly. Herds whose owners did not consent were replaced with the next herd in the random sample list.

Characteristics of selected animals

The age was provided by the owner and/or determined by dental observation [29] while the Body Condition Score (BCS) on a scale of 0 to 5 was determined as previously described by Hervieu et al. **Q1**[29]. Small ruminants were grouped into three (3) age classes as proposed by Aklobessi [31] as such: young (age ≤ 1 year); adults (animals in production stage) age > 1 year and ≤ 3 years) and old animals or animals at the end of their production stage (age> 3 years). Similarly, a classification according to the size of the herd was carried out as follows: small herd (size ≤ 10 animals); medium herd (10 to 20 animals) and large herd (≥20 animals).

Detection of antibodies against FMD virus non-structural proteins

An indirect ELISA was used for the detection of antibodies directed against the non-structural proteins of FMD virus, irrespective of the serotype involved and the vaccination status of the animal [32]. In this study, "PrioCHECK® FMDV-NS" Kit (Pronics Lelystad B.V. the Netherlands) was used according to the protocol provided by the manufacturer.

Detection of antibodies against serotypes A and O

The Non-structural protein ELISA positive samples were retested for A and O serotyping. The ELISA "PrioCHECK® FMDV Type A" and "ELISA PrioCHECK® FMDV Type O" kits were used to detect antibodies against FMDV A and O serotypes [33] according to the protocol provided by the manufacturer.

Statistical analysis

Individual animal laboratory data generated during testing alongside individual animal biodata obtained during sample collection (species, sex, age) were entered in Microsoft Excel (Microsoft Corporation. (2018). Data in MS Excel was cleaned and coded before being exported and analysed using IBM Statistical Package for Social Sciences (SPSS) software IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp. Descriptive analysis was used to determine the seroprevalence of FMD based on endogenous and exogenous factors. A univariate analysis using the $\chi 2$ test and Fischer test (when the conditions of the $\chi 2$ test were not met) was performed to test the association between the potential risk factors and seroprevalence of FMD as recommended by Campbell [34] and Richardson [35]. Factors with $p<0.2$ after univariate analysis were introduced into the final model. A multivariate logistic regression was then used to build the final model with seropositivity to NSP; type A; type O as the dependent variable and risk factors as independent variables. The odds ratios of the risk factors with their respective 95% confidence intervals (CI) were obtained in the final model. A value of $P <0.05$ was considered as significant association in this study.

Results

The characteristics of the sampled animal species are presented in **Table 1**.

Anti-FMD seroprevalence

The anti-FMDV antibodies are frequent in small ruminants (anti-FMDV-NSP antibodies (45.4% (95% CI: 40.3 – 50.7)). Furthermore, anti-FMDV Serotype A (4.6% (95% CI: 2.8 – 7.3)) and anti-FMDV Serotype O (17.4% (95% CI: 13.8 - 21.8)) were widespread in the Northern regions of Cameroon **(Table 2)**. Overall, 45.4% (159) of 350 small ruminants tested in the three regions (Adamawa (n=93), North (n=105), Far North (n=152)) showed positive reactions for at least one of the anti-FMDV antibodies detection method used in this study.

Risk factors of FMD in the study area

In both species **(Table 3)**, region was significantly associated to FMDV seroprevalence. In sheep, old animals and pregnant females recorded highest seroprevalences for NSP anti-antibodies while the physiological status was not a risk factor for type O. In Goats, none of the tested parameters was significantly linked to any of the estimated antibody seroprevalence.

When the two species were considered together, the main risk factor was locality **(Table 4)**. In fact, animals in the Far North region were more

likely to be exposed to type A (OR: 7.3 (95% CI: 1.9 – 27.9), p=0,004) than in the North region. Young animals are more likely to have FMD as per the NSP (OR: 2.2 (95% CI: 1.0 – 4.7), P=0.049) and type O (OR=4.8 (95% CI: 1.7 – 13.7), P=0.003) seroprevalences. There was no significant difference for the other parameters.

Table 1. Characteristics of small goats and sheep populations sampled in the three northern regions of Cameroon in 2020.

