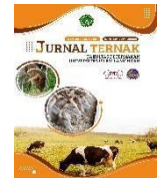


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## Study of Fat, Lactose, and Protein Concentrations of Holstein Friesian Cow's Milk Early Lactation

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### ARTICLE INFO

#### Article history:

Received 07 September 2022

Revised 29 October 2022

Accepted 12 December 2022

Available online 31 December 2022

#### Keywords :

Fresh Milk,  
Fat,  
Lactose,  
Protein

#### IEEE style in citing this article:

P. Surjowardojo *et.al* " Study of Fat, Lactose, and Protein Concentrations of Holstein Friesian Cow's Milk Early Lactation" Jurnal Ternak : Jurnal Ilmiah Fakultas Peternakan Universitas Islam Lamongan, vol. 13, no. 2, pp. 76 – 82, 2022.

### ABSTRACT

This study aims to determine the concentration of lactose, fat, and protein in FH cow's milk at the beginning of lactation which is intensively reared at the People's Farm of the Dairy Cattle Farming Cooperative (KPSP) located in Tukur District, Nongkojajar, Pasuruan Regency, East Java Province, Indonesia. The research material used was fresh milk from lactating dairy cows. The research method used is laboratory analysis with purposive sampling technique. FH dairy cows that were in 3rd lactation period was taken as samples on the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> milking days in the morning and evening milking times. Data were analyzed descriptively and qualitatively. The results showed that the average fat concentration of FH cow's milk in the morning milking was  $4.23 \pm 0.68\%$ , while in the afternoon milking was  $4.99 \pm 0.65\%$ . The average lactose concentration in the morning milk was  $4.10 \pm 0.66\%$ , while in the afternoon milk was  $4.48 \pm 0.71\%$ . The average protein concentration in the morning milking was  $3.23 \pm 0.94\%$ , while in the afternoon milking was  $3.32 \pm 0.65\%$ . This study concluded that the high concentration of fat, lactose, and protein in the afternoon milking was caused by the shorter time interval between morning and evening milking than the afternoon to morning milking time. The concentration of fat, lactose, and protein in FH cow's milk, which is higher than the SNI standard, is due to several factors including environmental, nutritional, climatological, and managerial factors. The factors are inseparable from each other in influencing milk quality. The quality of fresh milk produced by the Dairy Cow Farming Cooperative People's Farm (KPSP) located in Tukur District, Nongkojajar, Pasuruan Regency, East Java Province, Indonesia is in good condition, safe, and suitable for consumption as milk quality standards meet SNI No. 01-3141.1-2011.

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## 1. Introduction

Milk as a food source of animal protein has high nutritional value and is very important in meeting the nutritional needs of the community [1]. The quality of milk is the basis for paying the price of milk [2]. Milk is a white liquid containing nutrients in the form of fat, lactose, protein, and some vitamins and minerals, which are released by all adult female mammals as food for their young [3]. Milk is one of the foodstuffs that are consumed without having to process it first, and is generally considered the closest food to perfection. Nutritionists around the world agree that milk is a very

important food for the growth and development of children and young animals [4]. Nonetheless, it is not only important for feeding babies and children, milk (and dairy products) is also necessary for consumption throughout our adult lives. Milk is a complete food that is rich in protein, carbohydrates, minerals, vitamins, and calcium. Milk quality is paramount, therefore it must be stored properly and transported under optimal conditions [5]. Milking is usually done 2 times a day, in the morning and in the evening. The same time interval between morning and evening milking will give relatively few changes in the composition of milk, while different milking time intervals will result in different milk compositions as well. The quality of milk can be determined based on the content of its primary metabolites such as protein, fat, and lactose. Farmers must pay attention to this provision so that the quality of milk produced has high standards and safe for consumption [2]. Based on the Indonesian National Standard, good quality quality milk has 2.8% protein content and 3% fat [7]. In milk, several primary metabolites are important for the body including protein, fat, lactose and some contain other nutrients such as calcium, and other vitamins that are good for the health of the human body [7].

