PREVALENCE AND EFFECT OF BOVINE HERPESVIRUS TYPE 4 ON BIOCHEMICAL, HORMONAL AND ASSOCIATED LESIONS IN CATTLE IN NORTHERN CAMEROON

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Abstract

This study was carried out on 938 zebus of all ages, in the Adamawa, North and Far North regions, from January to June 2022. It's objective was to assess the effect to bovine herpes virus type 4 (BoHV-4) on the biochemical and hormonal parameters, and highlight the lesion associated with the presence of this virus. Before slaughtering the animals, a macroscopic examination was done in order to determine the characteristics of the animals. After slaughter, organ lesions were determined by observing macroscopic malformations. Blood was collected, then the serum obtained and stored at -20C. The diagnosis of BoHV-4 and the hormonal assays were performed by the indirect ELISA (Enzyme-linked Immunosorbent Assay) technique; biochemical assays were performed by colorimetry and absorbance reading by spectrophotometry. The overall BoHV-4 seroprevalence was 74,8%; and the prevalence by region were recorded as 56%, 94.9%, 97.7% respectively in Adamaoua, North and Far North. The Gudali breed aged between 4 to 7 years are the main risk factors for BoHV-4 seropositivity. In seropositve animals, mean concentration of glucose, cholesterol, ALT, AST, urea, creatinine, total protein, calcium, phosphorus and albumin were respectively 2,47± 0,77g/l, 189,4±0,37mg/dl, 20,80±1,89 U/I, 13,99±1,07 U/I, 6,52±0,75 mg/ dl, 0,94±0,13 mg/ dl, 4,68±0,24 mg/ dl, 2,70±0,26 mmol/l, 1,43±0,30 mmol/l et 6,78±0,28 g/l. Seropositivity to bovine herpes virus 4 would lead to a significant decrease in glucose, cholesterol, AST and total proteins; a significant increase in albumin. Mean estradiol and progesterone concentration in pregnant females were 1,48±0,57 ng/ml et de 1,13±0,20 ng/ml respectively; in non-pregnant females, these concentrations were 1,46±0,54 ng/ml et de 1,10±0,20 ng/ml respectively. The estradiol value was significantly elevated and that of progesterone remains normal. The mean testosterone value was low (1,54ng/l). Creatinine and ALT were positively and strongly correlated with bovine herpes virus 4 seropositivity, while ALT and glucose were negatively and weakly correlated with this seropositivity.

Key words: *Cattle, BoHV-4, prevalence, biochemical and hormonal parameters, lesions, Northern Cameroon*

INTRODUCTION

Cattle breeding is an important activity, highly dependent on the physical environment (relief, climate, vegetation, etc.) and the human environment, to which are added pathological factors. There is solidarity between the soil; climate, plants and livestock. This sector is a safe and huge value in the Cameroonian economy. It thus contributes nearly 165 billion CFA francs to the formation of the gross domestic product (GDP) and provides income to about 30% of

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the rural population [1]. Cameroon by 2035 has set itself the objective of being able to produce 42 kg/inhabitant/year in animal proteins, particularly meat and milk [2]**.** Despite a population whose population is estimated to have grown sharply from 5.08 to 7.4 million head of cattle with meat production increasing from 334312 to 357,500 tons in 2015 [2], the national coverage rates of the population's meat and milk needs remain very low. Many pathological problems can be at the origin of these deficits [3] such as abortions, metritis and many other reproductive disorders.

Reproductive disorders are a frequency of (44.8%) and mastitis (29.9%) [4]**.** The infectious etiology of bovine abortions is complex and includes viral, bacterial or fungal pathogens [5]. These pathogens sometimes destroy the efforts of farmers to multiply the herd, resulting in significant economic losses.

However, there are other abortive pathologies that are neglected in scientific research although they are silent but can cause damage when combined with other pathologies. It is with this in mind that we are interested in herpes viruses, mainly type 4. The detection of BoHV-4 even in healthy cattle [6] makes the study of this infection an interesting topic for researchers.

Herpes virus BoHV-4 (Bovine Herpes Virus type 4) is a recently discovered virus with a global distribution. It has been isolated in a wide variety of clinical cases, mainly metritis, vaginitis and mastitis, but also endometritis, abortion and orchitis [7]. Knowledge of the characteristics of BoHV-4 and its pathogenesis in the animal body, particularly in cattle, remains incomplete, as does its real prevalence and economic impact. However, at present, its involvement in acute puerperal metritis is established, and it seems to preferentially cause reproductive pathologies in domestic cattle. Its role as a secondary pathogen, i.e. in association with other agents, is increasingly documented [5]. The role of BoHV-4 in bovine abortions is a current subject of study, while the abortive role of BoHV-1 is well documented. The veterinary practitioner does not have a specific therapy for this virus and can only apply prophylactic methods, based on current knowledge; this becomes even more interesting.

Based on the emergence of a threat to bovine reproduction by this BoHV-4 infection, it is wise to question the circulation of this pathology in the northern regions of Cameroon and its repercussions on animal health. It is in this context that this work was carried out, the aim of which is not only to bring out the prevalence of BoHV-4 in the slaughterhouses of Ngaoundere, Garoua and Maroua, but to establish the frequency of target organs through biochemical and hormonal parameters.

