Journal of Animal and Veterinary Advances 6 (2): 190-193, 2007

Effect of Barn Ventilation on Some Physiologic and Milk Traits of Dairy Cows

[1]Nilufer Sabuncuoglu, [2]Omer Akbulut, [1]Omer Coban, [1]Ekrem Lacin, [1]Ahmet Yildiz,
[1]Yener Sagsoz and [3]Ziya Gokalp Ceylan
[1]Department of Animal Sciences, Faculty of Veterinary, University of Ataturk, 25700, Ilica, Erzurum, Turkey
[2]Department of Animal Sciences, Faculty of Agriculture, University of Ataturk, 25240, Erzurum, Turkey
[3]Department of Food Science and Technology, Faculty of Veterinary,
University of Ataturk, 25700, Ilica, Erzurum, Turkey

Abstract: Holstein Friesian and Brown Swiss cows were kept in different ventilation conditions. Respiration - pulse rates of animals and daily milk yield, some milk components were investigated in optimal, unventilated and open shed barns. In unventilated barn physiological traits of cows were affected considerably. Barn II had delayed effect on daily milk yield and milk fat of cows after they were transferred to open shed barn. Also, lower temperature in barn III had negative impact on daily milk yield. Milk dry matter and pH were not influenced by barn ventilation. It is thought to be the primer step to attach importance to the barn ventilation, especially in cold climates.

Key words: Holstien Friesian, barn, unventilated, Brown Swiss

INTRODUCTION

It is very important to optimize climatic conditions in barns, to keep health, welfare and production of the livestock. For dairy cattle, barn temperature and relative humidity are adviced to be 10-15°C and 50-70% (Alpan, 1993). Besides temperature and relative humidity; another factor can affect health is air quality. High ammonia (NH_3) level in barn air irritates mucosa of respiratory system and has potential toxic effect for livestock (Wenger, 1999; Nimmermark, 2004). Carbondioxide (CO_2) level in barns increases with respiratory functions of animals and it is also harmful for them. Mutaf and Sonmez (1984) declared that NH_3 and CO_2 must not exceed 3000 and 35 ppm in barn environment, for animal health.

In Eastern Anatolian region of Turkey, cold climate conditions reign about 6 months of a year. Temperature drops around (-20)-(-30)°C and it snows too much. Because of cold, cattle producers have a misconception that cattle have to be housed in hot barn to obtain maximum yield. Therefore, all air-inlets and outlets are closed tightly to raise the temperature of the barn (Yanar *et al*., 2000). As a result, temperature, relative humidity, carbondioxide, ammonia increase considerably.

The reaction of cattle to different climatic environment can be determined with the change amount of physiological and some production parameters. Limited researches were published reporting physiological traits and milk yield or milk composition of dairy animals kept in various environmental conditions. Frazzi *et al*. (2002) stated that microclimatic factors considerably effected cattles' rectal temperature, respiration rate, daily milk yield and some milk properties. Sevi *et al*. (2003) reported less milk yield and milk casein in unventilated sheep pens.

In this study, it is aimed to study the possible negative effects of the tradional habit (insufficient ventilation inbarns) on some physiological and milk traits of dairy cows.

MATERIALS AND METHODS

Holstein Friesian (10) and Brown Swiss (10) cows, in the stage of 2-4th months of the lactation periods, were used in this research. They were kept in individual stalls in Dairy Research Unit barns of Ataturk University, in November 2005. Cows were balanced in terms of parity (4. partrution), body condition score (Score 4) and milk production (2000-2500 kg). In the first ten days of the research (I): barns were ventilated naturally and mechanically. For the second period (II): The funnels, windows and doors of the barn were closed, to get an increase of temperature, environmental gas and relative humidity, for ten days; this period simulated common application of the region's breeders. At the last period (III): Cows were transfered to open-shed barn in the same unit for ten days.

Respiration and pulse rates were determined by using a stethescope; on 08:00-12:00 am and 08:00 pm, three times

Corresponding Author: Nilufer Sabuncuoglu, Department of Animal Sciences, Faculty of Veterinary, University of Ataturk, 25700, Ilica, Erzurum, Turkey

in a day, on last three consecutive days in each period. Daily milk yield (kg) was recorded and some milk traits (milk fat, dry matter and pH) were analysed on last three consecutive days of each period. Milk samples were analysed as stated by Tekinsen *et al.* (2001) in the laboratory of Agriculture College of Ataturk University; mean values were calculated for each period.

