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Research Article

Dairy Milk Quality After Foot and Mouth Disease in Ternak Sukses Bersama, Kediri Regency

Kualitas Susu Perah Pasca Penyakit Mulut dan Kuku di Ternak Sukses Bersama Kabupaten Kediri

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ABSTRACT

Background: Milk, a nutrient-rich substance obtained from udder secretions, can suffer quality degradation due to factors like disease-causing microorganisms. Foot and Mouth Disease (FMD), an acute viral infection affecting cloven-hoofed animals, can severely impact milk production and quality. **Purpose:** This study aims to analyze the quality of milk from dairy cattle following the FMD outbreak, as FMD not only reduces milk yield but also alters its composition, affecting consumer preferences and farmer income. **Method:** Milk quality tests were conducted on cattle following the FMD outbreak with each 50 ml sample stored in an icebox and analyzed using a calibrated Lactoscan tool. The analysis covered fat, solid-non-fat (SNF), density, lactose, salts, protein, temperature, freezing point, added water, total solids, and pH levels. The study received consent from local authorities and breeders. **Results:** The analysis of cow milk post Foot and Mouth Disease (FMD) outbreak reveals significant variability in milk composition, affecting quality and processing, with many falling below or above standard thresholds for fat content, SNFs, protein content, freezing point, and added water, while all samples had a pH level outside the acceptable range. **Conclusion:** Quality of dairy milk from dairy cattle after FMD outbreaks show decreasing of fat content in five milk samples, four samples in solid non fat, three samples in protein, nine samples in freezing point, eight samples in added water, and all samples fell outside the acceptable pH range.

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ABSTRAK

Latar Belakang: Susu, pangan kaya gizi yang diperoleh dari sekresi ambing yang dapat mengalami penurunan kualitas karena faktor-faktor seperti mikroorganisme penyebab penyakit. Penyakit Mulut dan Kuku (PMK) adalah infeksi virus akut yang menyerang hewan berkuku belah, dapat berdampak serius pada produksi dan kualitas susu. **Tujuan:** Penelitian ini bertujuan untuk menganalisis kualitas susu dari sapi perah setelah wabah PMK, karena PMK tidak hanya mengurangi produksi susu tetapi juga mengubah komposisinya, yang memengaruhi preferensi konsumen dan pendapatan petani. **Metode:** Uji kualitas susu dilakukan pada sapi setelah wabah PMK dengan jumlah sampel yag diambil adalah 50 ml. Sampel ditransportasikan menggunakan *cool box* dan dianalisis menggunakan alat Lactoscan yang dikalibrasi. Analisis yang dilakukan yaitu meliputi lemak, padatan bukan lemak *(SNF),* kepadatan, laktosa, garam, protein, suhu, titik beku, penambahan air, total padatan, dan kadar pH. Penelitian ini telah mendapat persetujuan dari pihak terkait dan peternak. **Hasil:** Analisis susu sapi pasca wabah Penyakit Mulut dan Kuku (PMK) menunjukkan variabilitas signifikan dalam komposisi susu, yang memengaruhi kualitas dan pemrosesan, dengan beberapa sampel berada di bawah atau di atas ambang batas standar terutama untuk kandungan lemak, *SNF,* protein, titik beku, dan tambahan air, sementara semua sampel memiliki kadar pH di luar standar yang ditetapkan. **Kesimpulan:** Kualitas susu sapi perah setelah wabah PMK menunjukkan penurunan kadar lemak dalam lima sampel susu, empat sampel padatan tanpa lemak, tiga sampel pada protein, sembilan sampel pada titik beku, delapan sampel pada air tambahan, dan semua sampel berada di luar kisaran pH yang dapat diterima.

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Kata kunci: Susu Perah, Penyakit Mulut dan Kuku, Lactoscan

INTRODUCTION

Milk is a liquid substance from udder secretions obtained through the milking procedure. Fresh milk contains natural ingredients without reducing or adding other ingredients and has not received any treatment except the cooling process that does not affect its purity (SNI 01-3141-2011). The nutrients in milk supply high-quality energy, protein, and essential micronutrients (calcium, magnesium, potassium, zinc, phosphorus) that are easily to absorb. Milk minerals are essential for human health and development (Ansari-Lari *et al.*, 2017). The calcium in milk plays an important role in the development, strength, and density of bones, as well as in the prevention of bone loss and fractures (Górska-Warsewicz *et al.*, 2019). Milk can endanger human health if milk components are damaged. Milk quality can decrease or be damaged due to the addition of other components or microorganisms. One of the causes of damage to milk quality is the presence of disease-causing microorganisms, such as cattle suffering from Foot and Mouth Disease (FMD) (Lyons *et al.*, 2015).

