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Albumin/Globulin (A/G) Ratio Before, During, and After Treatmen in Cattle Infected With Foot-and-Mouth Disease (FMD)

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Abstract

This study aims to determine the albumin/globulin (A/G) ratio in cattle infected with Foot-and-Mouth Disease (FMD) before, during, and after treatment in Yogyakarta. FMD is a highly contagious viral disease that affects cloven-hoofed animals, including cattle, buffaloes, sheep, goats, pigs, deer, camels, and elephants. Clinically, infected animals show characteristic symptoms such as blisters or lesions in the mouth and on the feet. The disease is caused by the Foot-and-Mouth Disease Virus (FMDV), which belongs to the *Picornaviridae* family and *Aphtovirus* genus. A total of six FMD-infected cattle, consisting of four cows and two bulls with an average body weight of 316–408 kg, were included in the study. Blood samples were collected from the animals before treatment (n = 4), during treatment (n = 6), and after treatment (n = 5) for hematological analysis. The results showed no statistically significant difference ($p > 0.05$) in the A/G ratio across the three stages. However, the observed variations in the A/G ratio may be influenced by factors such as environment and age

Keywords: cow; FDD, albumin/globulin ratio

Introduction

Cattle are among the most important livestock species kept by humans for the production of meat, milk, labor, and other essential needs. Globally, cattle contribute approximately 50% of the total meat supply, 95% of milk production, and about 85% of leather materials used for shoes (Rianto and Purbowati, 2006). In addition to meat and milk, cattle also provide manure for fertilizer and can serve as draft animals (Pane, 1993).

Foot-and-Mouth Disease (FMD), also known as *Aphtae Epizootica* (AE), is an acute and highly contagious viral disease caused by the Foot-and-Mouth Disease Virus (FMDV), which belongs to the *Aphtovirus* genus of the *Picornaviridae* family (Stenfeldt *et al.,* 2015). The disease primarily affects cloven-hoofed animals such as cattle, buffaloes, goats, sheep, and pigs, with a reported morbidity rate of 90–100% (Adjid, 2020). Common clinical signs include fever, depression, anorexia, excessive frothy salivation, and vesicles or blisters in the oral cavity and on the feet (Sajeda *et al.,* 2017).

In Indonesia, FMD was first reported in Malang, East Java, in 1887. Through intensive eradication efforts from 1974 to 1986, the country was declared FMD-free by Ministerial Decree No. 260 of 1986, a status officially recognized by the World Organisation for Animal Health (OIE) in Resolution No. XI of 1990. However, FMD re-emerged in Indonesia in mid-April 2022, with outbreaks reported in several regions of Java and Sumatra. High-risk areas for FMD include districts or cities where livestock are fed swill (leftover food from ports, airports,

or hotels), regions bordering non-FMD-free countries, and areas with active international ports and airports (Budi *et al.,* 2019).

Albumin and globulin are two major fractions of plasma proteins, largely synthesized in the liver. These proteins, along with fibrinogen, form the core components of blood plasma proteins. The concentrations of albumin and globulin affect total serum protein levels and are influenced by factors such as age, sex, nutrition, stress, and fluid balance (Sudarman *et al.,* 2019). The albumin/globulin (A/G) ratio is a useful indicator for assessing the health status of cattle, particularly in relation to liver function, hydration, and immune response (Jackson, 2007). Abnormalities in the A/G ratio may reflect physiological disturbances, especially during infection such as FMD (Iskandar *et al.,* 2020).

This study aims to analyze the A/G ratio in cattle infected with FMD before, during, and after treatment. The findings are expected to provide valuable information to researchers and veterinary practitioners regarding changes in protein balance and the physiological condition of infected animals, contributing to better management and treatment strategies.

Materials and methods

Experimental Design

This study involved six (6) Limousin cattle, consisting of four (4) adult female cows and two (2) male calves. The body weights of the cattle ranged from 316 to 408 kg. The adult cows were between 2 and 8 years old, while the male calves were approximately 7 months old. All cattle were housed in individual pens to minimize external influences and cross-contamination.

The animals were fed twice daily, in the morning and evening, with a diet consisting of forage and concentrate. Clean drinking water was provided ad libitum. Based on clinical examination, all cattle exhibited signs of illness consistent with Foot-and-Mouth Disease (FMD) infection.

