CHAPTER IV

RESULTS

Temperature, relative humidity, temperature humidity index and physiological change

Mean environmental temperature, relative humidity (RH) and THI during the experimental periods are presented in Table 2. Temperature in EVAP was lower than temperature in NEVAP. Minimum, maximum and average temperature in EVAP and NEVAP were 22.2, 29.1 25.4 and 23.6, 35.8 and 28.5 °C, respectively. The difference of ambient temperature between EVAP and NEVAP was only 3 °C. Mean ambient temperature between 0700 to 1900 h in EVAP and NEVAP are shown in Table 3. Ambient temperature in EVAP was lowest (23.9°C) at 0700 h and highest (26.8°C) at 1500 h. During the day, ambient temperature in NEVAP was higher than 24°C, the level which has been suggested to be the critical temperature for dairy cattle. There was a big difference in mean relative humidity between EVAP and NEVAP. Relative humidity in EVAP was 86 % compare to 70 % in NEVAP. However, when average THI was calculated both housing had similar THI (77 vs 81). Mean RH and THI during the day are shown in Table 4, 5 and Figure 3, 4. RH and THI in EVAP during the day was consistent. While in NEVAP, the relative humidity was high in the morning, getting lower when the ambient temperature increased. On the other hand, THI started to increase when the ambient temperature increased. The effects of housing system EVAP and NEVAP on THI, RR and RT during 0700 to 1900 h are shown in Figure 5 and 6. Mean of RR (breath/min) and RT (^{O} C) between 0700 to 1900 h in EVAP and NEVAP are shown in Table 6 and 7. During 0700 to 1900 h RR and RT of cows in EVAP were significantly higher than in NEVAP. RR were significantly different at 1500 h ($P<0.01$) and 1700 h ($P<0.03$). RT were significantly different at 1100 h ($P<0.01$), 1300 h ($P<0.01$) and 1500 h ($P<0.01$), 1700 h ($P<0.01$) and 1900 h ($P<0.05$).

Table 2. Mean environmental conditions (maximum, minimum and average - temperature), mean relative humidity and mean temperature humidity index during the experimental periods

Item	EVAP	NEVAP
[1]Maximum temperature (°C)	29.1 ± 1.3	35.8 ± 1.4
	(27.1 - 31.7 °C)	(33.5 - 38.4 °C)
[1]Minimum temperature (°C)	22.2 ± 2.9	23.6 ± 2.4
	(16.1 - 25 .0 °C)	(31.0 - 29.0 °C)
[1]Average temperature (°C)	25.4 ± 1.8	28.5 ± 1.5
[2]Average temperature (°C) (0700 am – 1900 pm)	25.7 ± 0.9	30.0 ± 3.3
[2]Mean relative humidity (%) (0700 am – 1900 pm)	86 ± 2.2	7 0 ± 10.1
Mean temperature humidity Index (0700 am – 1900 pm)	77 ± 1.3	81 ± 3.6

[1] recorded by digital thermometer.

[2] recorded by dry bulb and wet bulb thermometer.

Table 3. Temperature (°C) between 0700 t0 1900 h in EVAP and NEVAP (mean ± SD)

Time	EVAP	NEVAP
0700	23.9 ± 2.5	24.3 ± 2.4
0900	25.2 ± 1.6	28.5 ± 2.9
1100	25.9 ± 1.2	32.1 ± 1.6
1300	26.1 ± 1.3	33.6 ± 1.3
1500	26.8 ± 1.1	33.1 ± 1.6
1700	25.6 ± 1.5	30.5 ± 1.6
1900	25.9 ± 1.6	29.0 ± 1.3
Average	25.7 ± 0.9	30.0 ± 3.3

Table 4. Relative humidity (%) between 0700 t0 1900 h in EVAP and NEVAP (mean ± SD)

