EFFECTS OF SODIUM BICARBONATE SUPPLEMENTATION ON MILK YIELD AND MILK FAT RATIO OF DAIRY COWS UNDER HIGH TEMPERATURE CONDITIONS

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ABSTRACT

An experiment was conducted to investigate the effects of sodium bicarbonate supplementation on milk yield and milk fat ratio of dairy cows raised under high temperature conditions. 12 Holstein cows divided into 2 groups and fed with regular (control) and sodium bicarbonate supplemented (2 %) diets during the 8-week experimental period. Feed consumption, regular and 4 %-fat corrected milk yields, fat-free dry matter, pH, density of the milk were found to be 17.49±1.10 and 17.15±0.99 kg; 16.70±0.86 and 16.72±0.72 kg; 12.34±0.71 and 13.21±0.64 kg; 10.57±0.50 and 10.98±0.19 %, 6.56±0.33 and 6.63±0.30; 1.018±0.001 and 1.017±0.001 g/ml for the control and bicarbonate groups, respectively; while, body temperatures were 39.25±0.65 and 39.04±0.45 ^{0}C; number of pulse 85.57±7.02 and 77.91±4.70 per m; respiration counts 82.41±8.83 and 80.83±4.06 per m. Thermal humidity index (THI) calculated for July and August were 79 and 78. There were no significant differences between the two groups in terms of the criteria evaluated above (P>0.05). Depending upon the data obtained from the experiment, it could be stated that sodium bicarbonate supplementation of the diets during hot and humid days of Summer in Antalya did not significantly affect their performance and milk composition criteria in Holstein cows.

Key words: Dairy cattle, sodium bicarbonate, milk yield, milk fat.

1. Introduction

In Mediterranean Region high temparature and humidity in July and August increase water intake, respiration rate, CO_2 loss and acidity in rumen; decrease feed consumption, milk yield, VFA, produced in rumen and milk fat ruminal absorbtion

In order to prevent heat stress systems for air conditioners, evoporative coolers, fans, showers and tunnel ventilation. Similarly diets should be changed. NaHCO3 supplementation is one of the applications thought that can prevent the heat stress.

This experiment was conducted to investigate the effects of sodium bicarbonate supplementation on milk yield and milk fat ratio of mild lactating dairy cows raised under high temperature conditions.

2. Materials and Methods

12 Holstein Friesian cows at first lactation were selected and devided into two groups; fed: 50% alfalfa hay + 50 % compound.feed (16 % CP ; 2400 kcal/kg ME). 6 cows received a diet supplemented 2 % $NaHCO_3$ (Table 1).

Table 1. The composition and the nutrient components of compound feed used in the experiment.

Feeds	%
Corn	10
Cracked wheat	12
Barley	20
Wheat bran	18
C.S.M.	5
S.F.M.	10
Corn bran	6
Ground Lentil	6
Poultry meal	2
Ground marble	2
Molasses	8
NaCl	0.9
Min. – vit. Premix.	0.1

Nutrients, %	
Dry matter	89
M. E., kcal/kg	2400
Crude protein	16
Crude fiber	8.81
Ether extract	3.10
Ash	8.65
Ca	1.10
P	0.50

[1] Min. – vit. Premix contains per kg: Vit A 15000000 IU; vit D 3000000 IU, vit. E 30000 mg; Mn 50000 mg; Zn 50000 mg; Fe 50000 mg; Cu 10000 mg; I 800 mg; Co 200 mg; Se 300 mg; Mg 100 mg; Ca 143272 mg.

The experiment starting on July 1st (following 15 d preliminary period) lasted 8 wks. Milk production was measured daily in the morning and evening. DM, fat, density and pH measurements of the milk samples were carried out weekly. During the experimental periots thermal heat index (THI) was calculated depending on temperature and humidity data obtained. Number of respiration and pulsation, rectal body temperature measurements have been realised in each two days. The overall data obtained from the whole experiment have been evaluted with T test (MINITAB).