Carbondioxide and ammonia levels in barn's athmosphere were measured by using a carbondioxide analyser (infra red) and the dragger device (electrochemistry), three times in a day. Temperature and relative humidity were recorded continously by using a thermohygrograph, means were calculated.

The cows were fed concentrate feed (1.5 kg/head) before the milking in the morning and evening. Wet sugar beet pulp (8 kg/head) and dry hay and water were offered *ad. lib.* daily to the animals.

Because of that physiological (three times/day; nine times/period) and milk traits were measured on same animals for three periods (three times/period) barn effect was thought to be dependent (within effect), breed effect was independent group (between effect); so Repeated Measures Variance Analysis was performed with two factorial interaction model. For multiple comparisons, Bonferroni Multiple Comparison test was used (SPSS version 9.0, 1997).

RESULTS AND DISCUSSION

Descriptive values for climatic and athmospheric measures in three barn conditions are shown in Table 1. In mechanically ventilated barn (I), environmental temperature was 8.8°C; relative humidity was 74%; concentrations for CO_2 and NH_3 were 2500 ppm (0.2-0.3%) and 6 ppm, respectively.

In open-shed barn, environmental temperature and relative humidity were measured as -7°C and 54%. Levels for CO_2 ve NH_3 were 0.01-0.1 and 0.30×10^{-6} ppm, respectively.

For second period, CO_2 and NH_3 concentrations were higher but especially CO_2 was close to upper levels, stated as 5000 ppm, by some researchers (Mutaf and Sonmez, 1984; Akcan, 1986). In the barns, where this research performed, floor was concentrate constructioned and ceiling of the barn was made from wood and there were straw bales on the windows which works as a filter; so

Table 1: Means of climatic factors values, measured in three barn conditions

Barn types and/ or conditions (*)	Temperature (°C)	Relative humidity (%)	CO_2 (% and ppm)	NH_3 (ppm)
Barn I	8.8	74	0.25 and 2500	6
Barn II	18.9	81	0.45 and 4500	21
Barn III	-7.0	54	0.01and 100	0.30×10^{-6}

(*)I: Stall barn with mechanical ventilation (routine ventilation) II: Stall barn and ventilation funnels, windows were closed, III: Open-shed barn

Table 2: Descriptive value and statistical test results for respiration and pulse rates measured in three barns

Classification	N	Respiration rate (breaths min^{-1}) $X\pm S_x$	Pulse rate (pulsesmin^{-1}) $X\pm S_x$
Breed		NS	NS
Holstein friesian	10	30.2±1.0	63.0±1.1
Brown swiss	10	31.3±1.1	63.4±1.1
Barn types		****	****
I	20	27.2±1.1 a	61.7±1.0a
II	20	38.3±1.0 b	66.3±1.5b
III	20	26.7±0.6 a	61.6±0.7a
Breed x barn		NS	****
HF x I	10	27.3±1.5	58.9±1.4a
HF x II	10	37.1±1.4	69.1±2.1c
HF x III	10	26.4±0.9	61.1±0.9a
BS x I	10	27.2±1.6	64.5±1.4b
BS x II	10	39.6±1.5	63.6±2.2b
BS x III	10	27.0±0.9	62.2±1.4b

Means with different letters are statistically different, NS: Non significant *: $p<0.05$ **: $p<0.01$ ****: $p<0.001$

gas concentration had not exceed to abnormal levels although ventilation was impeded. If barns are made completely from concentrate constructions, may have more difficulties when ventilation is slowed down. Researchers attracted attention to this problem in the barns of Kars region in Turkey (Karademir *et al.*, 2001). For three barn conditions, means for physiological traits and statistical analysis results are shown in Table 2. Barn types caused very significant variation for the physiological traits. That ammonia, temperature and relative humidity did not exceed upper limits; it is thought that, increased physiological traits were caused by carbondioxide in barn II. Inadequate condition (II) mean values was increased from 27.2 to 38.3 and from 61.7 to 66.3 min for respiration and pulse rate, respectively. In second period of our experiment, respiration and pulse rates were higher than those of open shed (III) measures. In barn III, breath and pulse rates of cows were similar to those of barn I. Interaction of breed x barn was not significant for respiration rate but it was found to be significant statistically for pulse rate ($p<0.001$). Change amount of respiration rate of both breeds were not different in three barn types, interaction was statistically non significant. The highest pulse rate (69.1) belonged to Holstein Friesian cows in non-ventilated barn conditions (II). However, pulse rates of Brown Swiss cows had same averages for all barn types.