.Materials

Blood sampling was conducted using a 10 mL syringe (OneMed, PT One Med Health Care, Surabaya) equipped with an 18-gauge needle. Cotton and 70% alcohol were used to disinfect the venipuncture site as an antiseptic. Blood samples were collected into non-EDTA Vacutainer tubes (Becton Dickinson and Company, USA).

Following collection, the blood samples were centrifuged to separate the plasma. The resulting plasma was transferred into Eppendorf tubes (OneMed, Malang) for further analysis. Blood serum protein analysis was performed using the Cobas Pro Integrated Solutions system (Roche Diagnostics, Switzerland) employing the colorimetric method.

All experimental procedures in this study were approved by the Ethical Clearance Commission of the Faculty of Veterinary Medicine, Universitas Gadjah Mada, under approval number 078/EC-FKH/Int./2022.

Time and Place of Research

This research was conducted from August to September 2022. Blood sampling was carried out at a privately owned cattle shed located in Jamben Kidul, Sindumartani, Ngemplak, Sleman Regency, Yogyakarta, Indonesia.

Blood Sampling

Cattle were separated from the herd and manually restrained to facilitate safe and accurate blood collection. The venipuncture area was disinfected using cotton soaked in 70% alcohol. Blood samples were collected from the jugular vein using a 10 mL syringe equipped with an 18-gauge needle. Sampling was conducted in the afternoon to ensure consistency in sampling time.

Collected blood was transferred into Vacutainer tubes prior to centrifugation. After centrifugation, the separated plasma was placed into Eppendorf tubes for further analysis.

Analysis of Total Protein, Albumin, Globulin and A/G

The concentrations of albumin and total protein in the blood serum were measured using the Cobas Pro Integrated Solutions system (Roche Diagnostics, Switzerland) at the Sardjito Government General Hospital Laboratory. The globulin concentration was calculated by

subtracting the albumin concentration from the total protein concentration. The albumin/globulin (A/G) ratio was then determined by dividing the albumin concentration by the globulin concentration.

Statistical Analysis

Data on the albumin/globulin (A/G) ratio were recorded using Microsoft Office Excel and subsequently analyzed using Statistical Product and Service Solutions (SPSS) software version 16.0. A normality test was performed to assess data distribution. Statistical significance was set at $p < 0.05$ to determine differences in the A/G ratio among FMD-infected cattle before treatment, during treatment, and after treatment The results of the statistical analysis carried out will be converted into a file in the form *Microsoft Office Word.*

Results and Discussion

Based on the data in Table 1, the average serum albumin concentration in FMD-infected cattle before treatment was 3.43 ± 0.19 g/dL, during treatment was 3.23 ± 0.26 g/dL, and after treatment was 3.15 ± 0.29 g/dL. When compared with a study by Faruk et al. (2021), conducted in a different location, the average albumin levels in FMD-infected cattle were below normal values, with concentrations of 2.99 ± 0.23 g/dL in the primary stage, 2.17 ± 0.11 g/dL in the advanced stage, and 3.96 ± 0.18 g/dL in the recovery stage. The normal range for serum albumin in cattle is reported to be 2.1–3.6 g/dL (Faruk *et al.,* 2021).

In this study, the albumin level before treatment was within the normal range, but a gradual decrease was observed during and after treatment. According to Firdaus et al. (2022), elevated albumin concentrations may result from mild dehydration, chronic heart failure, impaired protein metabolism, or elevated glucocorticoid levels. Conversely, a decrease in albumin concentration may indicate liver or kidney dysfunction, malnutrition, or protein-losing enteropathy (Rousell *et al.,* 1997). Goce et al. (2004) also reported that lesions in the oral mucosa and interdigital areas may contribute to reduced albumin levels. Moreover, albumin is a negative acute-phase protein, and its concentration tends to decrease during inflammation (Mohamed *et al.,* 2010).

Table 1 presents the average values of albumin, globulin, and the albumin/globulin (A/G) ratio in FMD-infected cattle before, during, and after treatment. The average albumin concentration before treatment was 3.43 ± 0.19 g/dL, which decreased to 3.23 ± 0.26 g/dL during treatment and further to 3.15 ± 0.29 g/dL after treatment. According to Faruk et al. (2021), the normal albumin range in cattle is 2.1–3.6 g/dL. Thus, in this study, albumin levels were within normal limits but showed a decreasing trend following treatment.