MATERIAL AND METHOD

Study area

The present cross-sectional study took place in the northern zone of Cameroon (Adamawa, North and Far North) from April to September 2022. The choice of this study area is justified by the fact that 83% of Cameroon's cattle herd are located in the three regions of the North, the Far North and Adamawa [1]

Our study area is represented by Figure 1 showing the three Northern Regions in green.

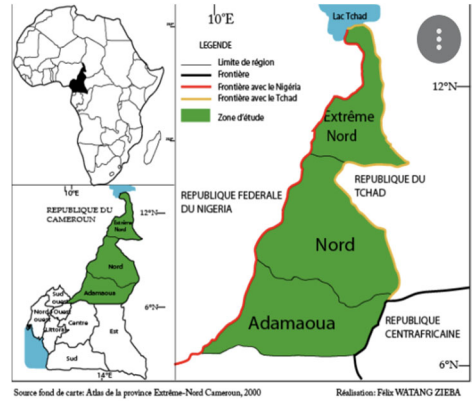

Fig. 1 Location of the study area

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Sample collection

A sample of 3-5 ml of blood was taken ante-mortem from each cow using a dry tube without additives such as Vacutainer. Each tube bearing a number allowing the identification of the animal. The blood samples were then stored at 4°C in a cooler equipped with dry ice before being transported to the laboratory.

In the laboratory, the vortex to homogenize the samples before analysis the centrifugation of the samples was at 3500 rpm for 5 minutes. Two phases were obtained, namely the pellet and the supernatant, also known as serum. The serum, which is the biological material for this study, was collected using a micropipette and stored in cryotubes bearing a number to facilitate the identification of the animal. The sera were then heated to -20°C in a freezer until the time of serological analysis.

Determination of prevalence and lesions related to BOH-V 4

The kit used for the detection of antibodies to *BOh-V 4* is the ID Screen® *BOh-V 4* Indirect kit (ID.vet, 310; rue Louis Pasteur (Grabels, France)) in the plasma or serum of cattle. This ELISA has a sensitivity of 100% (CI 95%: 89.28–100%) and a specificity of 100% (CI 95%: 97.75–100%). The microplate is read at 450 nm.

The serological analysis allowing the detection of Boh-v 4 in serum (indirect ELISA) took place at the LANAVET in Garoua. This indirect ELISA method follows a number of steps.

The test is validated if:

- The mean value of the positive control optical densities (pDOCs) is greater than 0.350. DOCp > 0.30
- The ratio between the mean of the optical densities of the positive control (DOCp) and the mean of the optical densities of the negative control (DOCn) is greater than 3. DOCp / DOCn> 3

The interpretation is done after calculating the percentages of inhibition (S/P %) of each sample from the means of the optical densities (OD).

$$\frac{S}{P}\% = \frac{\text{DO échantillion} - \text{DOCn}}{\text{DOCp} - \text{DOCn}}$$

Table 1 gives the different possibilities of interpretation according to the values of S/P %:

Table 1 Interpretation of the qualitative and quantitative evaluation

Result	Status
S /P%< 60%	Negative result
S/P% > 60%	Positive result

Evaluation of the effect of BOH-‘4 on biochemical and hormonal parameters

Biochemical and hormonal analyses were carried out at the IRAD laboratory in Wakwa.

➢ **Creatinine**

The assay is based on the reaction of creatinine with sodium picrate**.** Creatinine reacts with alkaline picrate forming a red complex. The time interval chosen for the measurements avoids interference from the other constituents of the serum. The intensity of color formed is proportional to the concentration of creatine in the sample.

➢ **AST**

Aspartate aminotransferase (AST), formerly known as glutamate oxaloacetate (GOT), catalyzes the reversible transfer of an amino group from aspartate to a glutamate-forming keto-glutamate and oxalacetate. The oxalacetate produced is reduced to malate dehydrogenase (MDH) and NADH.

➢ **ALT**

Alanine aminotransferase (ALT) or glutamate pyruvate transaminase (GPT) catalyzes the reversible transfer of an amino group of alanine to a glutamate-forming ketoglutarate and pyruvate. The pyruvate

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produced is reduced to lactate-by-lactate dehydrogenase (LDH) and NADH.

- **Phosphorus**

The inorganic phosphate reacts in an acidic medium with the ammonium molybdate to form a yellow phosphomolybdate complex.

The intensity of the color formed is proportional to the concentration of inorganic phosphorus in the sample.

- **Glucose**

Glucose in the presence of glucose oxidase gives gluconic acid+H2O2 2H202+4aminophenazone+phenazone+phenal, in the presence of peroxidase gives quinoneimine+4H2O2 to form a colored complex whose absorbance proportional to the glucose concentration in the sample is measured with a spectrophotometer at 500nm.

- **Total Protein**

The proteins give an intense blue-violet complex with copper salts in an alkaline medium, iodide is included as an antioxidant. The intensity of the color formed is proportional to the total protein concentration of the sample.

- **Cholesterol**

The cholesterol present in the sample comes from a colored complex, according to many reactions. The intensity of the color formed is proportional to the concentration of cholesterol in the sample.

- **Albumin**

Albumin in the presence of bromocresol green with a slightly acidic Ph produces a change in color of the indicator from yellow-green to blue-green.

The intensity of the color formed is proportional to the concentration of albumin in the sample.

- **Calcium**

The measurement of calcium in the sample is based on the formation of a colored complex between calcium and o-cresol phthalein in an alkaline medium:

The intensity of the color formed is proportional to the concentration of calcium in the sample.

