Effects of Season and Parity on Milk Production and Milk Composition of Holstein Cows

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Abstract. This study aimed to investigate the effects of seasonal change and parity on milk production and milk composition of Taiwan Holstein Cows. The 171 complete lactation records from 68 Holstein cows, with parity 1, 2, 3, and more than 4 were used in this experiment. Data were grouped into different lactation periods and seasonal CC, CH, HH, and HC (C: Cool, H: Hot). The cool season is from November to April, while the hot season is from May to October. Variables observed were 305-2X-ME, daily milk yield (MY), fat %, protein %, lactose %, total solid %, somatic cell count (SCC), and somatic cell score (SCS). Results showed that season was not significantly associated with 305-2X-ME, lactose %, SCC, and SCS. However, the season had a significant effect ($P<0.01$) on daily milk yield, protein %, total solid% and tend to be associated ($P<0.1$) with fat%. The highest milk yield was observed at CH, CC for fat%, lactose% and total solid%, while HH was for protein%. In this study, parity did not significantly affect 305-2X-ME, lactose%, and total solid%. However, it showed significant affect ($P< 0.01$) in daily milk yield, ($P<0.05$) in protein and SCC.
Keywords: Holstein, season, parity, milk yield, milk composition.

1 Introduction

Milk production from dairy cows is affected by both genetic and environmental factors, which play the major role in determining lactation performance. Some studies reported that environmental conditions such as season, has association with temperature and nutrition which significantly affecting milk yield, DIM lactation, and milk composition [1,2]. Under the hot season and high temperature, dairy cow will respond by changing the behavior like increasing respiration rate, rectal temperature and dringking. On other side the cow will reduce total feed intake, eating and chewing behavior [3]. High temperature and humid climate will cause an imbalance between metabolic heat production inside the cow body and its dissipation to the surroundings results to heat stress in dairy cows [4].

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Seasonal variation related to temperature stress has been widely recognized as one of key limiting factor for milk yield, due to directly influences feed intake, metabolic activity, and the physiological responses of dairy cows. Aside from that, parity has also been reported to affect milk yield and composition, with differences observed across successive lactations due to changes in physiological maturity and mammary gland development [5,6]. Given that both season and parity play critical roles in milk production and milk composition, it is interesting to investigate their combined effects in Holstein cows. Therefore, this study aimed to evaluate the effect of season and parity on milk production traits of Holstein cows.

2 Materials and methods

2.1 Animal and milk production traits

A total of 68 Holstein cows with 171 lactation records were included in this study. With distributed as follows: 56, 50, 31, 20, 11, and 3 records for the 1st, 2nd, 3rd, 4th, 5th, and 6th lactation records, respectively. The milk production traits evaluated included 305-2X-ME, daily milk yield, fat %, protein protein %, lactose %, total solids (TS %), somatic cell count (SCC), and somatic cell score (SCS). Milk production traits were obtained from Dairy Herd Improvement (DHI) databank provided by website of Taiwan Livestock Research Institute (http://www.angrin.tlri.gov.tw/menue_all.htm)

The seasonal effects on milk production traits were classified into four categories: cool–cool (C–C), cool–hot (C–H), hot–hot (H–H), and hot–cool (H–C). Specifically, C–C indicates a lactation period beginning and ending in the cool season; C–H indicates a lactation starting in the cool season and ending in the hot season; H–C indicates a lactation starting in the hot season and ending in the cool season; and H–H indicates a lactation beginning and ending in the hot season. In Taiwan, the cool season extends from November to April, while the hot season extends from May to October. The effect of parity on milk production traits was analyzed by grouping cows into four categories: 1st, 2nd, 3rd, and ≥4th parity.

2.2 Statistical analysis

All production data were analyzed using SAS software (version 9.2, SAS Institute, Cary, NC, USA). The effects of season and parity on 305-2X-ME, daily milk yield, fat%, protein%, lactose%, TS%, SCC, and SCS were evaluated using a general linear model (GLM). The results are presented as least squares means ± standard error (SE) with a significance level set at $p < 0.05$.

3 Results and discussion

Season was not significantly associated with 305 corrected milk yield, lactose, SCC and SCS. However season had significant association ($P < 0.05$) with daily milk yield, protein and total solid and tended to be associated ($P < 0.1$) with fat (Table 1). The highest daily milk yield was obtained by C-H season followed by H-C, C-C, and H-H season (28.85 ± 0.50 kg/d vs. 27.98 ± 0.76 kg/d vs. 27.14 ± 0.58 vs. 26.98 ± 0.68 kg/d, respectively). The highest fat was obtained by C-C season followed by H-H, H-C, and C-H season (3.86 ± 0.07% vs. 3.80 ± 0.06% vs. 3.72 ± 0.08% vs. 3.65 ± 0.05%, respectively). The highest protein was obtained by H-H season followed by C-C, H-C, and C-H season (3.31 ± 0.03% vs. 3.29 ± 0.04% vs. 3.21 ± 0.03% vs. 3.18 ± 0.04%, respectively). The highest total solid was obtained by C-C season followed by H-H, H-C and C-H season (12.66 ± 0.11% vs. 12.55 ± 0.09% vs. 12.35 ± 0.11% vs. 12.35 ± 0.08%, respectively). Those explanations delineated that the highest daily milk yield was obtained in C-H season and the highest milk component (fat, protein, total solid) was obtained by C-C season. Possible explanation for this fact might be because combination of different temperatures and diet in each season. We suspect that peak milk production at early lactation upto mid lactation was accured at low temperature in cool season. Hence, it has potency to affect cow behavior to increase feed intake which affects milk production and milk composition. In other situation, we suspect that decreasing milk yield at C-C season was cause by cows spend most of their lactation period in the summer or hot season, due to the onset of lactation at the end of cool season. [7] reported that seasonal change affected milk composition and related indices. Similar findings have been observed from several authors, despite the fact that the primary milk ingredients varied in some investigations [8,9,10]. These authors clarified that varying ingestible diet are the reason why the primary milk components shift with the seasons. For instance, the majority of the cows' summer diet consisted of grass, whereas the winter diet consisted of pasture that was supplemented with silage. Seasonal variations in pasture quality and availability are linked to dietary nutritional shifts. The nutritional fluctuations of diet at different seasons are related to changing availability and quality of pasture. Many studies clearly reported that increasing air temperature and temperature humidity index above confort zone of air cows result in a decrease in DMI, milk yield, and efficiency of milk production [11]. and significantly affect the milk composition [12]. Seasonal variation can affect the neuroendocrine system in cows and then influence hormonal equilibrium, energy balance, water balance, and body temperature, and ultimately affect milk yeild, and the immune system of dairy cow [13].