In comparison, Faruk et al. (2021) reported lower albumin levels in FMD cattle at various disease stages, with values of 2.99 ± 0.23 g/dL in the primary stage, 2.17 ± 0.11 g/dL in the advanced stage, and 3.96 ± 0.18 g/dL in the recovery stage. The decrease in albumin concentration in the present study may be attributed to inflammatory responses or liver dysfunction. Albumin is known to decrease in response to inflammation, liver and kidney disorders, and protein loss through enteropathy (Roussel *et al.,* 1997; Mohamed *et al.,* 2010). Lesions in the oral and interdigital areas may also contribute to reduced albumin levels (Goce

Table 1. Average Albumin, Globulin, and A/G Ratio of cows infected with FMD between before treatment, during treatment, and after treatment

Physiological status	N	Rata- rata Albumin (g/dL)	Rata-rata Globulin (g/dL)	Average A/G Ratio (g/dL)
Before being given treatment	4	3.43 ± 0.19	3.99 ± 0.66	0.89± 0.20
When given treatment	6	3.23 ± 0.26	4.87 ± 0.86	0,81 ± 0.21
After being given treatment	5	3.15 ±0.29	4.28 ±0.70	0.80 ± 0.22
Reference		2.1-3.6	2.2-4.2	0.84 -0.94

* Irfan, Ida Zahidah, A. Esfandiari, and C. Choliq. 2014. "Total protein profile, albumin, globulin and albumin globulin ratio of bulls."*Journal of Animal and Veterinary Science*19(2):123–29. two: 10.14334/jitv.v19i2.1040

et al., 2004).

Meanwhile, the globulin concentration before treatment was 3.99 ± 0.66 g/dL, increased to 4.87 ± 0.86 g/dL during treatment, and then slightly decreased to 4.28 ± 0.70 g/dL after treatment. These values fall within the normal globulin range of 2.9–4.9 g/dL (Faruk *et al.,* 2021). When compared to Faruk et al.›s findings—globulin values of 2.40 ± 0.08 g/dL (primary), 2.14 ± 0.14 g/dL (advanced), and 2.35 ± 0.30 g/dL (recovery)—this study reported notably higher values. Elevated globulin levels indicate increased immune activity, as globulin includes immunoglobulins that respond to infection (Kaslow, 2010; Hicks *et al.,* 1998). However, statistical analysis showed no significant differences in globulin levels across treatment phases ($p > 0.05$).

The A/G ratio was 0.89 ± 0.20 before treatment, 0.81 ± 0.21 during treatment, and 0.80 ± 0.22 after treatment. The normal A/G ratio in cattle ranges from 0.84 to 0.94 (Irfan, 2014). The A/G ratio in this study showed a slight decrease from pre-treatment to post-treatment phases, indicating a relative increase in globulin levels compared to albumin. This pattern is consistent with Eidan et al. (2017), who found a lower A/G ratio in bulls recovering from FMD (0.51 ± 0.0 g/dL) compared to healthy bulls (0.87 ± 0.03 g/dL). A reduction in A/G ratio is often associated with increased globulin synthesis during infection and inflammation (Sembulingam & Sembulingam, 2012).

Statistical analysis indicated that changes in the A/G ratio were not significantly different between treatment stages ($p > 0.05$). These findings suggest that although physiological changes occurred, they were not sufficient to alter the A/G ratio beyond statistical thresholds. Factors such as age, colostrum intake, and environmental conditions may also influence A/G variation (Irfan *et al.,* 2014).

The decrease in the A/G ratio during treatment may be associated with the therapeutic interventions administered. These included antibiotics, antihistamines, antipyretics, and nutritional supplements. Antibiotics help suppress secondary bacterial infections, while antihistamines reduce inflammation by blocking histamine receptors (Australian Chicken Meat Federation Inc., 2005). Antipyretics, such as dipyrone (NSAID) and lidocaine, function as analgesics and antispasmodics to alleviate fever and pain (Lee, 2007). Vitamin B1 supplementation supports energy metabolism and may alleviate limb weakness, particularly by aiding neuromuscular function (Baggot, 2001; Plumb, 2008).

Conclusion

This study demonstrated that the albumin/globulin (A/G) ratio in cattle infected with Foot-and-Mouth Disease (FMD) decreased progressively from the pre-treatment to post-treatment phases. Although changes in the A/G ratio, albumin, and globulin levels were observed, statistical analysis showed no significant differences ($p > 0.05$). The decline in albumin levels and the relative increase in globulin suggest an active inflammatory response and the influence of therapeutic interventions. Monitoring the A/G ratio can provide useful insights into the physiological status and immune response of FMD-infected cattle, although further studies with a larger sample size are recommended.

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