Table 2. Thermal humidity index (THI) figures calculated at different temperatures and humidity ratios [1,2]

Temp.	**Humidity , %**																				
^{O}C	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	
	Thermal humidity index (THI)																				
21.1	64	64	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	70	70	
21.6	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	70	70	70	71	71	
22.2	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71	***72***	***72***	Starting heat stress
22.7	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	***72***	***72***	73	73	
23.3	66	66	67	67	67	68	68	69	69	70	70	70	71	71	***72***	***72***	*73*	73	74	74	
23.8	67	67	67	68	68	68	69	69	70	70	71	71	***72***	***72***	73	73	74	74	75	75	
24.4	67	67	68	68	69	69	70	70	71	71	***72***	***72***	73	73	74	74	75	75	76	76	
25	67	68	68	69	69	70	70	71	71	***72***	72	73	73	74	74	75	75	76	76	***77***	Sudden falls in production
25.5	68	68	69	69	70	70	71	71	***72***	73	73	74	74	75	75	76	76	***77***	***77***	78	
26.1	68	69	69	70	70	71	71	***72***	73	73	74	74	75	76	76	***77***	***77***	78	78	79	
26.6	69	69	70	70	71	***72***	***72***	73	73	74	75	75	76	76	***77***	78	78	79	79	80	
27.2	69	70	70	71	***72***	72	73	73	74	75	75	76	***77***	***77***	78	78	79	80	80	81	
27.7	69	70	71	71	***72***	73	73	74	75	75	76	***77***	77	78	79	79	80	81	81	82	
28.3	70	71	71	***72***	73	73	74	75	75	76	***77***	78	78	79	80	80	81	82	82	83	
28.8	70	71	***72***	73	73	74	75	75	76	***77***	78	78	79	80	80	81	82	83	83	84	
29.4	71	***72***	72	73	74	75	75	76	***77***	78	78	79	80	81	81	82	83	84	84	85	
30	71	***72***	73	74	74	75	76	***77***	78	78	79	80	81	81	82	83	84	84	85	86	Treshold area
30.5	***72***	73	73	74	75	76	***77***	77	78	79	80	81	81	82	83	84	85	85	86	87	
31.1	***72***	73	74	75	76	76	***77***	78	79	80	81	81	82	83	84	85	86	86	87	88	
31.6	73	74	75	75	76	***77***	78	79	80	80	81	82	83	84	85	86	86	87	88	89	
32.2	73	74	75	76	***77***	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90	
32.7	74	75	76	76	***77***	78	79	80	81	82	83	84	85	86	86	87	88	89	90	91	
33.3	74	75	76	***77***	78	79	80	81	82	83	84	85	85	86	87	88	89	90	91	92	
33.8	75	76	***77***	78	79	80	80	81	82	83	84	85	86	87	88	89	90	91	92	93	
34.4	75	76	***77***	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	
35	76	***77***	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	
35.5	76	***77***	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94	95	96	
36.1	***77***	78	79	80	81	82	83	84	85	86	87	88	89	91	92	93	94	95	96	97	
36.6	***77***	78	79	80	82	83	84	85	86	87	88	89	90	91	93	94	95	96	97	98	
37.2	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	96	97	98	99	
37.7	78	79	80	82	83	84	85	86	87	88	90	91	92	93	94	95	97	98	99	100	

[1]THI = Dry bulb thermometer (^{O}C) + 0.36 (dew point temperature, ^{O}C) + 41.2

[2] (West, 1995)

