

The effect of some seasonal conditions on oestrus occurrence in cows

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Abstract

In this study, the effect of climatic conditions on oestrus occurrence was investigated by using 9 972 oestrus records of cows recorded between 1995 and 2003. A distinct seasonal variation in the oestrus occurrence was determined. Oestrus occurrence observed in January, March, November and December was less than that in June and September ($P < 0.05$). Annual distribution of the oestrus occurrence was positively correlated with environment temperature and insulation duration, but it was negatively correlated with rainfall ($P < 0.01$). However, there was no relationship between oestrus occurrence and relative humidity. In addition to these, there was a slight decrease in the oestrus response when the temperature-humidity index (THI) was above 72; nevertheless, this decrease was not significant ($P > 0.05$). The data presented in this study demonstrated that the increase in the environmental temperature up to 23 °C did not cause a suppressive effect on the ovarian activity. In conclusion, annual distribution of the oestrus occurrence is positively correlated with environment temperature and insulation duration whereas it is negatively correlated with rainfall in Holstein cows, in this study.

Keywords: cattle, climatic conditions, oestrus response

Zusammenfassung

Einfluss der Jahreszeiten auf die Brunst bei Kühen

An Hand von 9 927 Östrusdaten von Holsteinkühen aus den Jahren 1995 bis 2003 wurde der jahreszeitliche klimatische Einfluss auf das Brunstgeschehen bei Kühen untersucht. Grund war die Beobachtung einer saisonalen Veränderung des Östrusauftritts. So wurde ein geringeres Brunstauftreten in den Monaten Januar, März, November und Dezember gegenüber den Monaten Juni und September beobachtet. Die Datenanalyse ergab, dass signifikant das jahreszeitliche Östrusauftreten positiv mit der Umgebungstemperatur und der Sonnenscheindauer aber negativ mit der Niederschlagsmenge korreliert war. Keine Zusammenhänge fanden sich zwischen der relativen Luftfeuchtigkeit und dem Östrusgeschehen. Tendenziell wurde eine geringe Abnahme der Östren nachgewiesen, wenn der Wert des Temperatur-Feuchtigkeits-Indexes (THI) über 72 lag. Die Ergebnisse dieser Studie zeigen, dass Umgebungstemperaturen bis zu 23 °C die Ovarienaktivität nicht negativ beeinflussen. Zusammenfassend wird geschlussfolgert, dass bei dem vorliegenden Tiermaterial ein jahreszeitliches Östrusverhalten positiv mit

der Umwelttemperatur sowie der Sonnenscheindauer, jedoch negativ mit der Niederschlagsmenge korreliert ist.

Schlüsselwörter: Kuh, Jahreszeit, Brunst

Introduction

Cows are polyoestric and have cyclic activity throughout the year. However, seasonal variations are effective on cyclic activity as well as on reproduction in cows and heifers (MCNATTY *et al.* 1984, PENNINGTON *et al.* 1985, BORELL 2000, WHITE *et al.* 2002). Environment temperature has an important role on reproductive performance (WILLARD *et al.* 2003). High environment temperature and relative humidity influence endocrine activity and reduce reproductive efficiency (RYAN *et al.* 1992, GREVE *et al.* 1996, DEMİRCİ 2002, DERENSIS *et al.* 2002, SARTORI *et al.* 2002, SÖNMEZ *et al.* 2005).

The detrimental effects of heat stress are the suppressed intensity of oestrus, a reduced magnitude of the preovulatory luteinizing hormone (LH) surge, decreased secretion of luteal progesterone, altered ovarian follicular development, decreased embryo development and lower fertility (KANITZ *et al.* 2001, AL-KATANANI *et al.* 2002, MANTEUFFEL 2002, WILLARD *et al.* 2003). Negative energy balance due to heat stress leads to reduced LH secretion and anovulation in dairy cows. Therefore, low oestradiol secretion from the dominant follicle (DOBSON and SMITH 2000) causes poor expression of oestrus with a reduction of oestrus detection rate and fertility (DE LA SOTA *et al.* 1998). Hyperthermia caused by heat stress decreases conception rate by increasing embryonic mortality (DE LA SOTA *et al.* 1998). Progesterone levels in luteal phase of oestrus in winter are higher than those in summer (ALNIMER *et al.* 2002). Motor activity and other signs of oestrus are reduced and the incidence of anoestrus and silent ovulation are increased by heat stress in summer (HANSEN and ARÉCHIGA 1999, DE RENSIS and SCARAMUZZI 2003).

One of the most common ways of measuring the severity of heat stress in cattle is the temperature-humidity index (THI) (ARMSTRONG 1994, CARTMILL *et al.* 2001). THI is computed from the environment temperature and relative humidity measurements using a formula described before (ALNIMER *et al.* 2002). It is agreed that a THI value above 72 is stressful to dairy cows (SÖNMEZ *et al.* 2005).

In addition to the environment temperature and relative humidity, reproductive performance is affected by wind and photoperiod (GWAZDAUSKAS 1985, ORIHUELA 2000).