- **Urea**

The urea in the sample is enzymatically hydrolyzed to ammonia (NH4+) and carbon dioxide (CO2).

The ammonia ions formed react with salicylate and hypochlorite (NaClO), in the presence of the nitroprusside catalyst, to form a green indophenol. The intensity of the color formed is proportional to the concentration of urea in the sample.

- **Progesterone and Testosterone**

The principle of the assay combines the competitive enzyme-linked immunosorbent method.

The essential reagents required for the enzyme immunoassay include antibody, enzyme conjugate, and native antigen. When mixing a biotinylated antibody, an enzyme antigen conjugate, and a serum containing the native antigen, a competitive reaction occurs between the native antigen and the enzyme-antigen conjugate for a limited number of antibody-binding sites. The enzymatic activity in the antibody-bound fraction is inversely proportional to the native antigen concentration. Using several sera of different references, of known antigen concentration, a dose-response curve can be generated from which the unknown antigen concentration can be observed.

- **Estradiol**

The monocent, Inc. E2 ELISA assay system is based on the principle of the delayed competitive binding test between E2 for a constant amount of anti-estradiol monoclonal antibody epitopes (biotin reagent).

Statistical analysis of the data

The data collected through the survey sheets as well as the results of the laboratory analyses were entered into the Microsoft Excel®2013 spreadsheet and the statistical

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analyses were carried out using the SPSS® software (version 16.0). Prevalence was determined by descriptive statistical analysis. The variables statistically related to the presence of the disease led us to estimate the Odd Ratio (OR) by simple logistic regression and the corresponding 95% CIs. Variables with a P-value less than 0.05 were considered to be significant. Analysis of variance (ANOVA) to a factor associated with Duncan's post hoc test was performed to compare prevalence, biochemical and hormonal parameters. The Student test was used to make pairwise group comparisons. The Pearson correlation was used to determine the strength of the relationship between certain parameters.

RESULTS

Prevalence, risk factors and lesions related to BOHV-4

The overall prevalence of the disease was 74.8%. In Table 2 opposite, we obtained a significant variation in prevalence according to region and race. It was significantly higher in the Bokolo breeds in the Far North.

As presented in Table 3, the most observed lesions in the study areas were bronchopneumonia in the respiratory system, dermatitis in the skin, and splenomegaly in the spleen. Along the female genital tract, the most frequent lesions were mastitis and metritis in Adamawa; vaginitis in the north; orchitis in males and conjunctivitis in the eye.

Table 2 Prevalence of BoHV-4 according to the zootechnical characteristics of the animals in the study

Factors	Variables	Prevalence	P-value
Regions	Adamawa Far North North	$0{,}56^{a}$± 0,50 $0{,}97^{b}$± 0,15 $0{,}95^{b}$± 0,16	**0,000**
Race	Akou Bokolo Djaffoun Goudali	$0{,}78^{b}$± 0,41 $0{,}83^{b}$± 0,38 $0{,}78^{b}$± 0,41 $0{,}59^{a}$± 0,49	**0,000**
Age (Year)	[0 – 3] [4 – 7] [5 – 8]	0,84± 0,37 0,74± 0,44 0,84± 0,37	**0,131**
Sex	Male Female	0,78± 0,41 0,74± 0,44	**0,177**
Temperature (Ċ)	< 37.9 [38 – 39] >39	0,75± 0,43 0,74± 0,44 0,67± 0,48	**0,526**
NEC	1 2 3 4	0,68± 0,47 0,74± 0,44 0,75± 0,43 0,85± 0,36	**0,383**
Weight (kg)	[0 – 200] [201 – 401] [402 – 602]	$0{,}85^{a}$± 0,37 $0{,}73^{b}$± 0,44 $0{,}86^{b}$± 0,35	**0,024**
Physiological status	Pregnant Non-pregnant	0,75± 0,43 0,73± 0,44	**0,548**
Lesions	Present Absent	0,76± 0,43 0,75± 0,44	**0,745**

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Table 3 Distribution of organ injuries and diseases by region

Variables		Adamaoua	North	Far North	Total
		N (%)	N (%)	N (%)	N (%)
Respiratory system	Broncho pneumonia	5 (55,6)	1 (11,1)	3 (33,3)	9 (100)
	Emphysèma	1 (100)	0 (0)	0 (0)	1 (100)
	Nasal discharge	4 (80)	1 (20)	0 (0)	5 (100)
	Obstruction	5 (62,5)	0 (0)	3 (37,5)	8 (100)
Skin	Dermatitis	19 (65,5)	7 (24,1)	3 (10,3)	29 (100)
	Dermatose	0 (0)	1 (100)	0 (0)	1 (100)
Spleen	Splénomégaly	10 (52,6)	4 (21,1)	5 (26,3)	19 (100)
	Pétéchiae	1 (100)	0 (0)	0 (0)	1 (100)
Utérus	Métritis	18 (40,9)	13 (29,5)	13 (29,5)	44 (100)
Vagina/Vulva	Vaginitis	8 (22,9)	18 (51,4)	9 (25,7)	35 (100)
	Vulvovaginitis	5 (45,5)	4 (36,4)	2 (18,2)	11 (100)
	Vaginal prolapse	1 (100)	0 (0)	0 (0)	1 (100)
	Swelling	1 (50)	1 (50)	0 (0)	2 (100)
Penis/Testis	Orchitis	3 (37,5)	3 (37,5)	2 (25)	8 (188)
	Balanitis	1 (50)	1 (50)	0 (0)	2 (100)
	Posthitis	0 (0)	1 (100)	0 (0)	1 (100)
	Balanoposthitis	2 (100)	0 (0)	0 (0)	2 (100)
Udder	Mastitis	30 (47,6)	17 (30)	16 (25,4)	63 (100)
Eyes	Conjonctivitis	10 (62,5)	4 (25)	2 (12,5)	16 (100)
	Flow	6 (100)	0 (0)	0 (0)	6 (100)