Foot and Mouth Disease is an acute infectious disease caused by viruses from the Apthovirus genus. This disease is often called Apthae Epizootica (AE) and Aphthous Fever (Kitching, 2002). The level of FMD transmission is relatively high in cloven-hoofed animals, including dairy cattle. If FMD is not properly handled, it can cause serious animal welfare and productivity problems. Animals infected with FMD can not return to the ability to produce fresh milk (Lyons *et al.*, 2015). Foot and Mouth Diseas as first discovered in Indonesia in 1887, specifically in Malang, East Java. Since 1990, Indonesia has been declared FMD-free by the OIE and must maintain this status without vaccination. FMD infected livestock in Indonesia again, especially cattle in April 2022 (Adhi, 2022). Based on data from the Ministry of Agriculture, it is known that on May 17 2022, 15 provinces, 52 regencies/cities have been infected with FMD with the number of livestock sick reaching 13.965 heads. Transmission of FMD disease in an area can occur very quickly, with a morbidity rate of almost 100% (Sudarsono, 2022).

The incidence of FMD in dairy cattle has a negative impact in the form of significant losses in livestock health and the farmer's economy. Economic losses from foot and mouth disease (FMD) in Indonesian livestock are estimated to total IDR 38.67 trillion (Sumartono *et al.*, 2023). These losses include decrease milk production, hampered animal sales, and their derivative products. One of product derivative of dairy cattle that affected is milk. Based on data presented by Gading *et al.*, (2023), the decrease in milk production due to FMD incidents can reach 61% per day. The average milk production of dairy cows on smallholder farms in Indonesia typically ranges from 8 to 10 liters per head per day. However, the impact of FMD can lead to a significant drop in milk production, with affected cows producing less than 5 liters per head per day (Indriani, 2020; Purwadi and Prasetyo, 2024). Oktanella et al.'s research in 2023 further illustrates this, showing a decrease in milk production from 70 dairy cows diagnosed with FMD, dropping from 642 liters to 292.95 liters (54.37%) reduction. Foot and Mouth Diseas not only cause a decrease in milk production but is also accompanied by changes in quality or milk composition. That can influence people's purchasing preferences, which decreases the income level of entrepreneurs and breeders. Based on that reason, this study aims to analyze the quality of milk from dairy cattle after the FMD outbreak.

MATERIALS and METHODS

Material

Milk quality tests were carried out with the use of cattle milk samples after the FMD outbreak from the village livestock group "Ternak Sukses Bersama," Deyeng Village, Ringinrejo District, Kediri Regency, which is part of village community empowerment by the Faculty of Veterinary Medicine, Universitas Brawijaya.

Method

This research uses an exploratory research approach. Exploratory research is a type of research that aims to explore broadly the causes and effects or factors influencing the occurrence of an event. In this case, namely the effect of FMD outbreaks on the quality of dairy cows' milk (Janah *et al.*, 2018). This research employs an exploratory research approach. Exploratory study aims to broadly explore the causes and effects, or factors influencing the occurrence of an event. It specifically examines the impact of FMD outbreaks on the quality of dairy cows' milk (Janah *et al.*, 2018). Observation of milk quality was carried out from May to June 2023. A sampling of samples was implemented on May 19, 2023, and 19 milk samples were obtained. Milk samples were analyzed using the Lactoscan tool (Microtonic Ltd., Bulgaria) in the Veterinary Public Health Laboratory Faculty of Veterinary Medicine, Universitas Brawijaya. This study already got agreement from the village government and breeders with agreement declared using the inform concern form.

Testing Sample

The volume of milk collected was as much as 50 ml for each cattle. Milk samples from the milking procedures were immediately put into the retort pouch and stored in an icebox to maintain milk quality. Milk quality was determined through testing using a calibrated lactoscan tool.

Analysis Data

The data obtained were fat level, solid-non-fat (SNF), density, lactose, salts, protein, temperature, freezing point, added water, total solid, and pH. The data analysis method used in the research was quantitative analysis using Microsoft Excel.

