Research Article

Rejuvenated of Dairy Cows After Foot and Mouth Disease Infection Using Combination of Complete Feed to Increase Milk Production

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Abstract | The Foot and Mouth Disease (FMD) has been reported in Indonesia, which has impacted dairy cows. This research aimed to investigate the impact of various feed combinations on both milk production and quality in dairy cows that were previously infected with FMD. This research used 15 dairy cows that had been diagnosed with FMD. The cows were subsequently divided into three groups of feed treatment, each consisting of five cows. Group I, cows were fed a combination of basal feed and Karfeed concentrate, Group II, cows had a variety of basal feed, Karfeed concentrate, and premix, and Group III, cows got a combination of basal feed and Protelis® concentrate. The study had 55 days of treatment. The evaluation of milk production and quality was conducted before and after treatment. The research showed that all cows were diagnosed as healthy after suffering from FMD based on clinical symptoms, antibodies to FMD, and the FMD virus examined by Polymerase Chain Reaction (PCR). This result presents a significant difference ($p<0.05$) in milk production, which is a combination of basal feed with Protelis® concentrate supplementation. However, the milk quality presents insignificant differences ($p>0.05$). In summary, the composition between basal feed and Protelis® concentrate increased milk production by 28.3% and improved the quality of milk protein, milk fat, lactose, solid non-fat, and total solid.

Keywords | Dairy cows, Foot and mouth disease, Milk production, Milk quality

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INTRODUCTION

Foot and Mouth Disease (FMD) is reported to reappear in 2022 in Indonesia (Ditjen, 2022; Ismail *et al.*, 2023) that infects cloven hooves such as dairy cows, beef cattle, goats, sheep, pigs, and buffalo, which is caused by a Ribonucleic acid (RNA) virus from the genus *Apthovirus* family Picornaviridae (Ranjan *et al.*, 2016). The clinical symptoms of FMD infection are an increase in body temperature, the appearance of blisters on the tongue, muzzle, nose, nipples, nail interdigital, and other skin parts resulting in anorexia, hypersalivation, limping, a decrease in milk production by 80% and death (Lyons *et al.*, 2015; Ismail *et al.*, 2023). Based on a report from the Indonesian Milk Cooperative Association (GKSI), dairy cows infected with FMD showed a significant decrease in milk yield, reaching a maximum decline of 60%. Different authors have measured impacted of FMD in a variety of ways as follows: Şentürk and Yalçin (2008) reported a decrease of 22% in Turkey, while Barasa *et al.* (2008) found a decline of 53% in South Sudan. In Kenya, Onono *et al.* (2013) reported a decrease of 62%, and in Ethiopia, Bayissa *et al.* (2011) reported a significant decrease of 77.3%. This decrease in milk production occurs due to inflammation of the mammary glands and a decrease in feed consumption in dairy cows infected with FMD.

To effectively manage FMD in dairy cow production, it is important to implement appropriate handling practices and provide high-quality treatment. A timely supply of appropriate and sufficient nutrition can accelerate the healing process of dairy cows infected with FMD. The traditional usage of soda ash, raw honey, wheat flour, finger millet flour, whole rice, and jiggery for the management and control of FMD is supported by the rapid healing of the FMD lesions and improved milk production in the experimental animals to the tune of 80–90%, even up to 100% in almost all cows affected with FMD virus infection (Ranjan *et al.*, 2016). Hence, it could conceivably be hypothesised thatincreasing feed quality might increase milk production and improve milk quality in dairy cows. Previous studies (Mariyono and Romjali, 2007; Utomo and Pertiwi, 2010; Indriyani *et al.*, 2013; Syafri *et al.*, 2014) have reported that increased feed quality increases milk yield and improves milk contents in dairy cows. However, there is a lack of information about milk production and quality in dairy cows that were previously infected with FMD. This study aimed to enhance milk production and improve milk quality in dairy cows following FMD infection through the combination of basal feed, concentrate, and premix feeding strategies.