Time	EVAP	NEVAP
0700	90 ± 2.4	89 ± 3.1
0900	86 ± 5.5	70 ± 9.7
1100	84 ± 6.4	62 ± 7.3
1300	85 ± 7.3	61 ± 5.9
1500	83 ± 8.1	62 ± 8.3
1700	86 ± 7.1	66 ± 9.0
1900	85 ± 5.5	76 ± 6.8
Average	86 ± 2.1	69 ± 10.2

Table 5. Temperature humidity index (THI) between 0700 t0 1900 h in EVAP and NEVAP (mean ± SD)

Time	EVAP	NEVAP
0700	74	74
0900	76	79
1100	76	83
1300	77	85
1500	78	84
1700	77	81
1900	77	79
Average	77	81

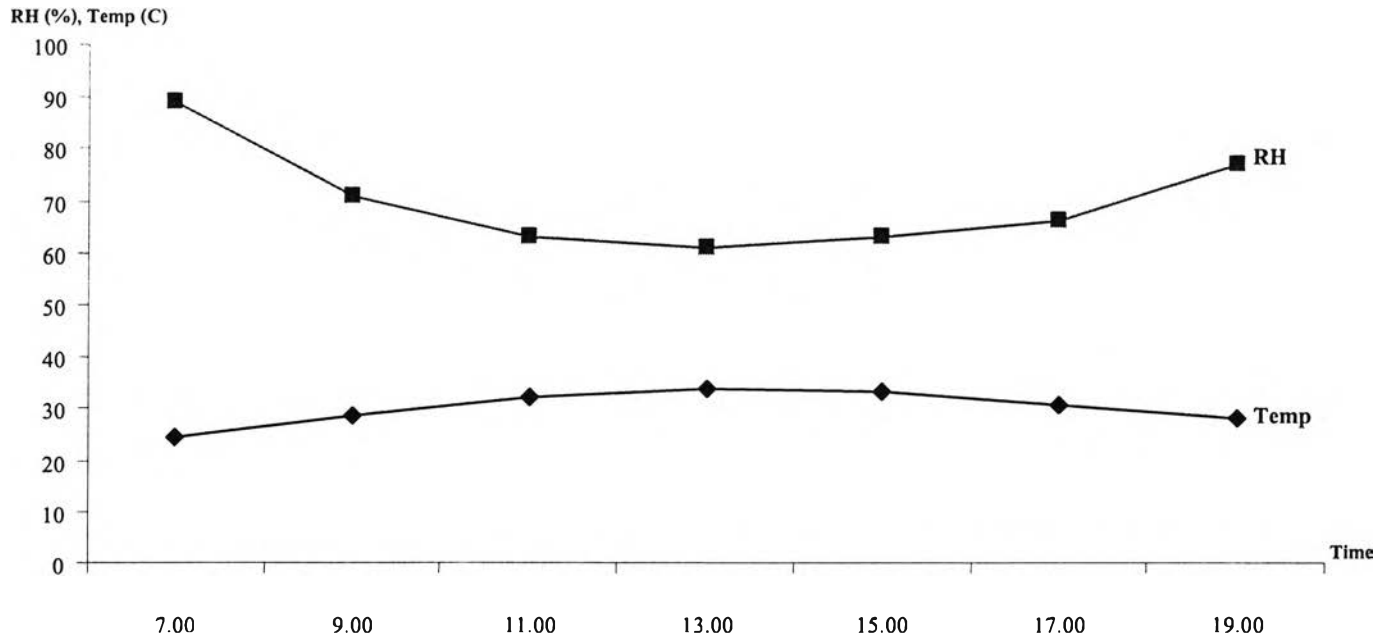

Figure 3. Temperature and relative humidity of NEVAP between 0700 to1900 h