Fat is the main source of energy in milk. Fat provides more energy compared to protein and lactose. One gram of fat provides  $\pm 9$  calories [7]. The concentration of milk fat content can be found in small cells suspended in water that vary by the nation of the livestock and the composition of the feed [3]. Fats contain various chemical elements such as triglycerides, unsaturated fatty acids, phospholipids, sterols, vitamin A, vitamin D, vitamin E, and vitamin K, (the fat content in milk varies between 3% - 6%) [7]. Milk fat consists of triglycerides composed of one molecule of glycerol with three molecules of fatty acids through ester bonds. There are at least 50 kinds of fatty acids in milk fat, of which 60-75% fat is saturated, 25-30% fat is unsaturated, and about 4% is polyunsaturated fatty acids [8].

Lactose is the main carbohydrate found in milk as much as 4.60% with a range of 3.50-6.00% and is found in a soluble state [8]. Lactose is a disaccharide consisting of D-glucose and D-galactose connected by an  $\alpha$ -1,4 glucoside bond [5]. The presence of lactose in milk is one of the peculiarities of milk itself since lactose is not present in nature except as a product of the mammary glands. Milk lactose is composed of condensation between galactose and glucose in the blood. Milk galactose comes from the merger of glucose molecules with Uridine Diphosphate (UDP), while blood glucose is sourced from propionic acid in the rumen [9]. The sweet taste of lactose is not as sweet as other disaccharides, a kind of sucrose. The sweet taste of lactose is only one-sixth of the sweet taste of sucrose. Lactose levels in milk can be damaged by several types of acid-forming germs [8].

Protein in milk is also a determinant of the quality of milk as a consumption ingredient. Protein is a food substance that is very important for the body, because it functions as a fuel for the body, building agent, and regulatory agent [7]. The most important milk proteins are casein, lactalbumin, and lactoglobulin [10]. Casein is 80% of the total protein contained in milk. It consists of:  $\alpha$  s1-casein,  $\alpha$  s2-casein,  $\beta$ -casein, and kappa-casein with proportions close to 38, 10, 36 and 13%. Casein can be precipitated by acidic substances (vinegar and HCl), pepsin enzymes, rennin, alcohol, and heating  $\pm 121^{\circ}\text{C}$  for 1 hour. Casein is an ingredient for making cheese. If the cheese material is added with acid, then the acid will take the electric charge of the cheese parts so that they do not reject each other again. The acid also takes Ca from the cheese material, then it is left insoluble casein (as thick granules in the milk). Similarly, when the old milk is in high temperatures, it has acidic results in the deposition of casein [8]. While lactamine is included in a simple protein as colloidal form in milk, there is a difference, namely, lactalbumin is easily confused by heating. Nonetheless, it cannot be precipitated by acid or rennin enzymes, because it does not contain phosphorus (P), and is the smallest constituent of milk protein. Although it is available in small quantities, it is very important in terms of nutrition because it is a component of casein. Additionally, because it is easily coagulated by heating [8], lactalbumin is of great importance in the stabilization of products from milk exposed to heat during processing. This lactoglobulin is found in milk as much as 0.1% of (including globulins and immunoglobulins). Lactoglobulin functions as an antibody, which will protect newborn calves from infections caused by pathogenic organisms. As with lactalbumin, lactoglobulins can also be depleted

by heating, but not by acids or rennin enzymes [8]. The milk protein complex contains a good proportion of all amino acids essential for growth and maintenance [5].

## 2. Method

The quality of fresh milk must meet the requirements of SNI standards to be consumed by the public. The quality can be seen from the content of high fat, lactose, and protein that simultaneously affect the selling value of milk.

This research was conducted at the Dairy Cattle Laboratory (LTP) of the Animal Science Study Program, Faculty of Animal Husbandry, Universitas Brawijaya. KPSP is located in Tukur District, Nongkojajar, Pasuruan Regency, East Java Province, Indonesia. The research method was laboratory analysis with purposive sampling technique, with criteria for FH dairy cows in the 3<sup>rd</sup> lactation period. Each sample was taken on the 1<sup>st</sup> to 7<sup>th</sup> milking day, in the morning and evening milking times.