N: number

Table 4 shows that the region and the department constitute the extrinsic risk factors for the seropositivity of the animals, while the intrinsic risk factors (Table 5) consist mainly of the Goudali breed aged 4 to 7 years.

Table 4 Influence of extrinsic factors on seropositivity

Variable	**Category**			**Dataset**		
		Ni	***ni***	***Seroprevalence (IC 95%)***	***OR (IC 95%)***	***p-value***
Region	Adamawa	500	280	56,0% [51,6 ; 60,4]	20,8 [12,2; 35,7]	0,000
	North	218	207	94,9% [92,0; 97,9]	8, [4,5; 16,0]	0,000
	Far North	220	216	97,7% [95,7; 99,7]	20,4 [8,2; 50,1]	0,000
Division	Vina	355	209	58,9% [53,7; 64,0]	3,8 [2,8; 5,2]	0,000
	Mbere	145	71	48,9% [40,7; 57,2]	4,1 [5,2; 5,9]	0,000
	Benoue	137	131	95,6% [92,2; 99,1]	8,8 [3,8; 20,2]	0,000
	Mayo Rey	81	76	93,8% [88,5; 99,2]	5,6 [2,2; 14,0]	0,000
	Diamare	101	99	98,0% [95,3; 100]	19,2 [4,7; 78,5]	0,000
	Mayo Danay	56	54	96,4% [91,4; 101]	9,7 [2,3; 40,3]	0,000
	Mayo Kani	63	62	98,4% [95,2; 102]	22,8 [3,1; 165,1]	0,000

Ni: actual total, **ni**: number of seropositive cases,

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Table 5 Influence of intrinsic factors on seropositivity

Variable	Category			Ensemble de données		
		Ni	*ni*	*Seroprevalence (IC 95%)*	*OR (IC 95%)*	*p-value*
Race	Akou	375	294	78,4% [74,2; 82,6]	0,7 [0,5; 1,0]	0,067
	Bokolo	69	57	82,6% [73,4; 91,8]	0,5 [0,2; 0,9]	0,029
	Djaffoun	305	239	78,4% [73,7; 83,0]	0,7 [0,6; 1,0]	0,062
	Goudali	189	112	59,3% [52,2; 66,3]	2,4 [1,7; 3,4]	0,000
Sexe	Male	247	193	78,1% [73,0; 88,3]		-
	Female	691	509	73,7% [70,4; 77,0]	1,2 [0,9; 1,8]	0,164
Age	[0; 3]	32	28	87,5% [75,4; 99,6]	0,4 [0,1; 1,2]	0,093
	[4; 7]	856	632	73,8% [70,9; 76,8]	2,2 [1,1; 4,2]	0,016
	[8; 11]	50	42	84,0% [73,5; 94,5]	0,6 [0,3; 1,2]	0,143
Body condition score	1 - 2	319	232	72,7% [88,3; 121,3]	1,2 [0,9; 1,6]	0,251
	3	592	447	75,5% [72,0; 78,9]	0,9 [0,7; 1,2]	0,511
	4	27	23	85,2% [70,9; 99,5]	0,5 [0,2; 1,5]	0,209
Lesions	Present	234	177	75,6% [73,0; 88,3]		-
	Absent	704	525	74,7% [70,4; 77,0]	0,9 [0,7; 1,3]	0,744

Ni: total number of HIV-positive cases and **NEC**: body condition score

Evaluation of biochemical and hormonal parameters of animals

The overall averages of glucose, cholesterol, AST and total protein are below the reference values, while the average of Albumin is above. BoHV-4 seropositivity seems to lead to a significant increase in creatinine and phosphorus; a significant decrease in glucose, cholesterol and calcium. Nevertheless, the averages of ALT, AST, urea, and albumin vary significantly in animals in each region. In addition, in the Far North region, the average glucose would be significantly low while the average cholesterol would be significantly high in the animals in Adamawa. In the northern region, the average of total protein would be significantly low in animals while that of phosphorus would be significantly high (Table 6). In females only, the mean value of progesterone is within the confidence interval while that of estradiol is high compared to the reference. The means of estradiol vary significantly with age and those of progesterone according to race and lesions (Table 7). While in males, the average testosterone value is low compared to the reference value. However, it varies significantly with age (Table 8).

Correlation between biochemical and hormonal parameters of positive animals

It should be noted that there is a strong correlation at 99% between several biochemical parameters such as ALT and creatinine with a positive correlation coefficient which means that when ALT increases, creatinine increases. Between glucose and creatinine, there is also a strong correlation at 99% but the correlation coefficient is negative, which means that when one of the parameters increases, the other decreases. There are also weak correlations (95%). This is the case between glucose and ALT with a negative correlation coefficient as well as albumin and ALT with a positive correlation coefficient (Table 9).