MATERIALS AND METHODS

Experimental design

Milk samples were examined at the Boyolali Regency, Central Java Province veterinary clinic, while blood samples were examined at the BBVET Wates laboratory in Kulonprogo Regency, Special Region of Yogyakarta Province. The research animals were 15 lactating Friesian-Holstein crossbreds selected based on breeder record data supported by examination results of FMD clinical symptoms (blisters in the mouth and nail area), blood antibodies, and FMD virus from oral swabs. The materials used are basal feed, premix, Karfeed concentrate, Protelis® concentrate, sterile swabs, disposable syringes, micro tips, and tips. The tools used are lacto scan, reverse transcriptase Polymerase Chain Reaction (RT-PCR), and enzyme-linked immunosorbent assay (ELISA) reader. The dairy cows were divided into three feed treatment groups, each comprising five cows per group. These groups were designated as Group I (control), Group II, and Group III. Basal feed in the form of King Grass (Pennisetum purpuphoides) was provided to each group. Group I got supplementary Karfeed concentrate, Group II was provided supplementary Karfeed concentrate along with premix, and Group III was supplied supplementary Protelis® concentrate. The basal feed was fed at a rate equal to 10% of the cows's body weight daily, while the feed supplement was provided at a rate of 1% (Table 1). As dry matter basis, the ratio between forages and the concentrate were 49%:51%, 49%:51%, and 48%:52%, respectively. The feeding treatment was implemented for a duration of 55 days. Daily observations were conducted to evaluate the general physical condition, milk production, and milk quality of the dairy cow. The nutritional composition of King grass and feed supplementation is shown in Table 2.

Table 1: Feeding treatment (*as fed*).

Feed treatment	King grass (kg/head/d)	Karfeed conc. (kg/head/d)	Karfeed plus* (kg/head/d)	Protelis® conc. (kg/head/d)
Group I	30	6,0	-	-
Group II	30	-	6,0	-
Group III	30	-	-	6,0

*Karfeed Plus = Karfeed concentrate + premix

Table 2: Nutritional composition of feed.

Nutrient	King grass	Karfeed conc.	Karfeed plus	Protelis® conc.
Dry matter (%)	16.58	86.30	86.30	91.06
Ash (%)	12.26	15.06	15.06	8.43
Crude protein (%)	9.96	10.63	10.63	18.95
Extract ether (%)	1.10	7.78	7.78	6.35
Crude fiber (%)	30.55	18.05	18.05	15.93
Ca (%)	0.29	0.75	0.82	1.21
P (%)	0.21	0.81	0.81	0.82
TDN (%)	56.52	70.84	70.84	73.41

Blood collection

Blood samples were taken from the jugular vein using a 10 ml syringe and a 21 G x ½ needle for examination of leukocytes (eosinophils, basophils, neutrophils, lymphocytes, monocytes), hemoglobin levels, packet cell volume, and fibrinogen. The blood sample that has been obtained will be put into an Ethylene diamante traacetic acid (EDTA) tube and then stored in a cool box to be transported to the laboratory. A nasopharynx swab sample will be taken and then observed for the possibility of the FMD virus using the RT-PCR method at BBVET Wates. Sampling was carried out on day 0 and day 50.

Milk quality assessment

The milk sampling technique will be carried out directly on days 0 and 50. A 500 ml milk sample is taken and put into a cool box for transportation to the testing location.

Examining milk samples, including protein content, fat, lactose, solid non-fat, and total solid, was carried out in the Boyolali laboratory.

Statistical analysis

A statistical analysis was conducted using analysis of variance using Proc Mixed with general linear model (GLM) using SAS studio for academics Online Edition (https://odamid-apse1.oda.sas.com/SASStudio/). An error was expressed as standard error mean (SEM). At the end, probabilities values were subjected in duncan multiple range test. The following model was used (Adli *et al*., 2023).