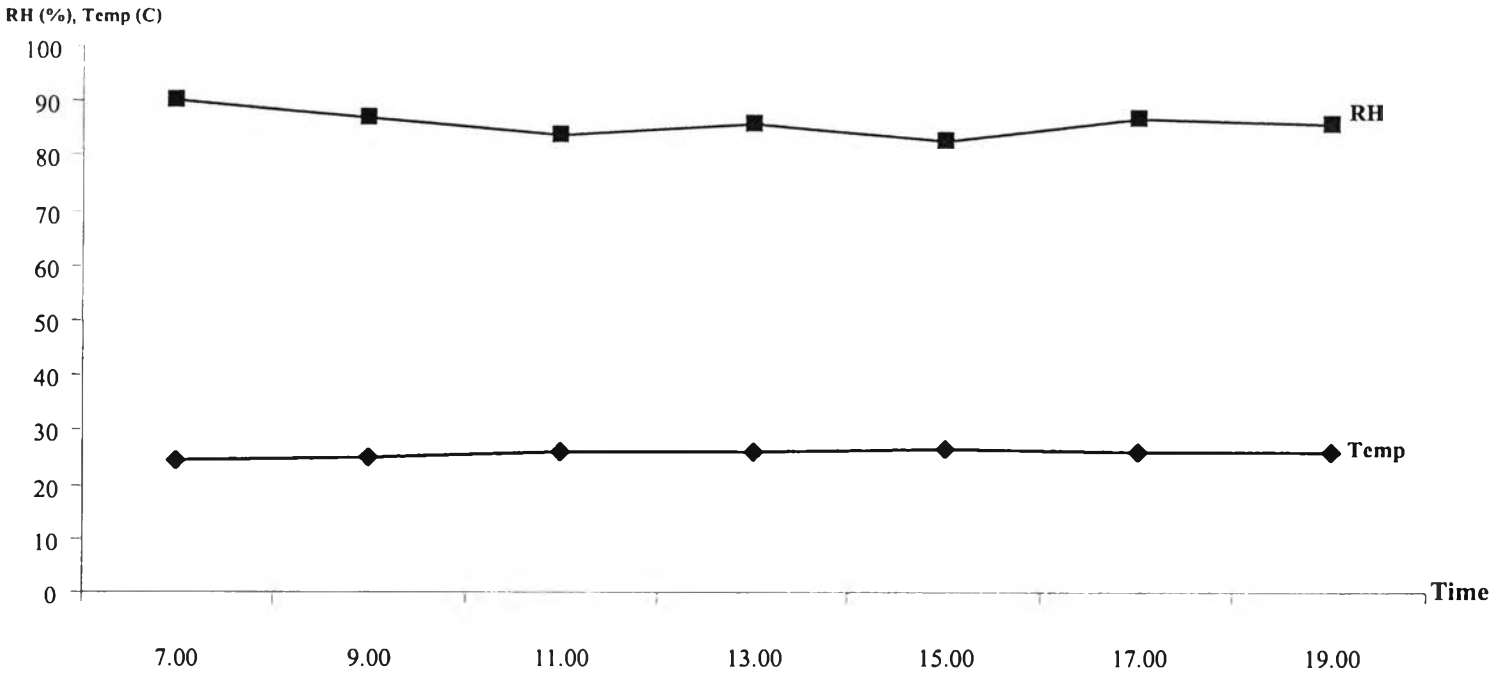

Figure 4. Temperature and relative humidity of EVAP between 0700 to1900 h

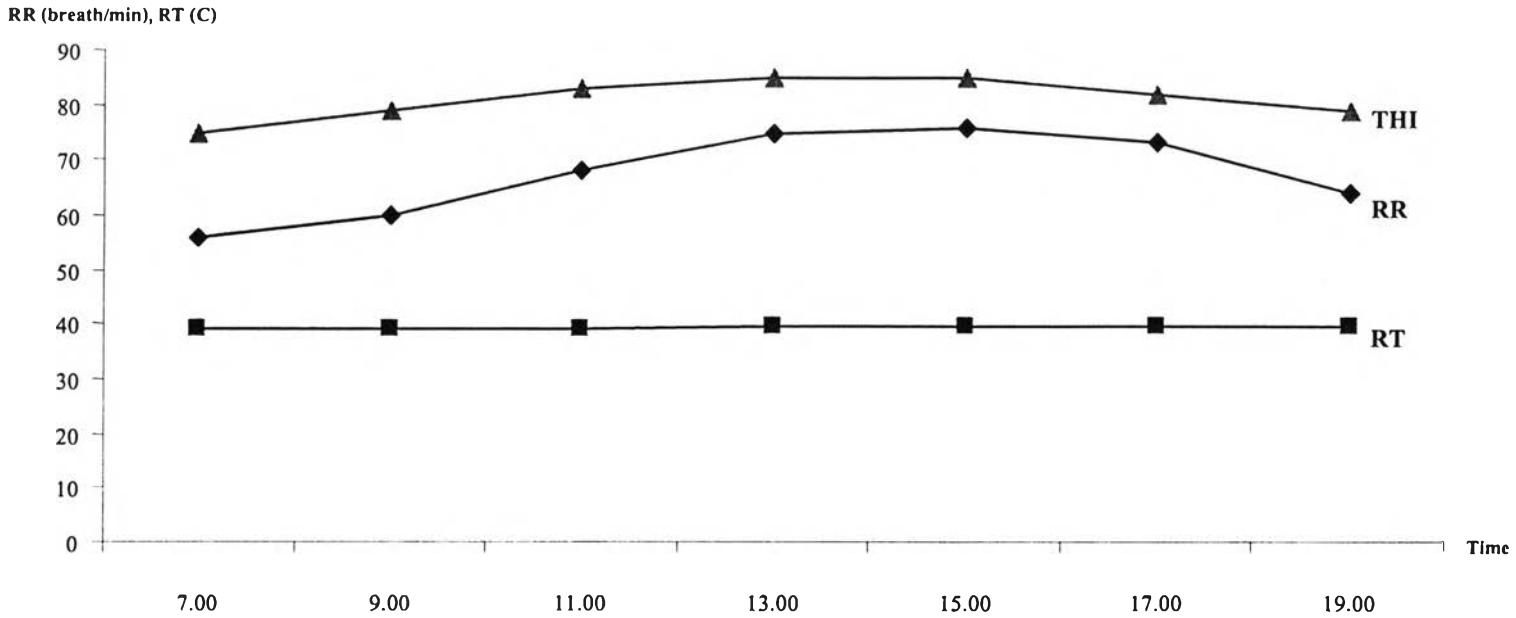

Figure 5. Temperature humidity index, respiratory rate and rectal temperature of dairy in NEVAP between 0700 to 1900 h