3. Results

3.1. Thermal humidity index (THI)

Table 3. Thermal humidity index (THI) data calculated from the experiment

JULY									
Weeks	**Day**			**Night**			**Whole day**		
	Temp., ^{0}C	Hum., %	THI	Temp., ^{0}C	Hum., %	THI	Temp., ^{0}C	Hum., %	THI
1	30.4	61.2	81	24.2	75.4	74	27.3	68.3	77
2	30.1	**67.9**	81	25.0	**85.1**	75	27.5	**76.3**	79
3	**33.4**	56.8	**84**	**26.4**	79.9	**77**	**29.9**	68.3	**81**
4	30.9	57.8	81	25.3	79.8	75	28.1	68.8	79
Average	31.2	60.9	81.7	25.2	80.0	75.2	28.2	70.4	79
AUGUST									
Weeks	**Day**			**Night**			**Whole day**		
	Temp., ^{0}C	Hum., %	THI	Temp., ^{0}C	Hum., %	THI	Temp., ^{0}C	Hum., %	THI
1	32.3	52.9	**81**	24.5	**88.2**	75	28.4	70.5	79
2	31.1	58.3	**81**	**26.8**	83.5	**78**	**28.9**	70.9	**80**
3	28.9	**68.7**	80	24.5	84.4	75	26.7	**76.5**	77
4	**31.4**	44.1	79	23.2	74.4	72	27.3	59.2	76
Average	30.9	56	80.2	24.7	82.6	75	27.8	69.2	78

THI data indicated animals were under heat stress during the whole experiment.

3.2. Feed intake

Table 4. Avarege feed intakes, kg/day.

Weeks	Control	$NaHCO_3$
Starting	15.17±0.98	15.05±1.11
1	15.21±1.08	15.01±0.61
2	18.30±2.57	17.51±3.00
3	17.36±1.38	16.86±1.46
4	17.33±0.91	16.96±1.21
5	17.51±0.70	17.48±1.29
6	17.76±1.01	17.36±1.74
7	18.13±1.46	17.58±1.31
8	18.96±1.34	18.50±0.70
0-8	17.49±1.10	17.15±0.99

There were no significant differences between the groups in terms of average daily feed intakes ($P>0.05$).

3.3. Milk Yield

Table 5. Milk yield data obtained from the experiment, kg/day/cow

Normal		
Weeks	**Control**	**$NaHCO_3$**
Starting	16.91±2.93	17.13±2.92
1	16.88±2.44	17.10±1.25
2	16.26±2.44	16.71±2.76
3	18.66±1.65	17.96±2.61
4	15.96±2.43	17.08±2.78
5	16.98±2.85	16.65±1.70
6	16.81±2.23	16.40±1.38
7	15.90±2.51	15.36±1.48
8	15.95±1.96	16.16±0.99
0-8	16.70±0.86	16.72±0.72
4 % fat corrected		
Starting	11.99±2.33	12.21±1.36
1	11.96±1.96	12.20±0.70
2	11.51±2.23	13.27±2.29
3	12.64±1.29	13.85±2.34
4	11.46±2.15	13.08±1.89
5	12.07±1.61	13.65±1.27
6	13.46±2.98	13.87±1.94
7	12.99±2.57	13.08±1.38
8	13.03±1.92	13.68±0.86
0-8	12.34±0.71	13.21±0.64

There were no significant differences between the groups in milk yield data ($P>0.05$).

3. 4. Milk Fat

Table 6. Average milk fat ratios, %.

Weeks	**Control**	**$NaHCO_3$**
1	2.05±0.22	2.10±0.26
2	2.03±0.33 a	2.63±0.36 b
3	2.02±0.23	2.48±0.52
4	2.06±0.21	2.46±0.41
5	2.23±0.42	2.83±0.63
6	2.66±0.91	2.96±0.53
7	2.76±0.56	2.98±0.29
8	2.78±0.54	2.98±0.29
0-8	2.32±0.34	2.67±0.31

[a-b] Figures on the same row with different letters are significantly different ($P<0.05$).

$NaHCO_3$ supplementation did not affect milk fat levels except the second week significantly.

3. 5. Dry matter, pH, density

Table 7. Fat free dry matter levels in the milk, %.

Weeks	Control	$NaHCO_3$
1	10.67±0.65	10.75±0.45
2	10.17±0.26	10.68±0.04
3	9.83±0.42	10.94±1.15
4	10.89±0.73	11.17±0.79
5	9.99±0.55	10.90±1.21
6	10.89±0.73	11.17±0.79
7	10.92±0.72	11.07±0.45
8	11.22±0.85	11.18±0.79
0-8	10.57±0.50	10.98±0.19

Table 8. Average pH values of the milk.