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where Yij was parameters observed, μ was the overall mean, Ti the effect feed, and eij the amount of error number. At the end, paired-sample t-test compares the mean of a single group. The nutritional requirements of dairy cows include dry matter (DM), crude protein (CP), and total digestible nutrient (TDN) calculated based on NRC (2001) for dairy cows. The content of TDN is calculated based on the Moran (2005) formula equation approach. TDN = 5.31 + 0.412 CP + 0.249 CF + 1.444 EE + 0.937 NFE. The content of ash, dry matter (DM), crude protein (CP), extract ether (EE), and crude fiber (CF) was obtained from the results of the proximate analysis. The material content of the extract without nitrogen (NFE) was obtained from the following formula: NFE (%) = 100% - ash (%) - CP (%) - EE (%) - CF (%). Analysis of nutritional adequacy (DM, CP, and TDN) is calculated by comparing feed requirements with feed supply analysis to obtain the nutritional adequacy status.

RESULTS AND DISCUSSION

Foot and mouth disease examination

The results of the physical examination, FMD antibody examination, and detection of FMD virus from oral swabs of cows using RT-PCR indicated that all the dairy cows utilized in the present study had experienced FMD infection and subsequently achieved recovery (Table 3). The FMD-infected dairy cows used in this research showed seropositivity for NSP and SP antibodies. The antibody of NSP FMD is formed due to FMD virus infection, and its antibody can survive long in the animal. When the animal has an FMD infection, the NSP and serotype O (SP-O) antibody would be presented. NSP antibody is used to distinguish whether the antibody raised due to post-vaccination or infection. The animals that are not infected and have been vaccinated with FMD show the NSP seronegative and SP seropositive. A total of 15 oral swabs were examined for the FMD virus using a real-time PCR test method, and all showed negative results for the FMD virus. This indicates that the cows had been infected with the FMD virus, but the FMD virus was not detected in the cow's mouth cavity.

Evaluation of feed supply

Dairy cows infected with Foot-and-Mouth Disease (FMD) show less feed intake, decreased productivity, and a decline in milk production, potentially leading to a total lack of production. According to Rokhayati (2010), it is essential to have a balanced protein and energy ratio in the diet of dairy cows. Excessive energy content in the ration has been shown to result in reduced feed utilization efficiency, and it tends to be stored in the body as body fat. If the energy in the feed is low and the protein contained in the feed is high, it will cause the efficiency of protein used to be low, resulting in a decrease in milk protein content and a decrease in fertilization. Providing balanced quality and quantity of feed will increase the productivity of dairy cows so that there is an increase in milk production, which will positively impact the farmer's income. The nutrient requirements for milk production are often higher than the cow's ability to consume nutrients, which results in a negative nutritional balance (Harvatinet and Allen, 2002; Lestari *et al*., 2015). Vitamins and minerals (premix) supplementation in feed will improve the nutritional quality of feed, which is beneficial in optimizing productivity and helping to increase livestock growth (Mariyono and Romjali, 2007). Suwignyo *et al*. (2004) stated that differences in the types of feed will lead to differences in palatability and nutritional content, which in turn lead to differences in the amount of feed consumed by livestock.

Table 3: Data on results of antibody and FMD virus examination in cows used in the study.

Group	n	Foot and mouth disease examination				Diagnosis
		Normal physical observation	Seropositive		Negative molecular RT-PCR	
			ELISA Ab NSP	ELISA Ab SP-O		
I	5	5 (100%)	5 (100%)	5 (100%)	5 (100%)	15 dairy cows have been infected with FMD and have recovered
II	5	5 (100%)	5 (100%)	5 (100%)	5 (100%)	
III	5	5 (100%)	5 (100%)	5 (100%)	5 (100%)	