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Table 6 Comparison of biochemical parameters of positive animals according to region and characteristics of subjects

Factor's		N (702)	Glucose (g/l)	Cholesterol (mg/dl)	ALT (U/l)	AST (U/l)	UREA (mg/dl)	Creatinine (mg/dl)	Total proteins (mg/dl)	Calcium (mmol/l)	Phosphorus (mmol/l)	Albumin (g/l)
Reference values			**3,33-6,10**	**200-240**	**18-40**	**16-38**	**2,49-7,49**	**0,6-1,4**	**5,5-9,1**	**2-3,25**	**0,80-2,26**	**3,5-5**
Negatives		40	2,83±0,54	192,6±9.60	20,79±1,53	14,09±0.83	6,49±0,47	0,91±0,11	4,73±0.18	2,79±0,26	1,31±0,27	6,74±0,25
Positives		702	2,47±0,77	189,4±0,37	20,80±1,89	13,99±1,07	6,52±0,75	0,94±0,13	4,70±0,23	2.70±0,26	1,43±0,30	6,78±0,28
Race	**Akou**	294	2,51±0,77^{b}	189,04±7,48	20,77±1,84^{a}	14,06±1,10	6,58±0,79^{b}	0,93±0,12	4,68±0,24^{a}	2,70±0,26^{b}	1,44±0,29^{b}	6,76±0,30
	Bokolo	57	2,20±0,76^{a}	187,29±10,25	21,32±2,02^{b}	14,05±1,10	6,67±0,74^{b}	0,96±0,12	4,68±0,27^{a}	2,57±0,22^{b}	1,56±0,27^{c}	6,82±0,21
	Djafoun	239	2,38±0,81^{ab}	189,79±9,83	20,44±1,78^{a}	13,84±1,07	6,52±0,75^{b}	0,93±0,13	4,71±0,21^{a}	2,68±0,22^{b}	1,45±0,29^{b}	6,78±0,27
	Goudali	112	2,69±0,58^{c}	190,39±6,27	21,01±2,02^{b}	14,06±0,90	6,28±0,57^{a}	0,94±0,13	4,76±0,20^{b}	2,75±0,29^{a}	1,27±0,28^{a}	6,82±0,21
	P-value		**0,000**	**0,105**	**0,000**	**0,082**	**0,002**	**0,452**	**0,018**	**0,000**	**0,000**	**0,440**
Age (years)	**[0 - 3]**	28	2,09±0,59^{a}	188,4±9,85	21,45±2,23	13,68±0,62	6,62±0,58	0,96±0,13	4,65±0,20^{a}	2,52±0,15^{a}	1,58±0,31^{b}	6,91±0,29^{a}
	[4 - 7]	632	2,48±0,76^{b}	189,3±8,50	20,77±1,86	13,99±1,09	6,53±0,75	0,93±0,12	4,70±0,22^{a}	2,70±0,25^{b}	1,42±0,29^{a}	6,77±0,27^{b}
	[8 - 11]	42	2,59±0,79^{b}	190,1±6,71	20,62±2,01	14,02±0,84	6,33±0,84	0,92±0,16	4,79±0,24^{b}	2,77±0,31^{b}	1,39±0,29^{a}	6,74±0,33^{b}
	P-value		**0,020**	**0,699**	**0,146**	**0,310**	**0,189**	**0,479**	**0,021**	**0,000**	**0,015**	**0,024**
Body condition score	**1**	32	2,84±0,41^{a}	192,0±6,42	20,00±1,88^{a}	14,16±1,30	6,33±0,99	0,91±0,13	4,78±0,25	2,76±0,30	1,38±0,30	6,73±0,38
	2	200	2,43±0,73^{b}	190,3±8,28	20,95±1,94^{b}	14,06±1,08	6,49±0,79	0,93±0,12	4,71±0,22	2,71±0,27	1,44±0,28	6,76±0,31
	3	447	2,45±0,79^{b}	188,7±8,72	20,77±1,87^{ab}	13,94±1,05	6,56±0,70	0,94±0,13	4,69±0,23	2,68±0,24	1,43±0,30	6,79±0,25
	4	23	2,76±0,70^{a}	190,1±5,24	20,70±1,66^{ab}	13,90±0,86	6,28±0,93	0,91±0,13	4,73±0,25	2,79±0,25	1,31±0,26	6,80±0,27
	P-value		**0,008**	**0,033**	**0,035**	**0,253**	**0,135**	**0,440**	**0,198**	**0,032**	**0,303**	**0,494**
Sexe	**Male**	193	2,46±0,81	188,0±9,84	20,83±1,91	13,97±1,03	6,55±0,70	0,94±0,13	4,68±0,23	2,66±0,25	1,46±0,30	6,81±0,27
	Female	509	2,47±0,74	189,8±8,45	20,77±1,88	13,99±1,08	6,51±0,77	0,93±0,12	4,71±0,22	2,70±0,26	1,42±0,29	6,76±0,28
	P-value		**0,911**	**0,013**	**0,069**	**0,407**	**0,544**	**0,466**	**0,073**	**0,049**	**0,102**	**0,041**
Lesions	**Present**	177	2,62±0,53	192.0±7,08	20,38±1,72	14,19±0,99	6,32±0,95	0,94±0,13	4,77±0,25	2,66±0,24	1,45±0,29	6,75±0,35
	Absent	525	2,42±0,82	188,4±8,69	20,92±1,92	13,91±1,08	6,59±0,65	0,93±0,12	4,68±0,21	2,70±0,26	1,42±0,30	6,78±0,24
	P-value		**0,000**	**0,000**	**0,001**	**0,002**	**0,001**	**0,859**	**0,000**	**0,058**	**0,164**	**0,306**
Physiological status	**Gestating**	126	2,42±0,70	190.3±8,24	20,68±2,03	14,04±0,99	6,48±0,74	0,93±0,13	4,75±0,23	2,74±0,28	1,41±0,32	6,79±0,29
	Non gestating	383	2,50±0,76	189,7±7,97	20,81±1,83	13,98±1,12	6,53±0,78	0,94±0,14	4,71±0,23	2,70±0,25	1,43±0,29	6,76±0,28
	P-value		**0,316**	**0,454**	**0494**	**0,571**	**0,531**	**0,803**	**0,039**	**0,174**	**0,504**	**0,338**
Region	**Adamawa**	280	2,61±0,59^{b}	190,5±7,97^{c}	21,7±2,08^{b}	14,0±0,96^{b}	6,3±0,64^{a}	0,95±0,14^{c}	4,79±0,22^{c}	2,74±0,32^{c}	1,31±0,27^{a}	6,78±0,28^{b}
	North	207	2,63±0,80^{b}	188,2±8,70^{a}	20,3±1,38^{a}	14,5±1,13^{c}	6,8±0,87^{c}	0,92±0,09^{a}	4,57±0,24^{a}	2,70±0,25^{b}	1,60±0,26^{c}	6,71±0,33^{a}
	Far North	215	2,15±0,83^{a}	189,1±8,69^{b}	20,0±1,51^{a}	13,6±0,95^{a}	6,6±0,65^{b}	0,93±0,14^{b}	4,73±0,16^{b}	2,64±0,13^{a}	1,43±0,12^{a}	6,84±0,20^{c}
	P-value		**0,000**	**0,010**	**0,000**	**0,000**	**0,000**	**0,034**	**0,000**	**0,000**	**0,000**	**0,000**

