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SHORT COMMUNICATION

Effect of foot and mouth disease virus infection on hematobiochemical profile in goats under natural conditions

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ABSTRACT

Foot and mouth disease (FMD) is a contagious viral disease that has a high economic impact on livestock industry affecting large and small ruminant. Most research works are carried out on hematobiochemical alteration due to FMD virus (FMDV) in bovine but there is a paucity of literature and a dearth of research on how FMDV affects the hematobiochemical profiles of goats. This study was aimed to investigate the impact of FMDV on hematobiochemical profile of goats. Forty two whole blood samples were collected from FMDV-infected (n=32) and apparently healthy (n=10) goats to estimate hematobiochemical profile alteration. There was a significant ($p<01$) decrease in values of hematobiochemical parameters *viz.* haemoglobin (6.45±0.55 g%), total erythrocytes (4.22±0.27x10^6/µl), packed cell volume (21.35±1.66%), mean corpuscular volume (50.49±0.65 fl), mean corpuscular haemoglobin (15.24±0.32 pg), mean corpuscular haemoglobin concentration (30.19±0.25 gm/dl), glucose (20.42±4.24 mg/dL), alanine transaminase (29.26±3.74 U/L), blood urea nitrogen (39.57±4.46 mg/dL), serum creatinine (0.7±0.12 mg/dL), sodium ion (143.73±1.33 mEq/L), total protein (7.57±0.55 g/dL), albumin (3.15±0.31 g/dL), globulin (4.425±0.37 g/dL). There was a significant ($p<01$) increase of aspartate transaminase (86.36±11.41 U/L), albumin: globulin ratio (0.715±0.08) as well as cholesterol (104.77±0.86 mg/dL) and no significant changes were observed in alkaline phosphatase (267.76±236.52 U/L), potassium ion (5.21±0.36 mEq/L), neutrophils, monocytes, lymphocytes, eosinophils in FMDV infected goats than the apparently healthy goat. Hematobiochemical parameters alter significantly in goat during the active phase of FMDV infection under natural condition and these findings would be useful for developing a therapeutic or preventive measure to avoid the biotic stress and negative effect of FMD virus infection in convalescent goat.

Keywords: Biochemical profile, foot and mouth disease virus, goat, hematological profile

In rural economies, goats have been regarded as poor man's cow due to its immense contribution to the poor man's economy. A few infectious diseases that are frequently encountered in goats includes mastitis, bluetongue, haemonchosis, enterotoxaemia, paste-des-petits ruminants, foot and mouth disease (FMD) etc.

The FMD virus (FMDV) is highly contagious in cloven-footed animals, most prevalent in cattle and buffaloes followed by sheep and goats, whereas pigs act as amplifiers. The causative agent of FMD is classified into seven serotypes, O, A, C, Asia-1, SAT-1, SAT-2 and SAT-3 which are serologically and immunologically distinct[2]. Disease is mainly characterised by fever, anorexia, ropy and foamy salivation, reluctant to walk in cattle whereas lameness, depression and anorexia is usually the first indication of FMD in sheep and goats[3]. Vesicles develop in the interdigital cleft, on the heel bulb and on the coronary band. In sheep vesicles also form in the mouth on dental pad, hard palate, lips and gums but they rupture easily[4]. The disease in goat is generally overlooked due to absence of frank clinical signs and symptoms. During the viraemic phase of FMDV infection haematological and serum biochemical parameters alteration may pose stress on animals which leads to production losses.

However, majority of works published are on hematological and biochemical alteration due to FMDV infection in cattle and buffaloes[5,6,7,8] but there are paucity of literatures dealing with FMDV infection and dearth of research on how FMDV affects the haematological and serum biochemical profiles of goats. Based on this, the present study was conducted to understand the hematological and serum biochemical profile alteration in goat infected with foot and mouth disease virus under natural condition. As per the author's knowledge, this was the first kind of work carried in goat under natural condition and findings of the present study

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Table 1. Haematological and biochemical profile (Mean ± SE) in FMDV affected and apparently healthy goats under natural condition.

