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The effect of months in dry season on somatic cell count, milk yield and quality of dairy cows in highland area, Vietnam

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Abstract: The objective of the study was to evaluate somatic cell count, milk yield and quality of dairy cows across periods of the dry season and highland region in the tropical country, Vietnam. The milk data of somatic cell count, yield and quality were collected from October 2021 to March 2022 in a highland area, Vietnam. The milk properties of freezing point (FP), fatness, lactose, protein, solids-not-fat (SNF), and total solid (TS) were analyzed in lab. The milk somatic cell count (SCC) was examined using Foss MilkoScan analyzer. The results showed the milk yield average of 14,988 data was 24.26 kg/day/cow, highest in December and January (25 kg/day/cow) and decreased in February and March (23.6 kg/day/cow) ($P < 0.001$). The characteristics of milk quality from 1,943 data were FP -0.52^{0}C, fatness 3.88%, lactose 4.51%, protein 3.35%, SNF 8.56%, and TS 12.66%. The milk fat percentage was highest at 3.99% in February and at 3.98% March, and lowest at 3.77% in January. The milk quality varied during months ($P < 0.01$). Milk SCC average of 1,192 data was 656,000 cells/mL, highest at 752,000 cells/mL in December, and lowest at 576,000 cells/mL in March. The SCC of milk decreased month by month from December to March ($P<0.01$). Our study showed that the months effected the milk yield and quality in the dry season, and the milk yield had the negative correlation with the milk contents. Milk SCC was influenced by months and had the positive relationship with the milk yield.

Keywords: Dairy cows, milk, milk quality, milk yield, somatic cell count

INTRODUCTION

The objective of development and application of the high technology in dairy cow husbandry was to increase milk yield, milk quality and reproduction. Beside that the climate, temperature and geography region also effected dairy cow production (Mauger *et al*., 2015; Moore *et al*., 2023; Souza *et al*., 2023). The milk yields were presented higher in temperate climate areas than in tropical countries, such as 39.1 kg/day/cow in Summer and 34.9 kg/day/cow in Winter in Japan (Nguyen *et al*., 2019), and 12.6-20.2 kg/day/cow in the dry season and 13.5-27.6 kg/day/cow in the rainy season in the Southern of Vietnam (Tran *et al*., 2022; Nguyen *et al*., 2023). In this study, we investigated the milk yield and quality in a mountainous province that located in the north of the highland regions in the Middle of Vietnam. This area has been a potential region to develop dairy cow husbandry, so several high-tech big farms have been investigated in recent years. The milk quality standards included freezing point, fatness, solids-not-fat, protein, lactose, total solid, and other contents. The main parameters indicated that were high milk fat, protein, total solid percentage, and low somatic cell count, and good hygienic milk to ensure the food safety (Riekerink *et al*., 2007; Ostensson *et al*., 2013; Alhussien, *et al*., 2018). Therefore, we aimed to investigate milk yield and quality of dairy cows across months, and evaluate the effect of months on somatic cell count, milk yield and quality in highland region in the tropical country, Vietnam.

MATERIALS AND METHODS

The milk yield data were collected from one farm in the highland area in the Middle of Vietnam including 14,988 data of collected samples. The cows were kept in a free-stall barn and fed total mixed ration silage (Table 1). The data were collected from October 2021 to March 2022. This period was the dry season (November to April) in the Middle of Vietnam. This region located in the highland area, so the average temperatures and humidity in the dry season were 22-25^{0}C and about 76% (Vietnam Weather Forecast, 2022).

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Table 1. Composition of total mixed ration silage produced on the farms.

Ingredients	Percent (%)
Corn silage	12.63
Corn tree	36.45
Complete product	14.42
Elephant grass 50 days	5.69
Soybean meal	4.60
Brewer's grain	7.43
Corn powder	7.97
Mombasa grass	6.83
Rumifat plus	0.34
Bicarbonate	0.18
Available Zn	0.01
Multivitamin	0.07
Salt	0.21
Mineral	0.06

And the quality contents of 1,943 milk samples were analyzed for freezing point (FP), fatness, lactose, protein, solids-not-fat (SNF), and total solid (TS) in lab. Total 1,192 data of milk somatic cell count (SCC) were examined by using Foss MilkoScan analyzer.

The method of sampling: After cleaning the surface of the udders and discarding the streams of foremilk, the milk samples were manually collected from four udders and then mixed to become a composite sample (Nguyen *et al*., 2020). The cows collected milk samples no showed any symptoms of clinical mastitis and other reproductive problems. The samples were gotten between 9:00-11:00 in the morning, kept on ice during their transportation to the laboratory, and stored at -20°C for further analyses.