RESULT

The results of the quality of milk samples can be seen in Table 1. Following the FMD outbreak, the analysis of cow milk showed a wide range of results across various parameters. For fat content, the minimum was 0.02%, the maximum was 9.84%, and the average was 4.75%, against a standard minimum of 3%. Five respondents' samples fell below this

standard, while fourteen met or exceeded it. For solids-not-fat (SNFs), results ranged from 6.59% to 9.62%, with an average of 8.18% compared to a standard of 7.8%; four samples were below this standard, and fifteen were above. The density ranged from 16.54% to 34.11%, with an average of 26.90%. Lactose content varied between 3.62% and 5.28%, averaging at 4.49%. Salt content ranged from 0.53% to 0.78%, with an average of 0.66%. Protein content was between 2.37% and 3.52%, averaging 2.98% against a standard of 2.8%; three samples were below this standard, and sixteen were above. The milk's temperature ranged from 16.73°C to 26.01°C, averaging at 22.02°C. The freezing point ranged from -0.62°C to -0.44°C, with an average of -0.53°C, and a standard between -0.52°C and -0.56°C; nine samples were outside this range, and ten were within. Added water content ranged from 0% to 15.19%, with an average of 2.19%; eight samples were outside the standard, while eleven were within. Total solids ranged from 9.04% to 16.95%, averaging 12.93%. The pH levels ranged from 7.31 to 7.42, with an average of 7.33, which is outside the standard range of 6.3 to 6.8, indicating that all samples fell outside the acceptable pH range.

Tabel 1. Dairy Milk Quality Test Result.

Breeder Name	Serial Number	Fat (%)	SNFs (%)	Density	Lactose (%)	Salts (%)	Protein (%)	Tempera-ture (°C)	Freezing Point (°C)	Water Addition (%)	Total Solids (%)	pH
1	CB-26578	5.08	8.07	26.21	4.43	0.66	2.94	24.48	-0.52	0.00	13.15	7.35
2	CB-26578	4.63	8.73	29.06	4.79	0.71	3.18	19.03	-0.56	0.00	13.36	7.33
3	CB-26578	3.43	9.62	33.46	5.28	0.78	3.52	24.35	-0.62	0.00	13.05	7.36
4	CB-26578	9.84	6.59	16.54	3.62	0.53	2.37	23.38	-0.44	15.19	16.43	7.28
5	CB-26578	5.75	7.74	24.37	4.25	0.63	2.82	23.77	-0.50	3.65	13.49	7.33
6	CB-26578	4.75	8.01	26.23	4.40	0.65	2.92	16.73	-0.51	1.34	12.76	7.39
7	CB-26578	4.33	8.00	26.56	4.39	0.65	2.92	20.10	-0.51	1.92	12.33	7.31
8	CB-26578	4.40	8.63	28.88	4.74	0.70	3.15	20.56	-0.56	0.00	13.03	7.35
9	CB-26578	8.78	7.65	21.45	4.20	0.62	2.77	18.29	-0.51	1.53	16.43	7.41
10	CB-26578	2.58	7.92	27.74	4.35	0.64	2.90	21.59	-0.50	4.80	10.50	7.32
11	CB-26578	9.13	7.82	21.80	4.30	0.63	2.83	19.07	-0.53	0.00	16.95	7.42
12	CB-26578	4.68	8.27	27.28	4.54	0.67	3.01	23.51	-0.53	0.00	12.95	7.34
13	CB-26578	0.02	9.02	34.11	4.96	0.74	3.32	22.44	-0.56	0.00	9.04	7.26
14	CB-26578	6.67	7.50	22.69	4.12	0.61	2.72	24.68	-0.49	5.96	14.17	7.36
15	CB-26578	2.07	8.05	28.67	4.42	0.66	2.95	20.82	-0.50	3.65	10.12	7.35
16	CB-26578	4.09	8.62	29.12	4.74	0.70	3.15	23.96	-0.55	0.00	12.71	7.25
17	CB-26578	4.57	8.65	28.81	4.75	0.70	3.15	26.01	-0.56	0.00	13.22	7.33
18	CB-26578	2.59	8.58	30.24	4.71	0.70	3.14	21.21	-0.54	0.00	11.17	7.28
19	CB-26578	2.79	7.98	27.80	4.38	0.65	2.92	24.48	-0.50	3.65	10.77	7.31
Min.		0.02	6.59	16.54	3.62	0.53	2.37	16.73	-0.62	0.00	9.04	7.25
Max.		9.84	9.62	34.11	5.28	0.78	3.52	26.01	-0.44	15.19	16.95	7.42
Average		4.75	8.18	26.90	4.49	0.66	2.98	22.02	-0.53	2.19	12.93	7.33
SNI 3141-1:2011		**Min. 3%**	**Min. 7.8%**				**Min. 2.8%**		**-0.520 until -0.560**			**6.3 – 6.8**