Because of the literature, we hypothesized that there would be correlation between oestrus response and some climatic conditions (environment temperature, relative humidity, insulation duration and rainfall), and the effects of these climatic conditions on oestrus occurrence were evaluated in cows, in this study.

Material and methods

This study was conducted in Şile, Istanbul, Turkey at the location of 41° 14' parallel and 29° 36' longitude. The oestrus records of cows were taken by veterinary surgeons in Şile Country Agriculture Directorate between 1995 and 2003. The records in 2001, 2002 and 2003 were taken by researchers on their own. A total of 9972 oestrus records of

reproductively normal (no purulent discharge during oestrus examination, minimum 50 days *post partum*), lactating Holstein dairy cows and heifers were evaluated cumulatively without splitting into successive years. The animals were housed indoors, milked twice a day, fed with a total mixed ration three times a day to meet the requirements of lactating cows, and had access to fresh water *ad libitum*.

Oestrus response was considered as the ratio of oestrus records in a month to the oestrus records totally in a whole year. All data obtained as years were combined and evaluated monthly in a whole year to realize the average data for months in a year. First, oestrus of each cow was followed by farmers according to the overt signs of oestrus (standing heat, vaginal discharge, red and swollen vulva, restlessness and reduced milk production) by 30 min observations twice a day. Second, these signs were confirmed by a veterinarian by visual observation and rectal palpation (a fluctuant dominant follicle and uterine tonus) in 2-5 h after first oestrus detection. Onset of the observations for oestrus was after *post partum* 45 days (voluntary waiting period). Each cows oestrus data was used only once for a year; that is, if a cows oestrus data was used once, it has not been used for another time in the same year.

Insulation duration (sunny hours of day) was considered as a period of time of daylight in a day. The information on monthly variation in environment temperature, relative humidity, rainfall and insulation duration were obtained from the local meteorological laboratory. The data were measured for three times in a day and the daily and monthly average values were calculated by local meteorological laboratory. Mean THI was calculated using the formula reported by ALNIMER *et al.* (2002):

$$THI = (32 + 1.8 \cdot ^\circ\text{C}) - (0.55 - 0.55 \frac{\text{Relative Humidity}}{100}) \cdot [(32 + 1.8 \cdot ^\circ\text{C}) - 58] \quad (1)$$

Correlation analysis was performed using the SPSS/PC (SPSS Inc., 10.0 for Windows) computer program to investigate the relationship between meteorological parameters and oestrus. The variation analysis method (one way, ANOVA) was used to evaluate seasonal differences for oestrus rate using the MINITAB (Minitab Inc., Release 12.1) computer program.

Results

Data of oestrus response (%), environment temperature ($^\circ\text{C}$), relative humidity (%), THI (units), insulation duration (h) and rainfall (mm) were summarized in Table 1.

An important seasonal variation in the oestrus occurrence was determined. Oestrus response was the lowest in December (5.5%) and the highest in June (10.3%). In summer months, oestrus occurrence was more than those in winter months. Oestrus occurrence in January, March, November and December was less than those in June and September ($P < 0.05$). In addition, oestrus determined in April, May, June, July, August, September and October was more than those in January and December.

Annual distribution of the oestrus occurrence was positively correlated with environment temperature, THI and insulation duration, but negatively correlated with rainfall ($P < 0.01$). THI was higher than 72 in July and August. There was a decrease in the oestrus occurrence with the increase of environment temperature over 20.5°C (July

22.4°C and August 23.1°C) and THI over 72 (July 72.2 and August 73.6). However, this decrease was not statistically significant. Insulation duration was higher in summer whereas rainfall was higher in winter. Annual distribution of oestrus occurrence was not correlated with relative humidity.

Table 1

Annual pattern of oestrus response, THI, environment temperature, relative humidity, insulation duration, and rainfall in Şile

Jahreszeitliches Östrusaufreten in % und Klimadaten sowie Beziehungen zwischen diesen Werten