Sagsoz *et al.* (2003) indicated that Holstein Friesian cows had 25.8 and 65.9; Brown Swiss cows had 22.9 breaths min^{-1} and 61.8 pulses min^{-1} when kept in the stall barn, at 12°C temperature; 69% relative humidity, 2788 CO_2 climatic conditions, quite similar to barn I in this experiment. Sagsoz *et al.* (2000; 2003) also reported with stating breed factor that, when these levels were higher (21°C, 82%, CO_2 = 5229 ppm and NH_3 = 34 ppm)

Table 3: Descriptive value and statistical test results for daily milk yield, milk fat%, dry matter and pH in three barns

		Daily milk yield		Fat (%)		Dry matter		pH	
Classification	N	$X \pm S_x$		$X \pm S_x$		$X \pm S_x$		$X \pm S_x$	
Barn									
I	20	7.6a	0.34	3.5 a	0.09	11.8	0.13	6.7	0.02
II	20	7.7a	0.28	3.4 a	0.09	11.8	0.14	6.7	0.02
III	20	6.9b	0.19	3.7 b	0.09	11.8	0.15	6.7	0.02
Significance		****		*		NS		NS	
Breed									
Holstein friesian	10	7.6	0.35	3.3	0.08	11.4	0.16	6.7	0.02
Brown swiss	10	7.3	0.37	3.8	0.08	12.3	0.17	6.7	0.02
Significance		NS		***		***		NS	
Barn x breed									
Significance		NS		NS		NS		NS	

Means with different letters are statistically different, NS: Non significant *: $p<0.05$ **: $p<0.01$ ****: $p<0.001$

respiration and pulse rates increased to 33.9-64.9 for Holstein Friesian and 29.2-62.4 for Brown Swiss cows. In this research, no difference determined between two breeds for respiration and pulse rates.

Means of daily milk yield, milk fat%, dry matter and milk pH of cows in three barn types and statistical test results are shown in Table 3. Daily milk yield of the cows were 7.6±0.34 kg for I. period and 7.7±0.28 for period II. In open shed barn (III), daily milk yield decreased to 6.9±0.19 kg ($p<0.001$). It is thought that this result was because of:

- A delayed effect of second climatic conditions: Insufficient ventilation of the barn (II) quickly changed respiration and pulse rates of the cows but it had a delayed effect on milk production, even barn II conditions were removed.
- Colder climatic conditions in barn III (open shed): The cows could not adapted new conditions from milk production standpoint; although researchers waited for 7 days before observations.

Shinde and Teneja (1986) stated a negative correlation between milk yield and climatic factors, especially temperature and humidity. Kabuga and Sarpong (1991) declared that variation in daily milk yield; milk fat% of the cows is only affected by environmental temperature. As Smith *et al.* (2006), evaporation in summer did not effect milk composition but daily milk yield. Our findings partially support the researchers above but 'delayed effect' may be detailed with more studies in various environmental conditions.

Milk fat% was not different (3.5 and 3.4%) in first two barn conditions but in third barn (III), it increased significantly (3.7%), ($p<0.01$). There thought to be negative correlation between daily milk yield and milk fat%. Dry matter and pH of the milk samples were not changed by ventilation conditions; opposite to the findings of Frazzi *et al.* (2002).

Although Holstein Friesian cows had little higher mean values, breed effect was not found to be important on daily milk yield statistically. Brown Swiss cows produced more milk fat% (3.8±0.08) than those of Holstein Friesians (3.3±0.08) and the difference was significant statistically. Whereas milk dry matter was found to be significant between breeds (Holstein Friesian: 11.4±0.16, Brown Swiss: 12.3±0.17), ($p<0.01$); but milk pH was similar. Milk yield and components can be affected by various factors, such as breed of the cows (Alpan, 1993). Barn x breed interaction was not significant statistically for measured milk traits. Milk yield and composition of two breeds were similar in all barn types.

CONCLUSION

Present findings showed that insufficient ventilation, especially high CO_2 ratio of inbarn athmosphere stimulated respiration and circulation fuctions of animals and had delayed effect on milk production. When it continues for a long time, for example six months, health and production parameters can be affected severely. It should be the primer step to attach importance to the barn and in-barn conditions in cold climates. Ventilation systems should be planned appropriately. It is also suggested that dairy cows must be prevented from extreme climatic conditions; which may cause adaptation problems observed in this research.

ACKNOWLEDGEMENT

This work was supported by Ataturk University BAP Project Foundation.

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