($^{a; b; c; d}$) values with different letters are significantly different ($P < 0.05$)

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Table 7 Hormonal parameters of positive females according to breed, age, BCS, presence or absence of lesions and physiological status

Variables		N	Progesterone	Estradiol
Reference value			(0,13-1,22ng/ml)	(0,01-0,04 ng/ml)
Ages	**[0 - 3]**	15	1,13±0,15	1,81±0,62^{b}
	[4 - 7]	480	1,11±0,20	1,46±0,52^{a}
	[8 - 11]	14	1,16±0,27	1,17±0,59^{a}
	P-value		**0,582**	**0,005**
Races	Akou	222	1,09±0,20^{ab}	1,46±0,52
	Bokolo	35	1,14±0,30^{ab}	1,66±0,52
	Djaffoun	188	1,14±0,19^{b}	1,43±0,52
	Goudali	64	1,07±0,16^{a}	1,45±0,61
	P-value		**0,029**	**0,136**
Lesions	Absent	144	1,14±0,27	1,52±0,59
	Present	365	1,10±0,17	1,44±0,51
	P-value		**0,045**	**0,142**
Body condition score	1	25	1,13±0,27	1,47±0,56
	2	175	1,12±0,22	1,46±0,52
	3	305	1,10±0,19	1,46±0,54
	4	4	1,05±0,12	1,74±0,64
	P-value		**0,554**	**0,787**
Physiological status	Gestating	126	1,13±0,20	1,47±0,52
	Non gestating	383	1,10±0,20	1,46±0,54
	P-value		**0,194**	**0,976**

($^{a; b}$) values with different letters are significantly different (P < 0.05)

Table 8 Hormonal parameters of positive males according to breed, age and BCS

Variables		N	Testosterone
Reference value			**2,5-10** ng/ml
Ages	**[0 - 3]**	13	1,26±0,61^{a}
	[4 - 7]	152	1,55±0,46^{b}
	[8 - 11]	28	1,81±0,30^{c}
	P-value		**0,001**
Races	Akou	72	1,58±0,50
	Bokolo	22	1,46±0,45
	Djaffoun	51	1,48±0,49
	Goudali	48	1,70±0,35
	P-value		**0,077**
Body Condition Score	1	7	1,76±0,62
	2	25	1,48±0,58
	3	142	1,55±0,44
	4	19	1,79±0,38
	P-value		**0,085**

($^{a; b; c}$) values with different letters are significantly different (P < 0.05).