DISCUSSION

Milk Fat

The post-Foot and Mouth Disease (FMD) outbreak analysis of cow milk indicates substantial variability in milk composition, which has important implications for dairy processing and product quality. FMD causes fever, anorexia, ulcers, vesicles, and erosions on lips, dental pad, tongue, and gum, leading to food avoidance due to pain that may be the cause of milk yield reduction and defects in milk components. The fat content ranged from 0.02% to 9.84%, with an average of 4.75%, surpassing the minimum standard of 3%. Despite the majority of samples meeting or exceeding this standard, the presence of five samples below the standard highlights potential deficiencies in the feeding practices and overall health management. The lower percentage of milk fat content indicated that dairy consume little crude fiber. This is related to the livestock's decreased appetite due to illness caused by FMD. The crude fiber in feed (cellulose and hemicellulose) will be changed into simple sugars like glucose and pentose. Glucose and pentose become acetate acids and are then converted into milk fat (Andriawan *et al.*, 2014). Dairy cattle that are sick cause FMD to experience a decrease in appetite, especially crude fiber. The same case has occurred in Southern Iran, where livestock infected with FMD experience changes in milk quality with a decrease in milk fat content (Ansari-Lari *et al.*, 2017).

Lower fat content in cow's milk can become an indication of mastitis due to an increased amount of somatic cells. Somatic cells consist of 22-25 % udder secretory epithelial cells (Namira *et al.*, 2022), where normally the number of somatic cells in milk is no more than 105 cells/mL. Cell epithelium secretory works as a place for the biosynthesis of milk fat. Riyanto *et al.*, (2017) stated that more secretory cells were

ruptured or damaged, indicating a high level of mastitis severity, which decreased milk fat content. This is supported by the statement from Delvia *et al.* (2023), where the number of somatic cells in milk can influence milk composition.

Solid Non Fat

The findings for solids-non-fat (SNFs), with a range of 6.59% to 9.62% and an average of 8.18%, suggest that while most samples are within acceptable parameters, the four samples below the standard of 7.8% indicate possible issues with milk dilution or nutrient content variations. This discrepancy can influence the textural and stability properties of dairy products. SNF levels in milk can increase along with increasing milk protein levels. This happens because the molecules are larger than molecules of fat (protein, lactose, vitamins, minerals) and will easily pass the intestinal lumen membrane, which increases the number of SNF (Vergi *et al.*, 2015).

Milk Lactose

Lactose content, ranging from 3.62% to 5.28%, remains within typical bounds. The standard lactose level in raw dairy cattle milk is 4.0%. Only one sample that didn't meet the standard. Lactose is the primary carbohydrate found in milk and plays a significant role in its sweetness and nutritional value. This level can vary slightly based on several factors, including the cow's breed, diet, stage of lactation, and overall health (Rabus *et al.*, 2023).

Milk Protein

The average protein content of dairy milk samples in Table 1 shows a normal value, its minimum of 2,8%. Milk protein levels in dairy milk of village livestock groups can be declared to have met the quality requirements for fresh milk because it is by SNI 3141.1:2011. Increased milk protein levels can occur due to high crude protein levels in concentrate. Protein molecules that pass rumen degradation will be digested in the intestine and produce amino acids. The small intestine's villi absorb amino acids, enter the blood vessels, and then enter the cell udder through the bloodstream. Synthesis of amino acids into milk protein occurs in the udder (Muktiani, 2017).