In statistical analysis, milk yield and quality data were analyzed by one-way ANOVA, Tukey pairwise comparisons, and Chi-Square Test to examine the effect of months. The statistical differences were significant at $P < 0.05$.

RESULTS AND DISCUSSION

Milk Yield Influenced By Months

The study was carried out on one farm in the highland area in the Middle of Vietnam. The herd population were about 10,514 cows with total 120 ha of fields (corn, Elephant and Mombasa grass). The results of milk yield on farms from 14,988 data were presented in Table 2. The milk yield average was 24.26 kg/day/cow. Vo (2016) evaluated the milk yield on dairy smallholders in the Southern of Vietnam, the average was 16.00 kg/day/cow, which was lower than our result. Nguyen *et al*. (2023) investigated the milk yields on two farms in Ho Chi Minh City (the Southern of Vietnam) from December 2021 to March 2022 showed 20.15 kg/day/cow from 121 dairy cows in one farm and 12.55 kg/day/cow of 220 dairy cows in another. And Tran *et al*., (2022) showed the milk yields were 13.5-27.6 kg/day/cow at 2 farms in Ho Chi Minh City. Moreover, Nguyen *et al*. (2023) carried out their study also in the dry season which was the same in this study, but the region was in the South of Vietnam. The average temperatures were 26°C - 31°C, and the average humidity was about 62% in the South of Vietnam for this season. So, the located places of dairy cow farms could be considered as different regions and the climate which would effect on the milk yields.

Table 2. The milk yield in months (Mean±SD)

Month	December	January	February	March	Total/ Average	*P-value*
n (data/cows)	2,924	3,321	4,294	4,449	14,988	
Milk yield (kg/day/cow) (Mean±SD)	24.86±7.72^{a}	25.18±8.98^{a}	23.63±7.91^{b}	23.67±7.61^{b}	24.26±8.06	*0.000*

^{abc} indicates the significant difference ($P < 0.05$) between months.

The results indicated the milk yields were highest in December and January at around 25 kg/day/cow, and decreased in February and March at 23.6 kg/day/cow ($P < 0.001$; Table 2). Comparing the milk yields in Ho Chi Minh city, they were peak of 21 kg/day/cow in December, and then dropped down from March at 18 kg/day/cow (Nguyen *et al*., 2023). Vu *et al.* (2016) showed the milk yield was higher in the dry season than it in rainy season in Ho Chi Minh City and Lam Dong province, and they also pointed out the highest milk yield in the highland region as Lam Dong province comparing with other places (Ho Chi Minh city,

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Binh Duong, and Long An province). Moreover, Salfer *et al.* (2019) stated that the milk yield followed a seasonal pattern of the year. Therefore, the results of milk yield influenced by months and higher in highland region were recorded in our study, it might be contributed by the lower environmental temperature and higher humidity in highland areas.

Milk Quality Varied By Months

The milk quality was evaluated from total 1,943 samples from October to March. The milk contents differed between months ($P < 0.05$; Table 3). The result presented the freezing point was around -0.52^{0}C which was one acceptable standard of milk quality (Shipe, 1959). Our results recorded 3.88% fatness, 4.51% lactose, 3.35% protein, 8.56% SNF, and 12.66% total solid (TS). The milk fat percentage was highest at 3.99% in February and at 3.98% in March, and lowest at 3.77% in January. While protein was highest at 3.40% in January and lowest at 3.27% in December. Total solid was 12.6-12.7% during 6 months in this study. Comparing the investigated results in Ho Chi Minh City, milk quality contents were lower at fatness 3.19%, higher at lactose 4.83%, similar at protein 3.49%, and higher at SNF 8.99% (Nguyen *et al.*, 2023). Vu *et al.* (2016) indicated the farm regions were high impacts of variation affecting milk fat percentage, the highest fatness was 3.79% in the highland region as Lam Dong province, then 3.77% in Ho Chi Minh City, and lowest at 3.62-3.68% in Long An and Binh Duong province in Vietnam; and milk fat percentage varied by season, highest in the dry period at 3.73% and lowest in the rainy season with 3.69%. However, Nguyen *et al.* (2020) showed the milk fat percentage was stable during summer and winter season, average 3.27-3.61%. Another milk content, total solid was 12.00-12.11% in the Sothern of Vietnam (Vu *et al.*, 2016), and it was different among farm regions including the highland area and other provinces and also between season (highest 12.11% in dry season and lowest 12.04% in rainy season).