Weeks	Control	$NaHCO_3$
1	6.91±0.29	7.07±0.13
2	6.97±0.17	7.01±0.19
3	6.03±0.18	6.40±0.03
4	6.41±0.38	6.46±0.35
5	6.42±0.13	6.47±0.10
6	6.88±0.40	6.86±0.10
7	6.27±0.10	6.27±0.04
8	6.64±0.17	6.55±0.13
0-8	6.56±0.33	6.63±0.30

Table 9. Average density of the milk, g/ml.

Weeks	Control	$NaHCO_3$
1	1.018±0.0010	1.020±0.0014
2	1.017±0.0010	1.017±0.0005
3	1.017±0.0004	1.016±0.0005
4	1.018±0.0017	1.018±0.0021
5	1.018±0.0015	1.017±0.0015
6	1.019±0.0005 a	1.017±0.0010 b
7	1.020±0.0005 a	1.019±0.0007 b
8	1.019±0.0009	1.019±0.0008
0-8	1.018±0.001	1.017±0.001

[a-b] Figures on the same row with different letters are significantly different ($P<0.05$).

No significant differences were found between the groups due to $NaHCO_3$ supplementation in fat free dry matter contents and acidity of the milk produced during the whole experiment. However $NaHCO_3$ decreased the density significantly ($P<0.05$) only during second and sixth weeks.

3. 6. Body temperature, pulsation and respiration counts

Table 10. Average body temperatures of animals, ^{o}C.

Weeks	Control	$NaHCO_3$
1	40.03±0.30	39.78±0.47
2	39.48±0.47 a	38.70±0.39 b
3	39.83±0.25 a	39.18±0.48 b
4	39.63±0.59	39.46±0.44
5	39.20±0.17	39.11±0.30
6	39.01±0.19	39.10±0.25
7	37.98±0.51	38.40±0.43
8	38.85±0.71	38.61±0.63
0-8	39.25±0.65	39.04±0.45

[a-b] Figures on the same row with different letters are significantly different (P<0.05).

Table 11. Average pulsation rates of animals, counts/m.

Weeks	Control	$NaHCO_3$
1	91.33±4.67	82.00±9.03
2	88.33±5.71 a	80.66±6.89 b
3	90.66±4.13	81.33±5.46
4	76.66±5.88	76.67±4.67
5	76.66±4.67	71.33±3.93
6	85.33±4.13	83.33±5.88
7	75.00±5.02	71.33±4.13
8	76.66±3.72	76.68±4.67
0-8	82.57±7.02	77.91±4.70

[a-b] Figures on the same row with different letters are significantly different (P<0.05).

Table 12. Average respiration rates of animals,, counts/m.

Weeks	Control	$NaHCO_3$
1	86.00±3.34	82.66±7.86
2	86.00±6.89	83.00±10.71
3	89.66±5.84	85.33±8.26
4	82.67±10.01	80.00±10.12
5	77.33±4.84	76.00±13.86
6	82.33±5.98	86.00±7.48
7	78.00±9.71	78.33±7.84
8	77.33±7.86	75.33±5.31
0-8	82.41±4.62	80.83±4.06

There were no significant differences in respiration counts in any week of the experiment; however differences in body temperatures and pulsation rates were significantly diğfferent in second and third weeks and second week, respectively.

3. 7. Body weight and the body weight gains

Table 13. Average body weight (BW) and weight gain (WG) data, kg.

	Control	$NaHCO_3$
Starting BW	382.17±41.81	398.50±33.64
Finishing BW	437.17±37.80	442.17±29.44
WG	55.00±17.24	43.67±14.33

No significant differences were observed between the groups in terms of both body weight and body weight gains.

4. Conclusions

- NaHCO3 supplementation did not almost any effect on all criteria evaluated.
- Cows fairly adapted to hot and humid days of summer.
- They did not reflect the heat stress suffered to production.
- NaHCO3 supplementation is not necessary for dairy cows if daily production does not exceed 20-25 kg.

5. References

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