Parameters		Species		Total
		Goats	Sheep	
Sex	Female	64	191	255
	Male	18	77	95
Age	Adult	51	118	169
	Young	17	90	107
	Old	14	60	74
Body condition score	Fat	1	2	3
	Thin	22	78	100
	Normal	59	188	247
Breed	Djalonke	33	50	83
	Kirdi	24	77	101
	Mayo kebi	0	42	42
	Oudah	0	57	57
	Peuhl	0	14	14
	Rousse	1	0	1
	Sahel	24	1	25
	Woïla	0	27	27
Total		**82**	**268**	**350**

Table 2. FMD NSP antibodies, serotypes A and O prevalence in small ruminants (sheep and goats) of the northern regions of Cameroon in 2020.

Parameters	Detection of anti-FMDV antibodies					
	Anti-NSP antibodies		Anti-Type A antibodies		Anti-Type O antibodies	
	N (%)	p (χ2)	N (%)	p (χ2)	N (%)	p (χ2)
Region Adamawa (93) Far North (152) North (105)	 78 (83.9) 49 (32.2) 32 (30.5)	<0.0001 (75.6)	 0 (0) 3 (2.0) 13 (12.4)	<0.0001 (21.5)	 0 (0) 35 (23.0) 26 (17.1)	<0.0001 (26.8)
Species Goats (82) Sheep (268)	 52 (63.4) 107 (39.9)	<0.0001 (13.9)	 2 (2.4) 14 (5.2)	0.233 (1.16)	 23 (28.0) 38 (14.2)	0.004 (8.3)
Age group Young (107) Adults (169) Old(74)	 34 (31.8) 87 (51.5) 38 (51.4)	0.003 (11.6)	 3 (2.8) 10 (5.9) 3 (4.1)	0.475 (1.5)	 8 (7.5) 33 (19.5) 20 (20.7)	0.002 (12.6)
Body condition score Thin (100) Normal (247) Fat(3)	 48 (48.0) 111 (44.9) 0	0.275 (2.8)	 5 (5.0) 11 (4.5) 0	0.812(0.2)	 24 (24.0) 37 (15.0) 0	0.129 (4.7)
Sex Female (255) Male (95)	 128 (50.2) 31 (32.6)	0.002 (8.6)	 13 (5.1) 3 (3.2)	0.326 (0.6)	 50 (22.0) 6 (5.3)	<0.0001 (13.4)
Total (350) (95% IC)	159 (45.4) (40.3 – 50.7)		16 (4.6) (2.8 - 7.3)		61 (17.4) (13.8 - 21.8)	

FMDV = Foot and mouth disease virus, NSP = Non-structural protein of FMDV, Type A = FMDV serotype A, Type O = FMDV serotype O

Table 3. Seroprevalence and associated risk factors of FMDV in small ruminants of the northern regions of Cameroon in 2020.