Month	Oestrus response, %	THI, units	Environment temperature, °C	Relative humidity, %	Insulation duration, h	Rainfall, mm
January	6.4 ^d	42.1	5.6 ± 0.5	84.1 ± 0.8	2.7 ± 0.5	78.9 ± 15.8
February	7.9 ^{bcd}	41.6	5.4 ± 0.6	80.6 ± 1.0	4.0 ± 0.4	79.0 ± 16.9
March	7.5 ^{cd}	44.4	6.9 ± 0.9	79.9 ± 1.7	3.9 ± 0.4	87.8 ± 9.4
April	8.7 ^{abc}	51.2	10.7 ± 0.8	81.3 ± 1.4	6.6 ± 1.3	63.4 ± 9.3
May	9.4 ^{abc}	60.3	15.7 ± 0.3	83.0 ± 1.3	6.3 ± 0.9	22.8 ± 7.5
June	10.3 ^a	68.9	20.5 ± 0.2	81.9 ± 1.2	8.5 ± 0.8	23.3 ± 6.7
July	8.9 ^{abc}	72.2	22.4 ± 1.0	83.4 ± 1.1	7.7 ± 1.1	41.6 ± 14.0
August	9.1 ^{abc}	73.6	23.1 ± 0.3	83.7 ± 1.5	7.3 ± 1.0	93.4 ± 34.9
September	9.8 ^{ab}	65.2	18.5 ± 0.6	83.6 ± 1.3	5.9 ± 0.5	61.0 ± 10.7
October	9.1 ^{abc}	60.1	15.6 ± 0.7	83.3 ± 0.9	4.2 ± 0.3	123.1 ± 28.0
November	7.4 ^{cd}	51.4	10.8 ± 0.5	83.7 ± 0.9	3.2 ± 0.3	86.5 ± 22.7
December	5.5 ^d	45.3	7.4 ± 0.6	82.3 ± 1.0	1.9 ± 0.3	115.1 ± 24.3
Correlation of oestrus response						
p		0.000	0.000	0.868	0.000	0.002
r		0.434	0.433	-0.17	0.392	-0.307

^{a,b,c,d} different letter superscripts denote significant differences within columns ($P < 0.05$) THI: see equation 1, Data for environment temperature, relative humidity, insulation duration, and rainfall reported as means ± S.E.M.

Discussion

Many wild species of Bovidae are seasonal breeders with spring and summer, the most suitable times of the year for calving. During the course of domestication, both dairy and beef cattle were selected against seasonality, facilitating them to ovulate and conceive throughout all the year (JAUNIDEEN and HAFEZ, 1987). However, it is reported that seasonal changes are still affecting reproductive performance in cows and heifers (BADINGA *et al.* 1985).

In this study, a distinct seasonal variation in the oestrus occurrence was determined. Oestrus occurrence in the January, March, November and December when the environment temperatures were between 5.5°C and 7.5°C was less than in June (20.5°C) and September (18.5°C) ($P < 0.05$). Contrary to this, WHITE *et al.* (2002) reported that oestrus expression/detection rate was lower in summer (between August and September) when the environment temperature was around at 27.6°C than that in winter (December-January) when the environment temperature was 5.8°C. The difference in findings may be because of the difference in environment temperature. In this study, the highest environment temperature was 23.1°C in August. HANSEN *et al.* (2001) reported that environment temperature up to 27°C did neither cause hyperthermia nor a negative effect on fertility with the similar findings of the present study. On the other hand, annual distribution of oestrus occurrence was positively correlated with insulation duration in

this study. The results agree with SALISBURY *et al.* (1978) who reported that light has a stimulative effect on reproductive performance in cattle and extra light application in winter nights increased oestrus and conception rate. That is, photoperiod has effects on reproductive performance (ORIHUELA 2000). JAINUDEEN and HAFEZ (1987) reported that, beef cows exposed to longer day light during late gestation and calving in the summer and fall resume ovarian cyclicity earlier than those calving in spring. High rates for oestrus response for summer may be because of day light. In addition to the effect of daylight, low oestrus response rates for winter may be because of pregnancies following artificial inseminations during summer months.

Some researchers reported that high environment temperature influences the endocrine activity and decreases the oestrus expression (LEE 1993, WOLFENSON *et al.* 1997, ROTH *et al.* 2001). In this study oestrus occurrence was positively correlated with environment temperature and the increase in the environment temperature up to 23°C did not cause a suppressive effect on the ovarian activity. The present results are agree with the findings of O'CONNOR (1993) who reported that the increase in the environment temperature of 23.8°C did not cause a suppressive effect on the reproductive performance and oestrus expression. In addition to this, O'CONNOR (1993) emphasized that, environment temperature up to 29.4°C had an adverse effect on the reproductive performance and oestrus expression. Even though there was a decrease in the oestrus occurrence with the increase of environment temperature over 20°C in the present study, it was not statistically significant.

In spite of the positive correlation of oestrus response with environment temperature, there was a decrease in the oestrus response with the increase of THI over 72 in July and August (72.2 and 73.6, respectively). These findings are similar with SÖNMEZ *et al.* (2005) who reported that heat stress reduces reproductive performance of cattle when the THI is higher than 72.

Some researchers (DE RENSIS *et al.* 2002, DE RENSIS and SCARAMUZZI 2003) reported that intensive relative humidity decreases oestrus expression and ovarian activity. In the present study, however, oestrus occurrence was not correlated with the relative humidity.

The present data showed that oestrus response was negatively correlated with rainfall. There is no literature reported about the correlation with rainfall and the annual distribution of oestrus occurrence in cows. In addition, the findings were similar to AKSOY *et al.* (2002), who studied in Anatolian water buffaloes and reported that oestrus occurrence was negatively correlated with rainfall.

In conclusion, there was a seasonal variation in the oestrus occurrence and it was higher in summer than in winter. In addition to this, annual distribution of the oestrus occurrence was positively correlated with environment temperature and insulation duration whereas it was negatively correlated with rainfall in Holstein cows.

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