The nutritional requirements of dairy cows are determined based on their ability to produce milk (NRC, 2001). The results showed that the average milk production was 10 kg/head/d. According to NRC (2001), the daily nutrient requirements of DM, CP, and TDN based on average milk production in this study were 12.4, 1.1, and 5.2 kg/head/d, respectively. Table 4 shows that dairy cows consumed 10 kg DM/head/d during the study period. The DM consumption in this study is lower than the requirement. Indriani *et al*. (2013) and Sarah *et al*. (2015) reported that the consumption of DM of Friesian-Holstein dairy cows reached 12.45 and 22.54 kg/head/d. This study showed that Groups I and II still need to meet their protein (CP) and energy (TDN) requirements, while Group III has met their CP needs. The average consumption of DM, CP, and TDN cows fed with King grass and Karfeed concentrate were 81.87%, 71.15%, and 73.60%, respectively. Mastopan and Hanfi (2014) and Nakano *et al*. (2018) stated that TDN positively correlates with CP. Increasing the supply of CP will increase the supply of TDN. Therefore, Protelis® concentrate supplementation in this study aims to improve feed quality to reduce the gap between nutritional requirements and nutrient availability.

Table 4: The supply of DM, CP, and TDN in feed treatments.

Feeding	Group I	Group II	Group III
Nutrients supply			
DM (kg/head/d)	10.15	10.15	10.44
CP (kg/head/d)	1.05	1.05	1.53
TDN (kg/head/d)	6.48	6.48	6.82
Percentage of supply			
DM (%)	81.87	81.87	84.17
CP (%)	71.15	71.15	104.13
TDN (%)	76.86	76.86	80.83

Table 5: Average milk production after feeding treatment.

Group	n	Milk yield (kg/head/d)	
		Before	**After**
Group I	5	11.71±3.72[a]	11.16±2.92[a]
Group II	5	7.09±1.47[a]	6.72±2.09[a]
Group III	5	8.82±1.94[a]	11.32±3.31[b]

[a,b] numbers with different superscripts on the same line indicate a significant difference at the 95% confidence level (p<0,05) based on the paired-sample t-test

Milk production

Table 5 shows that average milk production after treatment in Groups I, II, and III was 11.16 kg, 6.79 kg, and 11.32 kg, respectively. Utomo and Pertiwi (2010) and Nugraha *et al*. (2016) stated that average milk production of dairy cows in Indonesia ranges from 8 to 10 kg/head/d, while Christie *et al*. (2021) and Makin and Suharwanto (2012) reported 15 kg/head/d at BPPIBTSP Bunikasih in Cianjur and range of 13–15 kg/head/d in the West Java province, respectively. The results of the analysis of variance (ANOVA) indicated that there was a statistically significant (P<0.05) impact of different feed treatments on the amount of milk produced among different groups. There was no statistically significant difference observed in milk output between Group I and Group II before and after treatment. The addition of premix to Karfeed concentrate did not yield statistically significant effects (P>0.05) on dry matter (DM), crude protein (CP), and total digestible nutrients (TDN) intake in Group II. Consequently, the impact of this supplementation on the performance of dairy cows remains undetermined. Novianto and Sarwiyono (2013) and Suryahadi *et al*. (2004) reported that feed supplements improved and maintained livestock production performance. Premix improves and enriches the nutritional quality of feed because it contains various kinds of vitamins, micro minerals, macro minerals, and probiotics needed by livestock (Retnani *et al*., 2014). The observed difference in milk output between Group II and Group I may be attributed to variations in the individual circumstances of the animals used in each treatment. A possible consideration to consider is that the premix contained within the Karfeed concentrate may have adequately fulfilled the nutritional requirements of dairy cows. Consequently, the addition of supplementary premix in the Karfeed concentrate may have a negligible effect on enhancing milk output in Group II. Field (2007) stated that less variety of feed will not affect palatability, so feed consumption will remain the same so it does not affect livestock growth.