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Table 9 Correlation between biochemical and hormonal parameters of positive animals

		CREATININE	ALT	AST	PHOSPHORUS	CHOLESTEROL	GLUCOSE	TOTAL-PROTEINS	ALBUMIN	CALCIUM	UREA	PROGESTERONE	OESTRADIOL	TESTOSTERONE
CREATININ	Pearson Correlation	1												
	Sig. (2-tailed)													
	N	702												
ALT	Pearson Correlation	,266**	1											
	Sig. (2-tailed)	,000												
	N	702	702											
AST	Pearson Correlation	-,072	-,060	1										
	Sig. (2-tailed)	,057	,110											
	N	702	702	702										
PHOSPHORUS	Pearson Correlation	-,052	-,076*	-,065	1									
	Sig. (2-tailed)	,166	,043	,083										
	N	702	702	702	702									
CHOLESTEROL	Pearson Correlation	,039	,064	-,025	-,004	1								
	Sig. (2-tailed)	,299	,093	,501	,912									
	N	702	702	702	702	702								
GLUCOSE	Pearson Correlation	-,325**	-,092*	,205**	-,030	,047	1							
	Sig. (2-tailed)	,000	,015	,000	,424	,212								
	N	702	702	702	702	702	702							
TOTAL-PROTEINS	Pearson Correlation	,073	,162**	,000	-,258**	,126**	-,095*	1						
	Sig. (2-tailed)	,054	,000	,997	,000	,001	,012							
	N	702	702	702	702	702	702	702						

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

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Table 9 (follow-up) Correlation between biochemical and hormonal parameters of positive animals

		CREATININE	ALT	AST	PHOSPHORUS	CHOLESTEROL	GLUCOSE	TOTAL-PROTEINS	ALBUMIN	CALCIUM	UREA	PROGESTERONE	OESTRADIOL	TESTOSTERONE
ALBUMIN	Pearson Correlation	,082*	,091*	-,078*	,102**	-,075*	-,178**	,070	1					
	Sig. (2-tailed)	,031	,016	,039	,007	,046	,000	,065						
	N	702	702	702	702	702	702	702	702					
CALCIUM	Pearson Correlation	-,271**	,019	,295**	-,277**	-,032	,367**	,027	-,195**	1				
	Sig. (2-tailed)	,000	,613	,000	,000	,397	,000	,478	,000					
	N	702	702	702	702	702	702	702	702	702				
UREA	Pearson Correlation	,117**	-,078*	-,177**	,183**	-,043	-,159**	-,413**	-,072	-,178**	1			
	Sig. (2-tailed)	,002	,038	,000	,000	,260	,000	,000	,056	,000				
	N	702	702	702	702	702	702	702	702	702	702			
PROGESTERONE	Pearson Correlation	-,077*	-,062	-,005	-,047	,115**	,018	,050	-,097*	,087*	-,036	1		
	Sig. (2-tailed)	,042	,103	,897	,214	,002	,629	,184	,010	,021	,343			
	N	702	702	702	702	702	702	702	702	702	702	702		
OESTRADIOL	Pearson Correlation	,138**	,009	-,061	-,049	,111**	-,159**	,111**	,017	-,075*	-,063	,768**	1	-,775**
	Sig. (2-tailed)	,000	,819	,104	,199	,003	,000	,003	,652	,048	,094	,000		,000
	N	702	702	702	702	702	702	702	702	702	702	702	702	702
TESTOSTERONE	Pearson Correlation	,034	,023	-,019	,007	-,074	-,011	-,017	,081*	-,071	-,016	-,890**	-,775**	1
	Sig. (2-tailed)	,371	,549	,617	,854	,051	,771	,648	,032	,062	,667	,000	,000	
	N	702	702	702	702	702	702	702	702	702	702	702	702	702

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

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DISCUSSION

The overall seroprevalence of bovine herpes virus 4 was 74.8%, a value close to that obtained in Zaire 70% by [8]. A serological survey conducted in Colombia on a Serotheca of 959 samples of female animals of different ages reported a seroprevalence of 95.4% [9]**;** this difference in prevalence would be explained by the fact that the study areas differ at the national level and the technique used would also have an impact on this difference in result. The prevalences in the North and Far North, 94.9% and 97.7% respectively, were significantly higher than in Adamawa, 56%. This difference is due to the fact that cattle in the North and Far North undergo a lot of migration in search of pasture as well as cross-border trade with neighboring countries.

At the limit of our knowledge, publications concerning biochemical and hormonal variations in BoHV-4 are not documented. Nevertheless, our results have shown that the presence of BoHV-4 in animals leads to biochemical and hormonal changes.

The results showed an overall decrease in serum concentrations of energy parameters, specifically glucose, cholesterol and total protein, compared to their reference values, as well as the level of AST. Glucose is involved in several mechanisms in the body. The hypoglycemia could be explained by the fact that the animals intended for slaughter were at a prolonged fast. Indeed, the plants consumed by animals are rich in cellulose which is transformed into glucose by microorganisms. This drop in glucose is also the cause of liver failure, which leads to an inability of the liver to produce and store glucose. Whey proteins are the body's source of amino acids and are considered indicators of the nutritional status of the animal [10]. Indeed, the main factor in the variation of the concentration of total serum proteins is diet [11]**.** Thus, the decrease in total protein would be due to a low protein dietary intake and too much water in the blood because the total protein level provides us with a general indication of the state of hydration. Since albumin and globulins are the main fractions of total proteins, there is an increase in albumin levels, which could lead us to think that the low total proteinemia comes from a drop in globulins. The low cholesterol observed is different with those of [11] in Senegal where the values were higher than that of reference. This can be explained by the fact that some animals have a low rate of lipid infiltration of the liver [11]**.** The serum concentration level of AST also decreased from the baseline. As AST is a less specific marker of the liver than ALT, this enzyme is present in the cytoplasm and mainly in the mitochondria of hepatocytes and in almost all muscles; the decrease in this enzyme is not significant [12].