Table 3. The milk quality across months (n=1,943 samples, Mean±SD)

Month	n (samples)	Freezing point (^{0}C)	Fatness (%)	Lactose (%)	Protein (%)	SNF (%)	Total Solid (%)
October	211	-0.52±0.0006^{ab}	3.93±0.31^{a}	4.53±0.06^{a}	3.35±0.16^{ab}	8.52±0.12^{a}	12.72±0.39^{a}
November	281	-0.52±0.005^{a}	3.85±018^{b}	4.53±0.04^{a}	3.31±0.14^{c}	8.53±0.12^{a}	12.63±0.29^{b}
December	510	-0.52±0.002^{b}	3.81±0.24^{bc}	4.49±0.14^{b}	3.27±0.12^{a}	8.60±0.16^{b}	12.61±0.44^{b}
January	279		3.77±0.19^{c}		3.40±0.13^{d}		12.65±0.28^{b}
February	291		3.99±0.32^{d}		3.34±0.14^{ab}		12.74±0.40^{a}
March	371		3.98±0.22^{ad}		3.32±0.19^{bc}		12.64±0.39^{b}
Average		-0.52±0.003	3.88±0.25	4.51±0.11	3.35±0.14	8.56±0.15	12.66±0.38
P-value		*0.041*	*0.000*	*0.000*	*0.000*	*0.000*	*0.004*

^{abcd} indicates the significant differences ($P < 0.05$) between months

Somatic cell count (SCC) has been known an indicator of subclinical mastitis and was used as one of standards to evaluate and classify the milk quality. So, SCC was one of important parameters which decided food safety and affected the milk purchasing price in milking centers. McFadden (2011) and Vu *et al*. (2016) indicated SCC more than 400,000 cells per mL milk was a standard of evaluation or signal of subclinical mastitis. Total milk samples measured by SCC method were 1,192 samples from December to March in this study. Average somatic cell counts were 656,000 cells/mL, highest at 752,000 cells/mL in December, and lowest at 576,000 cells/mL in March (Table 4). The amount of somatic cells decreased month by month from December to March, and differed significantly by months ($P < 0.01$). Vo (2016) investigated the milk SCC from 120 farms in the Southern of Vietnam showed that the average of milk SCC was 1,300,000 cells/mL and 69% of the cows had SCC more than 400,000 cells/mL, and SCC did not show differently between the herd size of farms. However, SCC average was only 285,000 cells/mL from one farm in Ho Chi Minh City during December to March, 2022 which was the same period in our study, the highest at 352,000 cells/mL in January and lowest at 231,000 cells/mL in December (Nguyen *et al*., 2023). And Nguyen *et al*. (2023) also investigated another farm (100 dairy cows) in Ho Chi Minh City indicated that 40% milk samples had more than 400,000 somatic cells/mL, the highest rate of subclinical mastitis was 91.30% of cow group which had the milk yield less than 10 kg/day/cow, and the study pointed out the milk SCC was affected by the milk yield.

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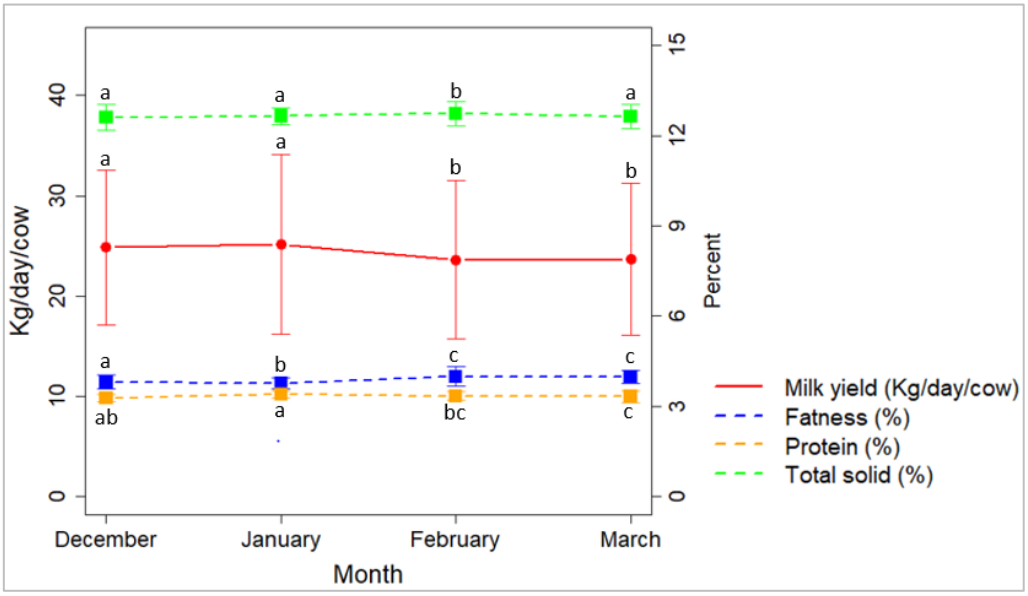
Table 4. Somatic cell count in milk across months (Mean±SD)