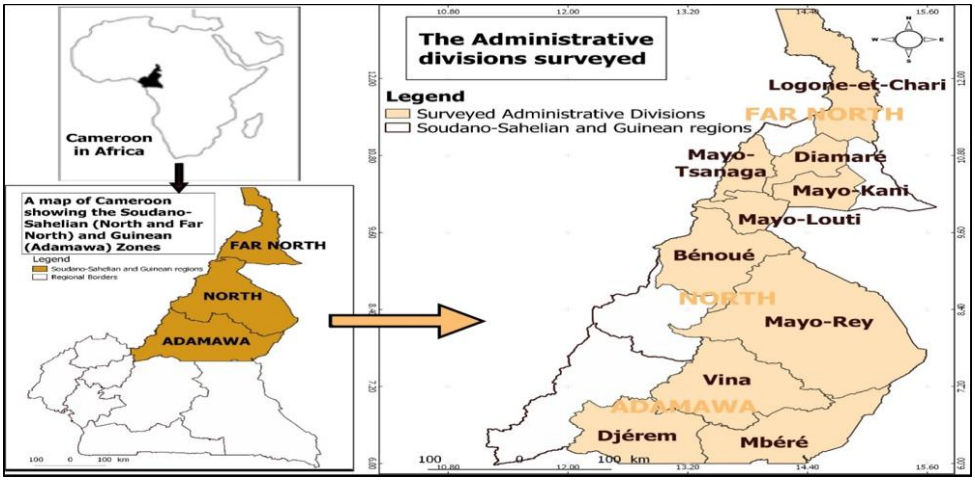
	Detection of anti-FMDV antibodies in Sheep[#] (n =268)						Detection of anti-FMDV antibodies in Goats (n=82)					
Parameters	Anti-NSP antibodies		Anti-Type A antibodies		Anti-Type O antibodies		Anti-NSP antibodies		Anti-Type A antibodies		Anti-Type O antibodies	
	N (%)	p (χ2)	N (%)	p (χ2)	N (%)	p (χ2)	N (%)	p (χ2)	N (%)	p (χ2)	N (%)	p (χ2)
Region Adamawa Far North North	51 (85.0) 36 (28.3) 20 (24.7)	<0.0001 (65.8)	0 (0.0) 2 (1.6) 12 (14.8)	<0.0001 (18.3)	0 (0.0) 22 (17.3) 16 (19.8)	0.001 (13.0)	27 (81.8) 13 (52.0) 12 (50.0)	0.018 (8.1)	0 (0.0) 1 (4.0) 1 (4.2)	0.51 (1.4)	0 (0.0) 13 (52.0) 10 (41.7)	<0.0001 (22.2)
Age group Young Adults Old	25 (27.8) 54 (45.8) 28 (46.7)	0.01 (8.4)	2 (2.2) 9 (7.6) 3 (2.0)	0.23 (2.9)	4 (4.4) 18 (15.3) 16 (26.7)	0.001 (14.8)	9 (52.9) 33 (64.7) 10 (71.4)	0.61 (1.2)	1 (5.9) 1 (2.0) 0 (0.0)	1 (1.3)	4 (23.5) 15 (29.4) 4 (28.6)	0.94 (0.2)
Body condition score Thin Normal Fat	36 (46.2) 71 (37.8) 0 (0.0)	0.30 (2.6)	4 (5.1) 10 (5.3) 0	1.00 (0.8)	16 (20.5) 22 (11.7) 0	0.14 (3.6)	12 (54.5) 40 (67.8) 0	0.19 (3.0)	1 (4.5) 1 (1.7) 0	1 (2.9)	8 (25.4) 15 (36.4) 0	0.57 (1.4)
Sex Female Male	84 (44.0) 23 (29.9)	0.02 (4.6)	11 (5.8) 3 (3.9)	0.39 (0.4)	35 (18.3) 3 (3.9)	0.001 (9.4)	44 (68.8) 8 (44.4)	0.05 (3.6)	2 (3.1) 0	0.61 (1.0)	21 (32.8) 2 (11.1)	
Physiological status Nursing Pregnant Empty Castrated Whole	24 (38.1) 39 (60.0) 21 (33.3) - -	0.005 (10.6) -	2 (3.2) 3 (4.6) 6 (9.5) - -	0.28 (2.6) -	11 (17.5) 10 (15.4) 14 (22.2) - -	0.59 (1.04) -	20 (74.1) 19 (70.3) 5 (50.0) 1 (25.0) 7 (50.0)	0.36 (2.0) 0.38 (0.8)	1 (3.7) 0 1 (10.0) 0 0	0.29 (2.5) -	9 (33.3) 9 (33.3) 3 (30.0) 1 (25.0) 1 (7.1)	0.98 (0.04) 0.31 (1.0)
Total (95% IC)	107 (39.9) (33.9 – 45.6)		14 (5.2) (3.1 – 8.5)		38 (14.2) (10.4 – 18.7)		52 (63.4) (15.0 – 24.4)		2 (2.4) (0.2 – 2.7)		23 (28.0) (5.7 – 12.6)	

FMDV = Foot and mouth disease virus, NSP = Non-structural protein of FMDV, Type A = FMDV serotype A, Type O = FMDV serotype O. # Physiological status computed only for females.

Table 4. Multivariable logistic regression model of FMDV associated risk factors in small ruminants of the northern regions of Cameroon, 2020.