Parameters	FMD affected (n=32) (Mean ± SE)	Apparently healthy (n=10) (Mean ± SE)	p value
TLC	11962.5 ± 1605.58	10780 ± 1877.82	0.058
Neutrophils (%)	36.75 ± 13.85	40 ± 8.27	0.488
Lymphocytes (%)	53.25 ± 14.03	49.3 ± 8.69	0.408
Eosinophils (%)	5.37 ± 2.82	4.5 ± 2.71	0.394
Monocytes (%)	4.62 ± 2.43	4 ± 1.63	0.453
N/L	0.84 ± 0.64	0.86 ± 0.31	0.932
Haemoglobin (g%)	6.45 ± 0.55	8.46 ± 0.32	< 0.01
PCV (%)	21.35 ± 1.66	27.38 ± 0.98	< 0.01
TEC (million/ul)	4.22 ± 0.27	5.23 ± 0.16	< 0.01
MCV (fl)	50.49 ± 0.65	52.345 ± 0.24	< 0.01
MCH (pg)	15.24 ± 0.32	16.173 ± 0.12	< 0.01
MCHC (gm/dl)	30.19 ± 0.25	30.896 ± 0.08	< 0.01
Glucose (mg/dL)	20.42 ± 4.24	50.7 ± 10.35	< 0.01
AST (U/L)	86.36 ± 11.41	33.92 ± 3.12	< 0.01
ALT (U/L)	29.26 ± 3.74	95.73 ± 9.82	< 0.01
ALP (U/L)	267.76 ± 236.52	138.5 ± 80.46	0.1
BUN (mg/dL)	39.57 ± 4.46	55.1 ± 7.37	< 0.01
Creatinine (mg/dL)	0.7 ± 0.12	1.19 ± 0.16	< 0.01
Na^+ (mEq/L)	143.73 ± 1.33	148.59 ± 1.56	< 0.01
K^+ (mEq/L)	5.21 ± 0.36	5.286 ± 0.49	0.603
TP (g/dL)	7.57 ± 0.55	9.61 ± 0.46	< 0.01
Albumin (g/dL)	3.15 ± 0.31	3.58 ± 0.32	< 0.01
Globulin (g/dL)	4.425 ± 0.37	6.03 ± 0.61	< 0.01
A/G ratio	0.715 ± 0.08	0.603 ± 0.11	< 0.01
Cholesterol (mg/dL)	104.77 ± 0.86	62.1 ± 13.34	< 0.01

P ≤ 0.05 and P ≤ 0.01 were taken as the significance level; TLC - Total leukocyte count, TEC - Total erythrocyte count, PCV - Packed cell volume, MCV - Mean corpuscular volume, MCHC - Mean corpuscular haemoglobin concentration, AST - Aspartate transaminase, ALT - Alanine transaminase, ALP - Alkaline phosphatase, BUN - Blood urea nitrogen, Na^+ - Sodium ion, K^+ - Potassium ion, TP - Total protein

would be useful for the development of a therapeutic or preventive measure to avoid the biotic stress and negative effect of FMDV infection in convalescent goat.

Cross sectional study was conducted in field under natural condition where all the animals were reared in same geographical climatic and environmental condition. Animals were divided into two groups, group (Gr) 1, FMDV infected [tested positive for FMD viral genome using FMDV specific primers (reverse primer: 5'-GACATGTCCTCCTGCATCTG-3; Forward primer: serotype 'O'- 5'- GTGACTGAACTGCTTTACCGCAT- 3', serotype 'A'- 5'- CAACGGGACGARCAAGTACTC- 3', serotype 'Asia 1'- 5'- GACCTGGAGGTYGCGCTTGT-3')] and Gr 2, apparently healthy (tested negative for FMD viral genome). Gr1 consisted 32 goats (n=32) whereas Gr 2 consists of 10 goats. This research protocol was approved by the Institute Animal Ethics Committee of Ranchi Veterinary College, Birsa Agricultural University, Kanke, Ranchi, Jharkhand followed by the committee for control and supervision of experiments on animals (CCSEA), Government of India vide letter no. V-11011(13)/12/2022-CPCSEA-DADF.

Whole blood samples were collected aseptically from all FMDV infected (n=32) and apparently healthy goats (10) through jugular vein. Two mL blood was collected in a heparinised vacutainer tube (BD, Franklin, USA) for estimation of hematological parameters while 10 mL blood was collected in a vacutainer tube containing clot activators (BD, Franklin, USA) to estimate the serum biochemical profile. Serum samples were separated by centrifugation of blood at 3000 rpm for 20 min and stored at -80^{O}C till estimation.

The haematological parameters *viz.*, haemoglobin (Hb), total erythrocyte count (TEC), packed cell volume (PCV), and total leukocytes count (TLC), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC) were estimated

using haematology analyser (Transasia, Sysmex, XN-550). Moreover, differential leukocyte count (DLC) was carried out manually on blood smear stained with Giemsa stain[9].