Effect of parity on milk production traits during lactation in Holstein cows were measured. Parity was not significantly associated with 305 corrected milk yield, lactose, SCC and SCS. However, parity had significant association ($P < 0.001$) with daily milk yield, ($P < 0.05$) with fat and protein (Table 1). The highest daily milk was obtained by ≥ 4th parity, followed by 3^{rd,} 2^{nd,} and 1st parity (30.20 ± 0.72 kg/d vs. 28.02 ± 0.72 kg/d vs. 27.55 ± 0.57 kg/d vs. 25.18 ± 0.51 kg/d, respectively). This finding are in line with [7 :14] who report that third- and fourth-parity dams had greater milk yield per lactation and milk yield per day than first- and second-parity dams and that second parity dams had greater milk yield per lactation and milk yield per day than first-parity dams, in agreement with the present research. [15] using Holstein Friesian cows, observed that the effect of lactation number on cumulative milk yield at 305 days and total test day milk yield showed an identical pattern to that milk yield traits evaluated in the present study.

On milk composition, the parity had significant effect ($P < 0.05$) with fat% and protein%. The highest fat% was obtained by 1st parity, followed by 2nd, 3rd and ≥ 4th parity respectively. While, the highest protein was obtained by 3rd parity followed by 2^{nd,} ≥ 4^{th,} and 1st parity respectively. Increasing parity were accompanied by decreasing fat% content. The possible explation for this situation is due to at primiparous parity tend to produce less milk production compared to the multiparous cows. In this study multiparous cows had higher daily milk yield than primiparous cows. This is because multiparous cows have biger body size and weight, which make it consume more feed than primiparous cows. This statement agrees with [1,14] who reported that milk production increases with lactation number and is maximized in the fourth lactation. This is a result of the increasing udder size, which has correlation with the number of secretoty cell in the udder, and increasing body size compared with the first lactation animal.

4 Conclusion

Season had a significant effect on daily milk yield, protein %, total solid % and tend to be associated with fat%. The highest milk yield was observed under CH, while CC resulted in the highest fat%, lactose% and total solid%. Parity had significant association effect with daily milk, fat and protein, whereby multiparous cows produced significantly higher on those traits than primiparous cows

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Table 1. Effect of season and parity on milk production traits of holstein cows

	n	305-2X-ME (kg)	Daily milk yield (kg/d)	Fat (%)	Protein (%)	Lactose (%)	Total solid (%)	SCC (10^4cells/mL)	SCS
Season		NS	*	†	*	NS	*	NS	NS
C - C	30	7,977 ± 238	26.98 ± 0.68[b]	3.86 ± 0.07[a]	3.29 ± 0.04[ab]	4.80 ± 0.02	12.66 ± 0.11[a]	32.36 ± 2.10	3.87 ± 0.18
C - H	58	8,069 ± 177	28.85 ± 0.50[a]	3.65 ± 0.05[b]	3.21 ± 0.03[b]	4.78 ± 0.02	12.35 ± 0.08[b]	30.37 ± 1.51	3.78 ± 0.13
H - C	32	8,203 ± 266	27.98 ± 0.76[ab]	3.72 ± 0.08[ab]	3.18 ± 0.04[b]	4.74 ± 0.03	12.35 ± 0.11[b]	31.89 ± 2.30	3.87 ± 0.20
H - H	51	7,788 ± 203	27.14 ± 0.58[b]	3.80 ± 0.06[ab]	3.31 ± 0.03[a]	4.73 ± 0.02	12.55 ± 0.09[ab]	33.78 ± 1.74	3.81 ± 0.15
Parity		NS	***	*	*	NS	NS	NS	NS
1	56	8,201 ± 177	25.18 ± 0.51[d]	3.86 ± 0.05[a]	3.19 ± 0.03[b]	4.79 ± 0.02	12.55 ± 0.08	29.08 ± 1.55	3.70 ± 0.13
2	50	7,854 ± 198	27.55 ± 0.57[bc]	3.81 ± 0.06[a]	3.25 ± 0.03[ab]	4.74 ± 0.02	12.51 ± 0.09	32.10 ± 1.74	3.81 ± 0.15
3	31	7,862 ± 252	28.02 ± 0.72[b]	3.79 ± 0.08[a]	3.33 ± 0.04[a]	4.75 ± 0.03	12.57 ± 0.11	35.11 ± 2.17	3.97 ± 0.19
≥ 4	34	8,120 ± 253	30.20 ± 0.72[a]	3.58 ± 0.08[b]	3.23 ± 0.04[ab]	4.77 ± 0.03	12.29 ± 0.11	32.11 ± 2.16	3.85 ± 0.19

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