The implementation of feed treatment in Group III resulted in a statistically significant increase in milk production ($p < 0.05$), with an average of 2.5 kg per head per day observed during the treatment period. The Protelis® concentrate, with a crude protein content of 18%, showed a higher milk production rate compared to the Karfeed concentrate in both Group I and Group II, which had a protein content of 15%. The observed improvement in the production of milk is probably due to an increased availability of essential nutrients, enabling dairy cows to produce milk in accordance with their genetic capacity. The milk production of cows was shown to increase by 28.3% after they were provided with a diet consisting of King grass supplemented with Protelis® concentrate. Enhancing the quality of feed has the potential to accelerate improvements in milk production prior to Foot-and-Mouth Disease (FMD) infection. Syafri *et al*. (2014) reported that feed protein consumption has a quadratic relationship with milk production and protein.

Dairy cows infected with FMD also showed high fever, so their bodies will spend much energy to maintain average body temperature (homeostasis). In addition to losing energy, cows will show a decrease in the feed's protein, vitamins, and minerals supply. Pasaribu and Firmansyah (2015) stated that the performance of dairy cow's production is influenced by feed; if the nutritional needs of dairy cows are met, then productivity can reach optimal. Syafri *et al.* (2014) stated that protein in feed determines feed quality because it affects milk production and quality. The higher the ability to provide feed protein as needed, the more milk will be produced.

As shown the Figure 1 the average milk production during treatment. Group III's milk production significantly increased compared to groups I and II. The increased supply of CP and TDN causes milk production to increase. Appropriate feeding management can affect the adequacy of the nutrients needed to produce optimum productivity for dairy cows. Laryska and Nurhajati (2013) stated that feeding dairy cows must be on the requirements and reasonable so that the feed remains efficient and the need for production can be fulfilled.

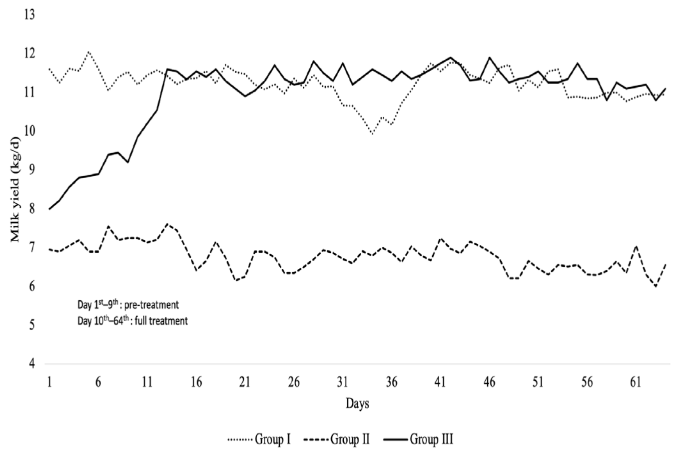

Figure 1: Average milk production daily during the study period.

Providing feed with protein content as needed will speed up the recovery process for milk production performance after FMD. Dairy cows can return to average production by increasing the feed quality. Protein consumption has a positive relationship with milk production, i.e., more protein consumption will be followed by increased milk production. Protein consumption from feed will become a source of amino acids during milk protein biosynthesis. Milk protein is a part or component of milk; if milk protein production increases, milk production will also increase. According to Indriyani *et al.* (2013), the productivity of dairy cows will be optimal if feed consumption is sufficient so that the results of digestion of feed absorbed by the blood have sufficient amounts to produce milk.

In ruminant animals, the balance of microflora, which plays a role in fermentation digestion, greatly influences digestive efficiency. Rumen microbial populations, including bacteria, fungi, and protozoa, are essential in fermentative digestion. Utomo and Pertiwi (2010) stated that optimal protein consumption would be followed by increased crude protein digestibility, increasing the nutrients used for milk biosynthesis. Protein consumption can affect milk production because feed protein will be processed in the rumen to be degraded by microbes so they can synthesize their body cells into microbial protein. Microbial protein is digested in the abomasum with the help of pepsin enzymes into polypeptides, which will be converted into amino acids to be used as a precursor for milk formation. Consumption of TDN affects milk production because it contains milk-forming precursors, especially glucose, as a precursor in milk lactose biosynthesis. Lactose is a component of milk that has the property of absorbing water. Yusuf (2010) and Syafri *et al.* (2014) stated that glucose from energy sources is the precursor for making milk lactose. At the same time, the increasing of lactose content in the milk are related to the milk productions.