Biochemical parameters *viz.*, glucose, aspartate transaminase (AST), alanine transaminase (ALT), serum alkaline phosphatase (ALP), urea, creatinine, Sodium ion (Na^+), Potassium ion (K^+), Total protein (TP), albumin: globulin, A/G ratio and cholesterol were performed on each serum samples. These serum biochemical parameters were estimated using commercial kits (Tulip diagnostics (P) Ltd) in autoanalyzer (Tulip semi-automated analyzer).

All values were presented as means ± standard error (SE). T-test was used to statistically analyze the significant difference between the group means. The value of $P \leq 0.05$ and $P \leq 0.01$ was taken as statistically significant[10].

The values of various haematological and serum biochemical profiles (mean ± SE) in FMDV infected and apparently healthy goats are depicted in Table 1.

Haematological parameters of FMDV infected and apparently healthy goats are shown in Table 1. There was a significant ($p<0.01$) decrease in the values of hematological parameters *viz.* haemoglobin, total erythrocytes, PCV, MCV, MCH, MCHC in FMDV infected goats than those of the apparently healthy goat (Table 1). Although, there was an absolute increase in the counts of total leukocyte, lymphocytes, monocytes, eosinophils whereas reduction in absolute count of neutrophils and neutrophils: lymphocyte ratio but all these changes were statistically non-significant.

Serum biochemical parameters of FMDV infected and apparently healthy goats are shown in Table 1. There was a significant ($p<01$) decrease in values of serum biochemical parameters *viz.* glucose, ALT, blood urea nitrogen, creatinine, sodium ion, total protein, albumin, globulin while significant ($p<0.01$) increase in the value of AST (86.36±11.41), albumin : globulin ratio and cholesterol and there was no significant changes were observed in value of ALP, potassium ion, neutrophils, monocytes, lymphocytes, Eosinophils in FMDV infected goats than those of the apparently healthy goat.

Initial replication of FMDV took place at primary site followed by viraemia and then reaches up to secondary site. At secondary site it replicated and produce vesicle followed by rupture of vesicle and leads to different types of wounds. During the viraemic phase of infection FMDV affects the hematological and biochemical profile of animals which disturb the harmony of general status of health and followed by production loss especially in cattle and buffalo but it was not studied in goat. Therefore, the present study was conducted to understand the hematological and serum biochemical profile alteration in goat infected with FMD virus under natural condition to develop therapeutic or preventive measures for avoiding the biotic stress and negative effect of the FMDV infection in goat.

There was a significant decrease in Hb in FMDV infected goats as compared to apparently healthy goat and this condition could be attributed to endocrinopathy effect occurring secondary to the viral infection[11]. Similar findings were also reported by the earlier workers[8,12,13] in cattle. FMDV infected goats has a significant reduction in TEC/RBC in compared to the apparently healthy goat and it could be due to the reduction in the process of erythropoiesis[14] and this report is in line with preceding published reports in cattle[6,11,12,13]. The PCV content of FMDV affected goats decreased significantly which could be due to reduction in RBC/TEC and it is comparable with the previous findings as demonstrated in cattle[12,13] but same time it contrary to the report published by Mousa and Galal[7]. MCV, MCH and MCHC values in the Gr1 (FMDV affected group) are significantly lower than Gr 2 (apparently healthy goat). In contrary to the present report, MCV and MCH values were shown to be considerably higher in the FMDV infected animals[7,11]. Few reports said that there is a non-significant change in these value[8,13]. In present study, TLC in Gr1 was higher than that of Gr 2 but it has not been differ significantly between the Gr 1 and Gr 2 and it has also been mentioned in the previous report[8,14]. In FMDV infected groups of goats the count of neutrophils and neutrophils: lymphocyte ratios were decreased whereas the count of lymphocytes, monocytes and eosinophils increased but these changes are non-significant in nature as compare to the apparently healthy group and similar finding were also recorded in published reports[6,15]. Lymphocytosis is the phenomenon of virus infection as it has also been observed in FMDV infected group under natural condition[16,17] during active phase of infection in the present study but few report said that there is a significant decrease in TLC, lymphocytes after 7-14 days post FMDV infection[18].