	December	January	February	March	Total/Average	P-value
n	249	279	291	373	1,192	
Soma (10^3 cells/mL) (Mean±SD)	752.41±94.22 ^{a}	698.79±76.91 ^{b}	635.60±201.40 ^{c}	576.10±305.50 ^{d}	656.16±216.17	0.000

^{abcd} indicates the significant differences (P < 0.01) between months.

Relationship Between Milk Yield and Milk Quality Across Months

The milk yield reduced by months and was higher in December and January than February and March (P < 0.01) (Table 2, Figure 1). The figure 1 showed that the milk yield had the negative relationship with the milk contents. The higher milk yield and lower milk contents of fatness, protein and total solid were indicated in December and January. Otherwise, the lower milk yield would be interacted with higher milk quality in February and March. The milk yield and quality were recorded highest in the highland area in our study comparing with other researches in Vietnam.



^{abc} indicates the significant differences (P < 0.01) between months.

Figure 1. Milk yield, fatness, protein, and total solid from December to March in farm.

Considering the milk SCC, they were still high results comparing with standards of less than 400,000 cells/mL. However, milk SCC tended to decrease from 752,000 to 576,000 cells/mL during December to March in our study, that might be the results of good managements in milking procedures and udder health. And Figure 2 presented that the milk SCC performed the positive interaction with the milk yield during the months. The good point was that the milk yield reduced from 24.86 to 23.67 kg/day/cow, but milk SCC dropped down much more near SCC standards of good milk quality.

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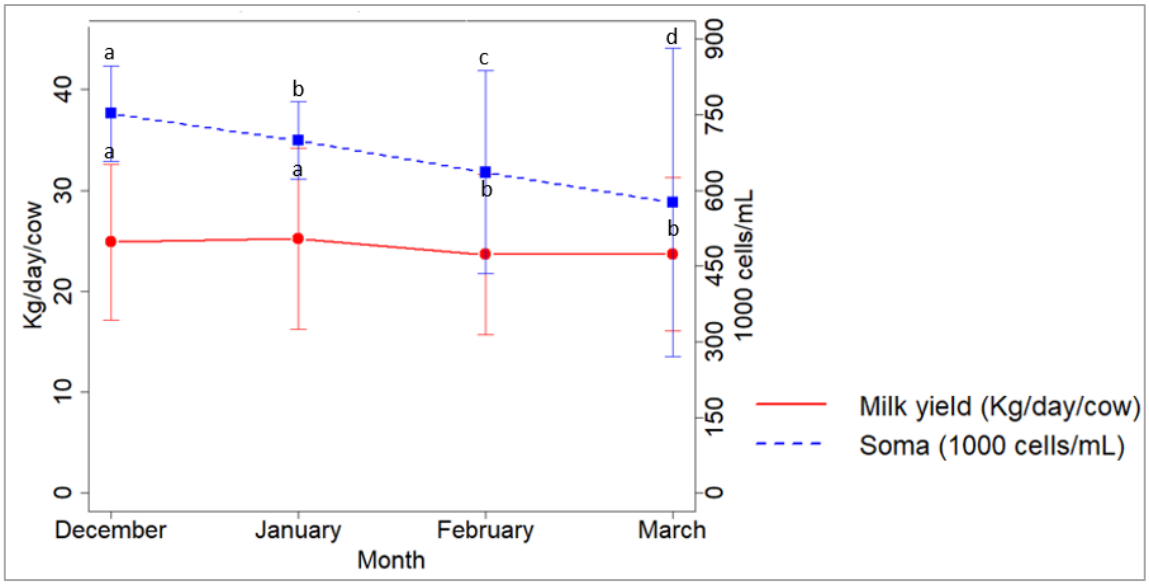

[abcd] indicates the significant differences (P < 0.01) between months.

Figure 2. Milk yield and milk somatic cells from December to March in farm.

CONCLUSIONS

Our study showed the milk yield and milk quality in this highland area were influenced by months, and they were evaluated as high milk yield and quality in Vietnam, especially the highest milk fat percentage. The milk yield had the negative correlation with the milk quality during months, while milk SCC had the positive relationship with the milk yield.

Conflict of Interest

The authors have no conflicts of interest to declare.

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