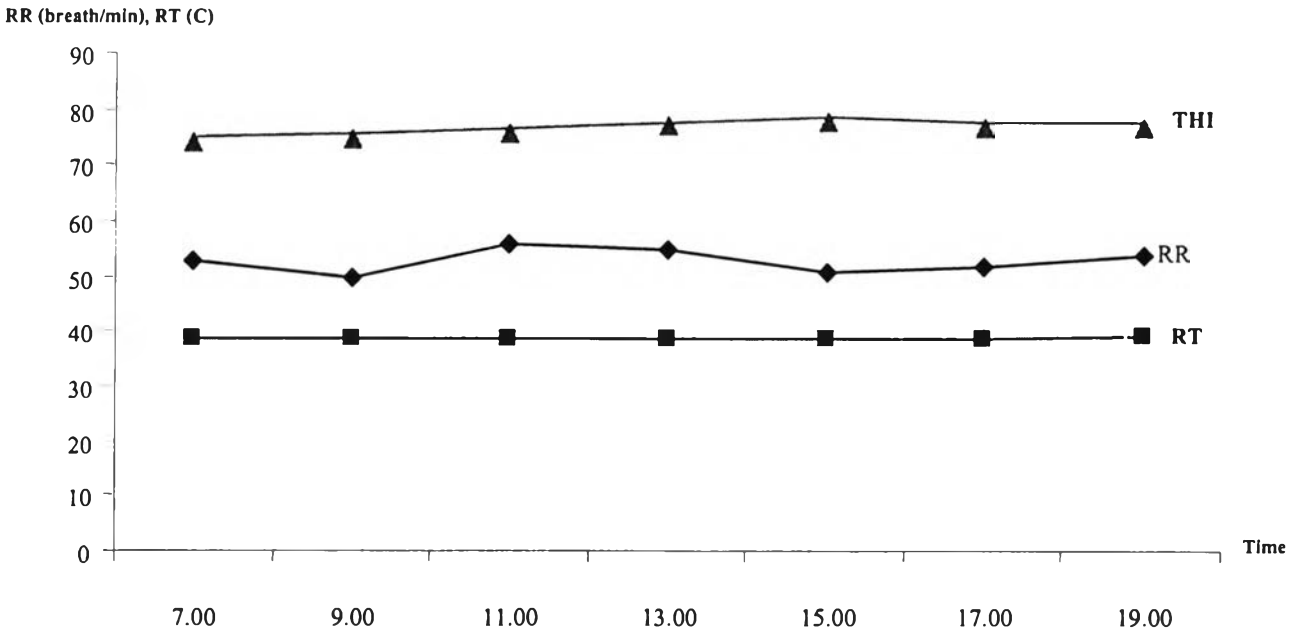

Figure 6. Temperature humidity index, respiratory rate and rectal temperature of dairy in EVAP between 0700 to 1900 h

Table 6. Respiration rate (breath/min) between 0700 t0 1900 in EVAP and NEVAP (mean ± SD)

Time	EVAP	NEVAP	P-value*
0700	53 ± 18.8	56 ± 15.5	NS**
0900	50 ± 15.9	60 ± 16.8	NS
1100	56 ± 17.5	68 ± 16.0	NS
1300	55 ± 21.2	75 ± 18.2	NS
1500	51 ± 15.1	76 ± 18.1	0.01
1700	52 ± 15.1	73 ± 19.6	0.01
1900	54 ± 17.9	64 ± 19.6	NS
Average	53 ± 2.1	67 ± 7.7	0.01

* P value by unpaired t-test between EVAP and NEVAP.

** NS = not significant.

Table 7. Rectal temperature (°C) between 0700 t0 1900 in EVAP and NEVAP (mean ± SD)

Time	EVAP	NEVAP	P-value*
0700	38.6 ± 0.6	38.9 ± 0.7	NS**
0900	38.7 ± 0.6	39.1 ± 0.7	NS
1100	38.7 ± 0.5	39.2 ± 0.6	0.01
1300	38.7 ± 0.5	39.6 ± 0.6	0.01
1500	38.7 ± 0.5	39.6 ± 0.7	0.01
1700	38.8 ± 0.5	39.7 ± 0.7	0.01
1900	38.9 ± 0.5	39.5 ± 0.8	0.05
Average	38.7 ± 0.1	39.4 ± 0.3	0.01

* P value by unpaired t-test between EVAP and NEVAP.

