Relationship between teat dimensions and milking efficiency by hand milking on dairy cows in Temanggung Regency

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Abstract. This research was completed at PT. Naksatra Kejora, Temanggung Regency, Central Java Province, Indonesia using 31 Holstein Friesian cows (lactation period I-V and lactation month 1-10). The observational method was used in this study. The parameters measured were teat dimensions (teat volume as X₁, teat circumference as X₂, and teat length as X₃) as independent variable and milking efficiency (milking time duration / milk production as Y) as dependent variable. Data obtained were analyzed using correlation, then using linear multiple regression to predict the milking efficiency from teat dimensions. Analysis of variance was used to test the significance of model. The result showed that there was no significant relationship between milking efficiency with teat volume (R = 0.070), teat circumference (R = 0.226) and teat length (R = -0.090). The multiple regression model was Y = 1.141 + 0.003 X₁ + 0.050X₂ - 0.092X₃ (R² = 0.236, no significant P = 0.061). It was concluded that it was difficult to predict the milking efficiency from teat dimensions on Holstein Friesian cow in Temanggung Regency.

1. Introduction
Milking can be done by suckling of the calf, manually (hand milking) or machine milking. There are 3 methods for hand milking, namely "pull down", "thumb in", and "full hand grip" [1, 2]. In the some developed country, hand milking is still used because labor is cheaper than automation method [1]. In dairy cows including Holstein Friesian, milk “let-down” was affected by oxytocin hormone that effective only 6 – 8 minutes after oxytocin was released from the posterior pituitary into blood which carries oxytocin to the udder [1]. Milking should be done quickly and optimally [2, 3]. Milking time duration is related to milk production and teat dimensions. Teat dimensions include teat length, teat circumference or teat diameter at teat base, teat barrel, teat apex [4, 5]. Generally, hind teats were shorter and tighter than front teats [6].

The location of the teat and the uniform of the high and size of teat will affect the time and level of milking efficiency [7]. The amount of milk removed from milking process was affected by the milker and how well the milking technique works for the individual milker [2]. It is reasonable to suspect relationships between the teat dimensions with milking efficiency. Therefore, this research was conducted to find the correlation and the model fit for those relationships.

2. Materials and Methods

2.1. Database
This research was completed at PT. Naksatra Kejora, Temanggung Regency, Central Java Province, Indonesia using 31 Holstein Friesian cows (lactation period I-V and lactation month 1-10), with body
weight 458.32±39.78 kg and initial milk production 12.78±2.47 kg. The observational method was used in this study. The parameters measured were teat dimensions (teat volume, teat circumference, and teat length, respectively, as measured on pre milking and average from front and hind teats) and milking efficiency (milking time duration / milk production. The milking time duration and milk production was determined on morning and afternoon milking time, and then milking efficiency was average of morning and afternoon milking. Hand milking method was used for milking process.

2.2. Statistical Analyses
Data obtained were analyzed using correlation, then using linear multiple regression to predict the milking efficiency (Y) from teat dimensions (teat volume as X₁, teat circumference as X₂, and teat length as X₃). Analysis of variance was used to test the significance of model at α level 5% [8, 9].

3. Results and Discussions
The correlation between parameter and linear regression models are shown in Table 1 and 2. In Table 1, P-value showed that there was no significant relationship (P > 0.05) on teat dimensions (teat volume, teat circumference, and teat length) with milking efficiency. All criteria of correlation were from very low until low. In Table 2, the multiple regression model (teat volume (X₁), teat circumference (X₂), teat length (X₃) with milking efficiency (Y)) were not significant (P = 0.061). Then, after the partial model was checked, all linear models were not significant (P > 0.05).

Generally, hand milking in Temanggung Regency was done by whole hand method and finishing by stripping method. In the present study, milking by hand in Temanggung District showed that teat dimensions were not related with milking efficiency. But only teat length had negative correlation (R = -0.090; P = 0.630) with milking efficiency, even not significant. This happen because the milking process was done by experienced of milkers for 31 dairy cows. All milkers had experience for this job more than 10 years. The milking process was affected by the milker and his knowledge and his experience about milking [2]. The average of teat dimensions were teat volume 49.03±12.46 mL, teat circumference 8.31±1.26 cm, teat length 5.87±1.07 cm. In addition, milking efficiency was 1.18±0.11 min/kg. Teat dimensions have associated with quarter position (front versus hind), parity and lactation stage. The increase in teat length was not significant from second parity on wards in front teats [6]. Teat dimensions and internal udder would permit to predict udder cisternal storage capacity [3].

In our research, all regression models were not significant (P > 0.05) and cannot be predict. In this situation, milking process on different teat dimensions will have similar milking efficiency. The ratio of milking time duration and milk production were relatively constant. It’s very important on dairy system with hand milking for have milker with knowledge and more experience about good milking practice. In every dairy farmers group, the milking process was better when conducted by the same milker at daily time. The presence of an unknown person during milking will get the cows under stress and had significantly influenced toward milk yield [10].

4. Conclusion
There were not relationships between teat dimensions (teat volume, teat circumference, teat length) with milking efficiency. It was concluded that it was difficult to predict the milking efficiency from teat dimensions on Holstein Friesian cows in Temanggung Regency.

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Table 1. Correlation between teat dimensions and milking efficiency on Holstein Friesian cows in Temanggung Regency

| Variable                                | R      | Criteria of R | P-value |
|-----------------------------------------|--------|---------------|---------|
| Teat Volume with Milking Efficiency     | 0.070  | Very Low      | 0.708   |
| Teat Circumference with Milking Efficiency | 0.226  | Low           | 0.222   |
| Teat Length with Milking Efficiency     | -0.090 | Very Low      | 0.630   |

* R = Coefficient of Correlation, Criteria of R based on Sugiyono [11].

Table 2. Summary and evaluation of linear regression between teat dimensions and milking efficiency on Holstein Friesian cows in Temanggung Regency

| Variable                                | Equation                                      | R      | R²      | P-value |
|-----------------------------------------|-----------------------------------------------|--------|---------|---------|
| - Teat Volume (X1), Teat Circumference (X2), Teat Length (X3) with Milking Efficiency (Y) | Y = 1.141 + 0.003 X₁ + 0.050 X₂ – 0.092 X₃  | 0.485  | 0.236   | 0.061   |
| - Teat Volume (X) with Milking Efficiency (Y) | Y = 1.151 + 0.001 X                          | 0.070  | 0.005   | 0.708   |
| - Teat Circumference (X) with Milking Efficiency (Y) | Y = 1.016 + 0.020X                          | 0.226  | 0.051   | 0.222   |
| - Teat Length (X) with Milking Efficiency (Y) | Y = 1.237 – 0.009 X                        | -0.090 | 0.008   | 0.630   |

* R = Coefficient of Correlation, R² = Coefficient of Determination.