Freezing Point

The variation in freezing point, with some samples outside the standard range of -0.52°C to -0.56°C, raises concerns about possible adulteration with water, thereby compromising milk purity and overall quality (Ceniti *et al.*, 2019). Milk freezing point is mostly used to confirm the methods used by milk producers, i.e., to find out if water has been added to milk. There were many factors affect the FP of milk such as milk components, feed, preservation, thermal treatment, time of milking, lactation stage, breed, year and period. It was related with added water result test that varied from 0% to 15.19%. Water may enter milk from milking machines as an accidental byproduct of improper milking techniques or as a required addition (Ceniti *et al.*, 2019).

Total Solid

Total solids ranged from 9.04% to 16.95%, with an average of 12.93%, while pH levels, ranging from 7.31 to 7.42 with an average of 7.33, were notably outside the standard range of 6.3 to 6.8. This uniform deviation in pH could signal bacterial contamination or improper handling practices, posing risks to both milk safety and shelf life. The average total solid levels (TS) of the dairy milk sample in Table 1 show normal values. The minimum TS level by the Indonesian National Standards Agency is 1.75%. A total solid is a solid that consists of dry material without fat or Solid Non-Fat (fat, lactose, protein) and fat content (Subagyo *et al.*, 2023). Milk TS levels can be influenced by feed. Feeding with a high dry matter content will increase the density of milk. This is because the dry material consumed by livestock will be used as a precursor in the formation of milk TS (Subagyo *et al.*, 2022). Feeding with a high crude fiber content in concentrate can increase the fat content. An increase in milk fat content can increase the TS value of milk (Saputra, 2018).

Milk pH

The average pH value of dairy milk samples in Table 1 has increased. According to SNI 3141.1:2011, the normal pH value of fresh milk is 6,3–6,8. The increased pH value in cattle's milk indicates subclinical mastitis. The increasing pH value of milk is consistent with an increased degree of mastitis. Changes in pH values can occur due to increased permeability of the material cell, resulting in udder epithelium displacement component blood to milk like citrate and bicarbonate. The movement of these components can trigger the abnormality of pH value (Riyanto *et al.*, 2017).

Foot and Mouth Disease Infection

Foot and Mouth Disease (FMD) infection in cattle also has an impact on milk production. FMD causes weight loss, loss of efficiency work, and decreased milk production. Cattle affected with FMD disease can cause decreased milk production by up to 5-8%. Decreasing milk production in a dairy farm can be caused by longer calving intervals, low growth in young cattle due to weight loss, and livestock mortality (Hussain *et al.*, 2017). Low growth rates in young cattle influence delayed first conception (Atabany *et al.*, 2011). Foot and Mouth Disease (FMD) has a significant impact on the quantity and quality of milk production in dairy cows due to inflammation in the mouth and mammary glands (Armson *et al.*, 2020). The FMD virus can enter through the respiratory system, upper digestive tract, and open wounds (Sukoco *et al.*, 2023). Subsequently, the virus replicates in the epithelial cells of the pharyngeal membrane and is then released into the lymphatic and blood vessels (viremia). The virus then spreads and infects the epithelium of other organs, such as the mouth, mammary glands, and feet, causing inflammation and vesicle lesions in these areas (Sarsana and Merdana, 2022). The mammary glands, particularly their secretory epithelium, have become a critical site for FMD virus replication

(Suchowski *et al*., 2021). The invasion of the mammary glands by the FMD virus can damage the nipple structure, consequently affecting the quantity and quality of milk produced (Armson *et al*., 2020). Furthermore, the appearance of vesicles in the mouth of infected dairy cows leads to decreased appetite, which in turn reduces the intake of feed. Since feed is the primary source of lipid formation required to fulfill metabolic needs, provide milk elements, and promote animal weight gain, the decrease in livestock appetite caused by FMD infection hinders the body from obtaining essential fats, resulting in a reduction in the fat content of the milk produced by dairy cows (Oktanella *et al*., 2023).

CONCLUSION

Quality of dairy milk from dairy cattle after FMD outbreaks show decreased fat content in five milk samples, four samples in SNFs, three samples in protein, nine samples in freezing point, eight samples in added water, and all samples fell outside the acceptable pH range.

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CONFLICT of INTEREST

There are no conflicts of interest with related parties in this study.

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ETHICAL PPROVAL

There is no need for ethical approval for this study.

AUTHOR'S CONTRIBUTION

Concept and design study: FNAEPD. Research sampling: FA. Sample analysis and processing data: RYOD, MAK. Manuscript drafting: FNAEPD, UK, MMO. Critical review/manuscript revision: FNAEPD.

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