** NS = not significant.

Dry matter intake, milk yield, feed utilization and productive performance

Feed ingredient analysis of the experimental period is shown in Table 8. The DMI, milk yield (MY) and productive performance of cross-bred Frisian are shown in Table 9. No significant difference was found on body weight during experimental period. DMI of animal in EVAP was significant higher ($P<0.05$) than NEVAP. DMI in EVAP was 10.45 kg/d compared to 8.35 kg/d in NEVAP. NDF intake in EVAP was significant difference ($P<0.03$) when compared with NEVAP. The total daily dry matter intake as percent body weight (DMI/%BW) was significant different when compared between EVAP and NEVAP ($P<0.05$). Animals in EVAP consumed 22.7% more feed than animals. Cows in EVAP produced significantly more milk than cows in NEVAP ($P<0.01$). Milk yield of cows in EVAP and NEVAP were 16.9 kg/d and 12.6 kg/d respectively. 4% FCM was significant higher in EVAP when compared with NEVAP ($P<0.01$). Cows in EVAP had amount of 4% FCM higher than cows in NEVAP ($P<0.01$). DMI/4%FCM of cows in EVAP and NEVAP were 0.70 and 0.77, respectively, in which no difference was found. It was found that animals in EVAP drank 54.7 liters of water per day compared to 93.6 liters in NEVAP which was highly significant ($P<0.01$). Water intake per DMI in NEVAP was significant difference when compared to EVAP ($P<0.01$). Cows in NEVAP consume 6.1 liter of water/kg DMI more than cows in EVAP. Milk compositions are shown in table 10. No significant differences in milk compositions between EVAP and NEVAP were found. Cows in EVAP tended to produce milk compositions which were higher in fat, protein and total solid than cows in NEVAP.

Table 8. Feed ingredient analysis (% dry matter basis)

Nutrients	%
Moisture	49.2
Crude protein	14.7
Neutral detergent fiber	32.7
Acid detergent fiber	21.1

Table 9. Dry matter intake, milk yield and productive performance of cross-bred Friesian heifers in evaporative and non-evaporative cooling system

Treatment	EVAP*	NEVAP*	P-value**
BW, kg	393.1 ± 12.55	367.6 ± 13.93	NS***
DMI, kg/d	10.5 ± 2.49	8.4 ± 2.18	0.05
DMI / %BW	2.8 ± 0.33	2.3 ± 0.25	0.05
NDF intake, kg/d	3.42 ± 0.84	2.72 ± 0.49	0.03
MY, kg/d	16.9 ± 2.84	12.6 ± 2.54	0.01
4% FCM, kg/d	15.4 ± 3.97	11.1 ± 2.29	0.01
DMI / 4% FCM	0.70 ± 0.18	0.77 ± 0.16	NS
[1]Water intake, l/d	54.4 ± 15.78	93.6 ± 35.77	0.01
[1]Water intake/DMI, l/kg	4.5 ± 1.15	10.6 ± 3.43	0.01

*Values are means ± SD (n = 20) [1] Values are means ± SD (n = 14)

** P value by unpaired t-test between EVAP and NEVAP *** NS = not significant

Table 10. Milk compositions of cross-bred Friesian heifers in evaporative and non-evaporative cooling system

Milk composition (%)	EVAP*	NEVAP*	P-value**
Fat	3.49 ± 0.7	3.26 ± 0.7	NS***
Protein	3.26 ± 0.2	3.08 ± 0.2	NS
Lactose	5.00 ± 0.1	4.97 ± 0.1	NS
SNF	8.97 ± 0.2	8.74 ± 0.2	NS
Total solid	12.46 ± 0.8	12.01 ± 0.7	NS

* Values are means ± SD (n = 20)

** P value by unpaired t-test between EVAP and NEVAP

*** NS = no significant

Milk allantoin concentration

The effect of EVAP and NEVAP on milk allantoin concentration, which reflected the ruminal microbial activity are shown in Table 11. During the experimental period, there were no significant differences in milk allantoin concentration during am. and pm. collection (P>0.05). There was also no difference in the milk allantoin concentration between EVAP and NEVAP. Milk allantoin from animals in EVAP high concentration compared in NEVAP (58.8 vs 55.0 mg/kg of milk).

Table 11. Milk allantoin concentration of cross-bred Friesian heifers in EVAP and NEVAP.

Concentration (mg/kg)	EVAP*	NEVAP*	P-value**
Morning	58.5 ± 15.3	53.5 ± 6.9	NS***
Afternoon	59.2 ± 14.7	56.9 ± 12.3	NS
Average	58.8 ± 13.4	54.9 ± 7.3	NS

* Values are means ± SD (n = 16)

** P-value by unpaired t-test between EVAP and NEVAP

*** NS = not significant

Volatile fatty acid concentrations.