Milk quality

Multiple regression analysis revealed that the different feed treatments between groups had no significant (p>0.05) effect on milk quality. Table 6 shows Protelis® concentrate supplementation increased milk quality, such as protein, fat, lactose, solid non-fat (SNF), and total solid (TS). Protein is the primary nutrient in milk because it contains the essential amino acids the body needs (Sigit *et al.*, 2021). The main ingredients for fermentative digestion and an essential source of nutrition for ruminants are forages, which contain cellulose, hemicellulose, pectin, and lignin, which are carbohydrates that makeup plant cell walls. Cellulose, hemicellulose, and pectin are subject to hydrolytic action and complex microbial enzymes (cellulases). The fermentative digestive ecosystem is complex, with waste products from one microbial species being utilized as substrates for other bacteria. *R. albus* will digest cellulose but cannot digest protein; this bacterium provides hexose for *B. ruminicola's* energy. *B. ruminicola* digests protein but cannot digest cellulose; this bacteria provides ammonic and branched chain fatty acids to grow *R. albus* (Bradley, 2020).

This study showed that premix supplementation in Group II could not significantly improve milk quality. Akhidiat et al. (2021) reported that supplementing 50 grams of premix to a group of high-producing dairy cows could increase their milk production capacity but not their fat quality or protein. Fatty acids can degrade milk protein because a decrease in microbial protein yield makes less protein absorbed and available for milk protein synthesis (Jenkins, 2000). Increasing the extraction efficiency of essential amino acids, milk blood flow, and glucose absorption are directly proportional to the increase in protein synthesis (Mackle *et al.*, 2000). Amino acids absorbed by the mammary glands from the blood are the primary nitrogen source for milk protein synthesis. Some amino acids also produce glucose and form volatile fatty acids (VFA) as a glucose source in lactose formation. The more lactose is synthesized, the more milk produced (Syafri *et al*., 2014).

The feed supplement provided contains macrominerals to increase the productivity of dairy cows (Sumartono *et al*., 2023). Based on research by Rabiee *et al*. (2021), supplementing minerals to dairy cows can significantly increase milk production by 0.93 kg/day, milk fat production by 0.04 kg/day, and milk protein production by 0.03 kg/day. Apart from that, Protelis® feed also contains probiotics. Parakkasi (1999) stated that probiotics can increase rumen microbes so that they will produce free fatty acids such as propionic acid. This propionic acid can be converted into glucose and then circulates in the blood, becoming a precursor to milk lactose. About 80% of milk lactose is synthesized from glucose, while 12% comes from amino acid gluconeogenesis. Premix combines several ingredients and micronutrient sources formulated in supplement form. The principle of a good ration formulation system for livestock is the addition of supplements that consider balanced main food substances such as energy, protein, calcium, and phosphorus.

Utami *et al*. (2014) reported that feed containing lots of forages would cause high milk fat levels. According to Mutamimah *et al*. (2013), fat content is influenced by acetic acid, which comes from forages, while the acetic acid precursor comes from crude fiber, which is fermented in the rumen so that it turns into volatile fatty acid (VFA), which consists of acetate, butyrate, and propionate. The main ingredients of fat are acetic and butyric acid; the higher the crude fiber content of the feed, the higher the acetic and butyric acid levels from the results of microbial breakdown in the rumen. Novianto and Sarwiyono (2013) stated that VFA is a precursor component of milk fat. Low milk fat levels will reduce the nutritional value contained therein so that the benefits provided by milk are reduced. The acetic acid resulting from fermentation digestion will enter the secretory cells of the udder and become milk fat (Musnandar, 2011). This study showed that fat content was in the range of 0.4–1.1%, lower compared to Syafri *et al*. (2014), who reported 3.28–3.51%. There is no significant difference in fat content after treatment between groups caused by the crude fiber contained in the ration being relatively the same. According to Laryska and Nurhajati (2013), dairy cows that are fed large amounts of concentrate and a smaller proportion of forage will have decreased result saliva production, resulting in lower rumen pH, resulting in reduced acetic acid production, as it is known that acetic acid formed in the rumen is the primary precursor for the formation of milk fat (Setyaningtias et al., 2014). Thus, the three experimental cow groups will have relatively balanced milk fat levels if the production of acetic acid in the rumen is balanced.