Parameters		Detection of anti-FMDV antibodies					
		NSP		Type A		Type O	
		P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)
Region	Adamawa	0.0001	0.06 (0.03 – 0.15)	0.994	/	0.992	/
	Far North	0.781	0.9 (0.5 – 1.7	0.004	7.3 (1.9 – 27.9)	0.703	1.1 (0.6 - 2.2)
	North	.	Ref	.	Ref	.	Ref
Species	Goat	0.022	0.5 (0.3 – 0.9)	0.393	1.9 (0.4 – 9.7)	0.0001	0.2 (0.1 - 0.5)
	Sheep	.	Ref	.	Ref	.	Ref
Sex	Female	0.016	0.3 (0.1 – 0.8)	0.452	0.6 (0.1 – 2.5)	0.021	0.2 (0.07 – 0.8)
	Male	.	Ref	.	Ref	.	Ref
Age group	Adult	0.368	1.3 (0.7- 2.5)	0.685	0.7 (0.2 – 3.0)	0.257	1.5 (0.7 – 3.2)
	Young	0.049	2.2 (1.0 - 4.7)	0.468	1.9 (0.3 – 11.1)	0.003	4.8 (1.7 – 13.7)
	Old	.	Ref	.	Ref	.	Ref
Body Condition Score	Fat	.	/	.	/	.	/
	Thin	0.420	0.8 (0.5 – 1.4)	0.297	0.5 (0.2 – 1.7)	0.027	0.5 (0.2 – 0.9)
	Normal	.	.	.	Ref	.	Ref
Physiological Status	Nursing	0.779	1.1 (0.5 – 2.4)	0.218	2.5 (0.6 – 11.2)	0.196	1.8 (0.7 – 4.3)
	Pregnant	0.557	2.4 (0.1 – 42.1)	0.332	2.1 (0.5 – 9.1)	0.591	1.3 (0.5 – 3.1)
	Empty	.	Ref	.	Ref	.	Ref

Figure 1. Map of Cameroon showing the Northern regions with the surveyed administrative divisions.



Discussion

The current study aimed at determining the seroprevalence and risk factors of FMD in small ruminants and cattle mixed herds in the Soudan-Sahelian and Guinean agro-ecological zones (AEZs) of Cameroon. We found that the percentage of positive sera for each serotype was different in sheep and goats in the current study. Non-Structural Protein (NSP) antibodies were found in 159 animals (45.4%), indicating that the animals had come into contact with the virus (presumably the wild strain) since they were not vaccinated. Serotype A antibodies were the least common in both sheep and goats. These findings are different from those reported by Habiela et al. [38], where serotype A was the most prevalent followed by serotype O. The later was the most prevalent in another survey conducted in small ruminants [37]. The distribution of these serotypes is different for both regions (North and Far North) of the Soudan Sahelian agro-ecological zone. None of the serotypes targeted were

detected in the Guinean region (Adamawa), probably because of the breeding system, where less breeders raise small ruminants with bovines.

The free movements of animals and co-existence with other ruminants in the same habitat, mainly cattle, may contribute to cross transmission of FMDV. In addition, it is advisable to control FMD outbreaks by restricting movement of small ruminants for two weeks after infection as sheep and goats are involved in the transmission of FMDV during the early stages of the disease [38]. Therefore, small ruminants should be included in the vaccination program [36]. It is worth noting that no animal related variables showed significant relationship with seropositivity. Husbandry related variables showed significant relationship with seropositivity in studies of Balinda et al. [39] and Chepkwony et al. [19] in Kenya.

At individual animal level, a significant difference was observed in seroprevalence of FMD among adults and young sheep and goats. This is in agreement with the results of Habiela et al. [38] even though the seropositivity levels in our study were higher. The difference in seropositivity between age groups may be due to the fact that mature animals might have experienced several exposures to FMD at grazing fields, watering points and at market places than in age group less than one year. Therefore, adult animals might have acquired infection from multiple strains and serotypes thus producing antibodies against multiple virus incursions of FMD. The low seroprevalence in young animals might also be indicative of persistent passive immunity and less frequency of exposure of the animal to the disease as the farmers keep their lambs and kids at homesteads.

Conclusion

This study was carried out to determine the seroprevalence and associated risk factors of FMD in small ruminants reared with cattle in the Soudan-Sahelian and Guinean regions of Cameroon. The overall seroprevalence of antibodies to the non-structural protein of the FMD virus was 45.4%, that of serotype A was 4.6%and that of serotype O was 17.4%. In sheep, age, sex and physiological status were significantly associated to seroprevalence. It is advisable that SATs (SAT1, 2& 3) serotyping be conducted using the current study samples. Molecular studies are required for more insights on the strains circulating in these regions for the elaboration of species-specific vaccines and detection of potential vaccine candidates. Ultimately, the real economic impact of this disease should be assessed nationwide.

Authors' contributions

SDJ, JAN, RNG, ID, LGY, SLS, CMM, ATN, AW: Study design, sample collection, statistical analysis, and drafted the manuscript. All authors have read, reviewed, and approved the final manuscript.

Data availability

The data used to support this study are available upon request.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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