There was significant decrease in the concentration of glucose in FMDV affected goats than the apparently healthy goats. This contrasts with a significant increase of glucose in diseased cattle and buffaloes compared to healthy animal in the previous study[12,14,19]. Possible mechanisms leading to hypoglycaemia include impaired glycogenolysis and gluconeogenesis in the liver or increased catabolism of glucose by the animal[20]. A reduction of blood sugar levels during infection is a well-regulated process that is a part of the body's natural antiviral response. Significant increase in the concentration of AST in FMDV affected group than the apparently healthy group and it could be due to involvement of liver, muscular or cardiac damages

occurs[14,21] and this finding coincide with the earlier report indicating hypoglycaemia due to FMDV infection[12,13,15]. A change in the amount of AST in the blood serum is one of the most distinctive indicators of the disruption of the integrity of the liver tissue[22]. As activity of AST reflects the functional state of liver that means FMDV also affects liver function during acute phase of infection. A significant decrease in the concentration of ALT was observed in FMDV affected group than the apparently healthy group of animals which concurred with the findings of earlier report[8]. This contrasts with no significant change observed in ALT in the previous study[12]. Enzyme activities of ALP were increased in FMDV affected group of animals in comparison to apparently healthy group of animals but there was no significant difference as reported in previous report[13]. Serum biochemical analysis showed significant reduction in total protein, albumin, globulin in FMDV affected group in the present study and similar finding were also reported by previous worker[7,13,15,23]. This is contrary to non-significant changes in serum total protein, albumin and A:G ratio was observed under experimental FMDV infection[18]. Low albumin and protein concentration may also be due to alteration in pancreatic β-cell function that might have developed during the clinical course of FMDV[24] and it could also be due to liver and kidney damage[25]. The hypoproteinemia might be attributed to hypoalbuminemia and hypoglobulinemia in present study and it could be due to anorexia, reduced feed intake, malnutrition, mal absorption, enteropathy, and transudation of plasma from ulcers due to FMDV infection[8,15,25]. Due to FMDV infection there is impairment in the function of thyroid gland[3]. Thyroid hormone increases both the rate of cholesterol synthesis and the rate of its catabolism by the liver. In hypothyroidism condition, lipids and cholesterol catabolism are decreased to a lesser degree than the synthesis of the cholesterol. The effect of these changes, results in an increase in serum cholesterol[26] due to this reason there was a significant increase in the cholesterol level in FMDV affected goat in present study. Significant reduction in the concentration of blood urea nitrogen (BUN) and creatinine has been observed in FMDV infected goats than the apparently healthy goats and this coincide with the finding of earlier worker and it could be due to hypoproteinemia[14]. This contrasts with non-significant changes observed in BUN and serum creatinine (sCRT) in the previous study[12]. BUN and sCRT are the commonly used biomarkers to know the intensity of renal failure since it is released in to the plasma at relatively constant rate in healthy state, which are freely filtered by the glomerulus and neither metabolized nor released by the kidney. By preventing or promoting renal tubular secretion, glomerular filtration rate or both, the real sCRT can be altered independently of variations in the glomerular filtration rate[27]. Significant reduction in the concentration of sodium ion was observed in FMDV affected group than apparently healthy goats[15]. The recorded hyponatremia may be attributed to sodium loss through exudation from erosions, excessive salivation and/or decreased sodium intake due to starvation resulted from fever in cattle[6,15]. No significant difference was observed in the serum potassium in both the infected and apparently healthy goats. There were significant changes in the parameters like AST, ALT, albumin, globulin, BUN, sCRT etc indicating that FMD virus has negative effect on liver and kidneys. Changes in the haematological parameters due to FMDV infection indicates that it affects the major organs like liver, kidneys etc and effect of these changes has been visible by significant changes in liver and kidneys function test parameters. Therefore, during the acute phase of FMDV infection liver and kidney protectant may be advisable to reduce the further health associated risk.

CONCLUSION

It would be concluded that during the viraemic phase of foot and mouth disease virus infection hematobiochemical parameters showed significant variations in FMDV affected goat than apparently healthy goat. Hematological parameters which significantly decrease in FMDV affected goats are haemoglobin, total erythrocyte, PCV, MCV, MCH and MCHC values. Biochemical parameters which significantly decrease in FMDV affected goats are glucose, ALT, urea, creatinine, sodium, total protein, albumin, globulin, A/G ratio while significant increase in AST and cholesterol. Changes in the haematological parameters due to FMDV infection indicates that it affects the major organs like liver, kidneys etc. and effect of these changes has been visible by significant changes in liver and kidney functions test. Present findings would be useful in developing therapeutic or preventive measures to reduce the health associated risk due to FMDV infection in goat to enhance productivity as these are not included in vaccination in most of the countries pursuing FMD control.

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