## 3. Results and Discussion

Based on the analysis of milk quality (fat content, lactose content, and milk protein) that has been carried out, the results of the analysis are obtained in the following table:

Table 1. The average concentration of fat, lactose, cow's milk protein FH first lactation in morning and evening milking.

Nutritional Content of Milk	Morning Milking (%)	Afternoon Milking (%)	Standard
Fat (%)	4,23 ± 0,68	4,99 ± 0,65	Minimal 3,00**
Lactose (%)	4,10 ± 0,66	4,48 ± 0,71	4,9*
Protein (%)	3,23 ± 0,94	3,32 ± 0,65	Minimal 2,8**

Description: \*\* National Standards Agency (2011) [11]

\* Mourad (2014) [12]

The results (Table 1) show an average concentration of fat, lactose, and milk protein that are higher in afternoon milking than in morning milking. This is because the time interval of milking in the morning to the evening is shorter than the time interval of milking in the afternoon to the morning. The same time interval between morning and evening milking will provide relatively few changes in the composition of milk, while different milking time intervals will result in different milk compositions. In Magdalena's study (2008), the results showed that the quality of milk in the morning milking was fat content as 3.17%, and protein content as 3.583%. The morning milking result was lower compared to afternoon milking that obtained fat content as 3.69%, and protein content as 3.61% [13]. The study by Christi *et al.*, 2022 stated that the lactose level in morning milking was 3.74% while in afternoon milking was 3.32% [14]. These results are also by Akbar *et al.* (2018) which state that the difference in the time interval between morning and evening milking will give changes to the composition of milk, while the same milking time interval will result in relatively similar milk composition [15].

**Fat Concentration**

Table 2. Average Milk Fat Concentration in Morning and Evening Milking From 14 Data Collection

No	Value	Fat Concentration	
		Morning	Afternoon
1	Average %	4.23	4.99
2	Minimal %	0.01	0.03
3	Maximum %	16.08	13.44
4	Standard Deviation %	0.68	0.65
5	Coefficient of Variation %	16.05	12.93

Description: n (number of samples): 434

Table 2 shows the concentration of milk fat in morning milking averaged as  $4.23 \pm 0.68\%$ , while in afternoon milking the average concentration of milk fat is  $4.99 \pm 0.65\%$ . This value was higher than the study conducted by Nugraha, et al., (2016) that resulted the average concentration of milk fat in the morning milk was 3.63%, while the afternoon milking was 3.88% [16]. The value was high from the fat content standard according to SNI No. 01-3141.1-2011 with minimum 3.0% applied to fresh milk. The concentration of these fats fluctuates and is widely influenced by the degree of lactation of milk production, the quality, and type of feed. The fat composition of milk will decrease further due to the feeding of concentrates. This is due to the fairly high protein content in the concentrate spurring the production of propionic acid. Forage feed produces a lot of acetate as a raw material for milk fat synthesis [8]. Milk fat content will decrease with the increase of milk production. The climatological environment is thought to also affect the quality and production of milk. The quality of milk in the afternoon milking is higher, but the amount of milk yield is lower due to the increase in temperature during the day, which affects the physiological condition of the cow. On the contrary, in the morning milking, the quality is lower with higher milk yield due to the physiological state of the cow which at night tends to rest. Milking time has a very noticeable effect on milk fat content where its fat content is higher in afternoon milking than in morning milking [16]. Another guess is that fat is a store of energy, so that, the low-fat content of the morning milking is used for milk biosynthesis in the afternoon.