On the other hand, these results show an overall high level of Albumin compared to the reference value. Indeed, an increase in the albumin fraction is due to dehydration and must be confirmed with the hematocrit. This high level of albumin could be explained by the fact that the animals were dehydrated before slaughter.

It appears that the mean values of progesterone are within the confidence interval and those of estradiol are above the range. The average estradiol level is relatively higher (1.4 ng/ml) at any stage of the sexual cycle compared to the reference values. This could correspond to the follicular stage of the sexual cycle in which the subjects were during the study. In the blood, estradiol is mainly transported by proteins such as albumin, which are also high in the blood of Bohv-4 positive subjects. A good knowledge of the variation in estradiol levels allows a better appreciation of the stage of growth and follicular maturation.

CONCLUSION

The aim of this study was to evaluate the impact of bovine herpes virus type 4 infection on variations in biochemical and

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hormonal parameters in cattle slaughtered in slaughterhouses in the north. Our study involved 938 animals of all sexes. The seroprevalence of BohV-4 was determined; indeed, 702 cattle slaughtered in the various slaughterhouses were carriers of antibodies against BoHV-4, i.e. a seroprevalence of 74.8% in northern Cameroon, with breed and age as major risk factors for infection. Biochemical and hormonal analyses were performed and revealed: a decrease in the mean values of glucose (2.47±0.77 g/L), cholesterol (189.4±0.37 mg/dl), total protein (4.70±0.23 mg/dl), and ALT (20.80±1.89 U/l) and an increase in the albumin value (6.78±0.28 g/l) compared to their reference values. The other parameters studied did not undergo any significant variation. The average estradiol level is relatively higher (1.4 ng/ml on average); that of progesterone remains within the confidence interval. The average testosterone value is low (1.54ng/l)

Thus, in order to participate in the efficiency of reproduction, it would be preferable to intensify awareness sessions on pathologies related to bovine reproduction, to strengthen the control of animal movements at the borders in order to limit the introduction of foreign animals into the herds and to identify the species of ticks likely to transmit BohV-4 as well as the different serotypes present in cattle. In-depth studies are needed on this pathology of the study as is the case in other countries around the world.

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REFERENCES

1. National Institute of Statistics. Cameroon. Statistical Yearbook. *National Institute of Statistics: Yaounde, Cameroon* **2018**, *1–3,* 3–28.
2. MINEPIA. Elevage et pêche, Annuaire statistique du Cameroun, *Institut Nationale de la Statistique* **2015***, 15,* 257-268.
3. Ebangi, AL; Erasmus, GJ; Mbah, DA; Tawah, CL; Ndofor-foleng, HM Evaluation of level of inheritance in the growth traits in the Gudali and Wakwa beef cattle breeds of Adamawa, Cameroon. *Lives. Res. Rural Dev.* **2011**, *23, 6*, 111-130.
4. Delacroix, M Maladies des Bovins, troixième édition, Paris, édition France Agricole **2000**, *70,* 312-351.
5. Chevanne, ERCF Le *bohv-4* chez les bovins et la place de sa recherche dans les protocoles « avortement bovin » en France: enquete auprès des laboratories départementaux analyses vétérinaire. These de Doctorat de Medecine Vétérinaire à l' Ecole Nationale Vétérinaire d'Alfort **2014,** 143.
6. Yilmaz, V ; Coskun, N ; Kuru, M ; Kaya, S ; Buyuk, F ; Celebi, O Virological investigation of bovine herpes virus 1 and bovine herpes virus 4 infections in cattle with endometritis in kars province of turkey. *Adv. Anim. Vet. Sci.* **2020**, *8, 5,* 531-535.
7. Chastant-Maillards BoHV-4 et reproduction chez les Bovins. *Le Point Vétérinaire* **2012,** *323,* 66-68.
8. Eyanga, E; Jetteur, P; Thiry, E; Wellemans, G; Dubuisson, J; Van opdenbosch, E Recherche des anticorps dirigés contre les BHV-1, BHV-2, BHV-4, le virus BVD-MD, les adénovirus A et B, le rotavirus et le coronavirus bovins chez les bovins de l'Ouest du Zaïre : résultats complémentaires. *Revue Elev. Méd. vét. Pays trop.* **1989**, *42,* 155-161.
9. Figueredo, GM Serological survey of bovine infectious causes of reproductive disorders in Colombia. *PhD thesis, Animal Health. Parme,* **2012**,2009-2011. Htps:/hdl.handle.net/1889/195
10. Quiroz-Rocha, GF ; Le Blanc, SJ ; Duffield, TF ; Wood, D ; Leslie, KE ; Jacobs, RM Reference limits for biochemical and hematological analytes of dairy cows one week before and one week after parturition. *Canadian Veterinary Journal* **2009**, *50, 4,* 383–388.
11. Sow, A ; Hakizimana1, JN ; Kalandi1, M ; Bathily, A ; Mouiche MMM ; Zabre1, MZ ; Kouamo, J ; Sawadogo, GJ Évolution des paramètres biochimiques chez les vaches laitières supplémentées par le maïs et le tourteau d'arachide dans la région de Kaolack (Sénégal). *J. Appl. Biosci.* **2016,** *100,* 9515 – 9521.
12. SAWADOGO, GJ Contribution à l'étude des conséquences nutritionnelles sub-Sahélienne sur la biologie du zebu gobra au Sénégal. *Thèse de Doctorat unique. Institut National Polytechnique, Toulouse, France* **1998**, 187.

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