SNF is the dry material that remains after the milk fat is removed. The increased SNF levels are caused by the fat content not included in this section, so the total remaining protein and lactose can influence the high percentage produced (Christi and Rohayati, 2017). Mutamimah *et al*. (2013) stated that the higher the protein and lactose, the higher the SNF. Feed protein consumption has a linear relationship with milk lactose, and milk lactose also has a linear relationship with milk production. Imanto *et al*. (2018) stated that milk lactose is the main carbohydrate in milk influenced by feed carbohydrates, which will be converted into glucose and then distributed by the blood, which will be carried to the udder to convert the absorbed glucose into high milk lactose. The level of milk production is influenced by the quality of feed (Sumartono *et al*., 2023).

Table 6: Milk quality (protein, fat, lactose, SNF, and TS) before and after treatment.

Milk content	Group I		Group II		Group III	
	Before	After	Before	After	Before	After
Protein (%)	3.13[a]	3.16[a]	3.18[a]	3.02[a]	3.19[a]	3.58[a]
Fat (%)	0.57[a]	0.41[a]	1.11[a]	1.24[a]	0.39[a]	1.15[a]
Lactose (%)	4.58[a]	4.62[a]	4.56[a]	4.41[a]	4.68[a]	4.69[a]
Solid non fat (%)	8.51[a]	8.59[a]	8.64[a]	8.30[a]	8.67[a]	8.73[a]
Total solid (%)	10.44[a]	10.36	10.77[a]	10.75[a]	10.61[a]	11.12[a]

[a,b] numbers with different superscripts on the same row and in the same group indicate a significant difference at the 95% confidence level ($p<0.05$) based on the paired-sample t-test.

The primary components composing total milk solids are fat, protein, and lactose (Saputra, 2018). According to the study's findings, the range of lactose concentration in milk was 4.4–4.6% (Table 6). The lactose levels observed in the present study were found to be higher compared to those reported by Syafri *et al*. (2014), who reported a lactose content of 4.10%. Christi and Rohayati (2017) stated that lactose is a composite of glucose and galactose. Suhendra *et al*. (2015) propose that propionic acid, which is produced by the ruminal fermentation of crude fiber, is the source of milk lactose.

CONCLUSIONS AND RECOMMENDATIONS

The improvement in feed protein value by supplementing Protelis® concentrate containing 18% crude protein in Group III increased milk yield and milk quality for dairy cows after FMD infection. The best feed formulation in Group III because it could provide better nutrients (DM, CP, and TDN) that produced more milk and quantity than the other treatment groups. This study's increase in milk production and quality proved that the combination of basal feed, supplementary concentrate, and premix met the dairy cows' needs, recovering productivity after FMD infection.

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NOVELTY STATEMENT

This research article provides preliminary information on a combination of basal feed, supplementary concentrate, and premix met the dairy cows' needs, recovering productivity after FMD infection and increasing milk production.

AUTHOR'S CONTRIBUTION

NS contributed to the acquisition of data and statistical analyses of data. NS and SHI contributed to the design of the manuscript. All authors contributed to drafting the manuscript, revising the manuscript, and preparing the manuscript for publication.

Ethical approval

The study protocol was reviewed and approved by the Research Ethics Commission Team, Faculty of Veterinary Medicine, Universitas Gadjah Mada, No. 70/EC-FKH/Eks/2023.

Conflict of interest

The authors have declared no conflict of interest.

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