**Lactose Concentration**

Table 3. Average Milk Fat Concentration in Morning and Evening Milking From 14 Data Collection

No	Value	Lactose Concentration	
		Morning	Afternoon
1	Average %	4.10	4.48
2	Minimal %	0.04	0.04
3	Maximum %	8.04	8.19
4	Standard Deviation %	0.66	0.71
5	Coefficient of Variation %	15.99	15.83

Description: n (number of samples): 434

Table 3 shows the lactose concentration of milk in morning milking is  $4.10 \pm 0.66\%$ , while in afternoon milking the average milk lactose concentration is  $4.48 \pm 0.71\%$ . This value is higher than the study conducted by E. Y. Christie *et al.* (2022), which obtained the average lactose concentration of morning milk milking was 3.74%, and in afternoon milking was 3.32% [14]. This is due to several internal and external factors, in each of which contributes quite a lot. Internal factors include physiological conditions, nation, lactation rate, estrus, pregnancy, lambing interval and age. External factors include the environment and feed consumed by cows. Milk lactose is a combination of galactose and glucose in the blood. Milk galactose combines glucose molecules with Uridine Diphosphate, while blood glucose is derived from propionic acid in the rumen produced by microorganisms as a result of fermentation products[17]. Consumption of feed with high BETN is also

able to increase blood glucose. The source of blood glucose can come from the process of gluconeogenesis in the liver[18][14]. Therefore, lactose and water greatly affect milk production.

### Protein Concentration

Table 4. Average Milk Fat Concentration in Morning and Evening Milking From 14 Data Collection

No	Value	Protein Concentration	
		Morning	Afternoon
1	Average %	3.23	3.32
2	Minimal %	0.02	0.02
3	Maximum %	8.76	8.18
4	Standard Deviation %	0.94	0.65
5	Coefficient of Variation %	29.00	19.63

Description: n (number of samples): 434

The results of the analysis in table 4 shows milk protein concentration in the morning milking of  $3.23 \pm 0.94\%$ , while in the afternoon milking, the average is of  $3.32 \pm 0.65\%$ . This value is higher than the protein concentration standard in SNI No. 01-3141.1-2011 with minimum 2.8%. The value is also higher than the study conducted by Nugraha, et al., (2016). The study resulted as the concentration of milk protein which tended to be constant in the morning milking at 2.90%, and the afternoon milking of 2.98% [16]. At the beginning of lactation, the protein content of milk is higher than the fat content. The first secretion formed by the mammal glands is a brass viscous liquid called colostrum, in which this colostrum contains more protein than milk [19]. Most of the proteins present in colostrum are immunoglobulin. The complete change from colostrum to milk occurs at 24-48 hours after the partus. Afterward, the protein concentration of milk will decrease little by little, while simultaneously followed by an increase in the concentration of milk fat. Such changes occur every 6 hours. Nevertheless, it will be constant after the composition of colostrum becomes the composition of whole milk [16]. The protein content is also influenced by the feed consumed by cows. The mechanism of milk formation comes from the consumption of feed which then flows into the blood and undergoes a filtration process into milk constituent ingredients. Some researchers state giving concentrates will increase milk proteins [16]. With the addition of concentrates, the available energy will increase for the formation of amino acids derived from microbial proteins. The increase of these amino availability acids will contribute to the increase of milk protein synthesis [5].

### 4. Conclusions

The fat concentration of the morning milking milk was lower (4.23%) than the afternoon milking (4.99%), and the lactose concentration of the morning milking milk was lower (4.10%) than the afternoon milking (4.48%). The protein concentration of the morning milking milk is lower (3.23%) than the afternoon milking (3.32%). This is because the interval between the morning and afternoon milking is shorter than the afternoon to morning milking time. The concentration of fat, lactose, and protein in FH cow's milk is higher than the SNI standard due to several factors including environmental, nutritional, climatological, and managerial. These factors are inseparable from each other in influencing milk quality. The quality of fresh milk produced by the Dairy Cow Farming Cooperative People's Farm (KPSP) located in Tukur District, Nongkojajar, Pasuruan Regency, East Java Province, Indonesia is in good condition, safe, and suitable for consumption. The milk meet national quality standards SNI No. 01-3141.1-2011.

## 5. Acknowledgment

The authors thank the support from the Institute of Research and Community Services Brawijaya University (LPMM) and the Faculty of Animal Science, Brawijaya University.

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