The ruminal volatile fatty acid (VFA) compositions, the total concentration of VFA and the ratio of acetate to propionate in EVAP and NEVAP during the experimental period are presented in Table 12. The concentrations of individual VFA (acetate, propionate, butyrate and valerate) from both groups of animals were similar. The total concentration of VFA, the ratio of acetate to propionate and ruminal fluid, pH were slightly higher in EVAP but no significant difference was found (P>0.05).

Table 12. The ruminal volatile fatty acids compositions, the total concentration and the ratio of acetate to propionate of cross-bred Friesian heifers EVAP and NEVAP

Treatment	EVAP*	NEVAP*	P-value**
VFA (mmol/ml)			
acetate (C_2)	119.2 ± 28.7	107.7 ± 39.6	NS***
propionate (C_3)	42.7 ± 15.1	43.8 ± 13.7	NS
butyrate (C_4)	19.0 ± 4.4	19.8 ± 6.1	NS
valerate (C_5)	2.04 ± 1.6	1.46 ± 0.9	NS
Total VFA	179.5 ± 39.2	158.5 ± 73.7	NS
$C_2 : C_3$	2.94 ± 0.8	2.54 ± 0.7	NS
pH	7.04 ± 0.3	6.81 ± 0.4	NS

* Values are means ± SD (n = 18)

** P value by unpaired t-test between EVAP and NEVAP

*** NS = no significant.

The total tract digestibility of the nutrients

The digestibility of DM, NDF and ADF are shown in Table 13. The digestibility of DM, NDF and ADF were slightly higher in EVAP group as compared to NEVAP but no significant difference was found (P>0.05). Cows in EVAP had better DM, NDF and ADF digestibility than cows in NEVAP at the rate of 5.1 percent. In addition, rumen passage rate were not significant different between groups.

Table 13. Total tract digestibility of the nutrients by cross-bred Friesian heifers in EVAP and NEVAP

Treatment	EVAP*	NEVAP*	P-value**
Nutrient digestion (%)			
DM	77.5 ± 3.0	74.9 ± 2.5	NS***
NDF	66.2 ± 6.7	61.1 ± 8.8	NS
ADF	60.4 ± 6.7	56.3 ± 7.6	NS
Rumen passage rate (%/h)	4.26 ± 0.9	4.23 ± 1.2	NS

* Values are means ± SD (n = 18)

** P value by unpaired t-test between EVAP and NEVAP

*** NS = no significant

Animal behavior

The behavior activities of cows in EVAP and NEVAP during experimental period are reported in Table 14. There were no differences in eating and ruminating times. However, cows in EVAP tended to spent more time on eating and ruminating about 35 and 94 minutes, respectively. Cows in EVAP spent time on chewing activities significantly higher ($P<0.02$) than cows in NEVAP, as a result the cows in EVAP spent less time for resting ($P<0.05$). No significant difference was found on NDF intake and DMI per ruminating time.

Table 14. Behavior of cross-bred Friesian heifers in EVAP and NEVAP

Dependent variable	EVAP*	NEVAP*	P-value**
Eating time, min/d	227.1 ± 23.9	192.4 ± 21.6	NS***
Ruminating time, min/d	349.5 ± 18.1	255.9 ± 47.5	NS
Total chewing, min/d	576.7 ± 14.8	448.0 ± 44.3	0.02
Resting time, min/d	863.3 ± 14.7	981.7 ± 46.4	0.05
NDF intake/ruminating time, g/min	12.80 ± 4.5	13.27 ± 5.4	NS
DMI/ruminating time, g/min	27.99 ± 8.5	28.62 ± 12.1	NS

* Values are means ± SD (n = 12)

** P value by unpaired t-test between EVAP and NEVAP

*** NS = no significant