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EFFECT OF TEMPERATURE-HUMIDITY INDEX, COLD STRESS INDEX AND DRY PERIOD LENGHT ON BIRTH WEIGHT OF JERSEY CALF

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Abstract

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This research was conducted in order to define the effect of temperature-humidity index, cold stress index and length of dry period on birth weight of calves. In this study, pedigree records of 551 Jersey calves in breeding cow pedigree which were born between 2000 and 2004 in Samsun Karakoy Agriculture Enterprise and temperature humidity index together with cold stress index that were calculated by using climatic data obtained from General Directorate of Meteorology were used. These data were classified as three groups for dry period length, temperature-humidity index, cold stress index. They were classified as THI-1(≤70), THI-2 (71-75) and THI-3 (76≤) for temperature-humidity index (THI); CSI-1(≤832), CSI-2 (833-847) and CSI-3 (947≤) for cold-stress index (CSI); DPL-1(≤60), DPL-2 (60-90) and DPL-3 (90≤) for dry period length (DPL). The means of among treatments differences were significant (P<0.001) for seasons. In respect to birth weight among CSI groups differences were significant. Dry period x temperature humidity index interaction were significant on calf birth weight (P<0.05). The highest temperature-humidity index and the shortest dry period length were determined decreasing to calf birth weight. As a result, cold stress index negatively affected on calf birth weight, when dry period of cows coincide with the winter months. Also, calf birth weight was decrease with increasing of temperature-humidity index and short dry period length.

Key words: cattle; ambient temperature; calf birth weight

Introduction

It is stated that production levels in herd are affected by genetic and environmental factors. In addition, animal performance are known to be important for continuity of the herd and the company for livestock enterprises (Akcapinar and Ozbeyaz, 1999). In animal production, calf birth weight takes part in substantial yield properties. Calf birth weight and is one of the important factors for a successful cattle breeding due to its strong relationship with vitality, growth performance, fertility and milk yield. Birth weight that is showing the growth in prenatal period is affected by genetic and environmental factors such as gender, birth type, maternal age, care and feeding at gestation period, dry removal time of mother before birth, temperature, humidity and cold stress (Akçapınar and Ozbeyaz,1999; Avendano-Reyes et al., 2006; Collier et al., 1982; Wolfenson et al., 1988; Akdag et al., 2011).It is reported that, since there is morbidity and mortality risk for calves having low birth weight, high birth weight is necessary for vitality (Nardone et al., 1997).

One of the most prominent problems in production performance of animals is the changes in temperature and ambient temperature. There are studies emphasizing that heat stress is maximal at lactation period because of excess metabolic heat production in dairy cattle (Bryant et al., 2007; Collier et al., 1982; Rodriquez et al., 1985; West et al., 1990). However, the prospect of dairy cattle's to be sensitive to heat stress in other periods of production cycle should be considered. In herd management, management of the cows in dry period is neglected in many dairy cattle enterprises. However, it is known that the dry period, which is in the last trimester of pregnancy, is the stage when the fetus development rate is at maximum and birth weight of the fetus is determined. Several studies were conducted to show the effects of heat stress on birth weight by modifying climate conditions (shade, sprinkle, fan, etc.) in dry period for dairy cattle (Avendano-Reyes

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et al., 2006; Collier, 1982; Wolfenson et al., 1988). Climate conditions such as ambient temperature, relative humidity, wind velocity and precipitation are used for the identification of heat and cold stress (Donelly, 1982; Davis 2003). In measurement of heat stress, usage of temperature- humidity index is recommended (Armstrong, 1994). It is reported that; in dairy cattle's milk yields are not affected in the situations temperature-humidity index (THI) is equal or lower than 70 but affected by 75 or higher values (Buffington et al., 1981).It reported that cold stress does not affect animals much in contrast of heat stress (Jordan et al., 1968; Hiranoko et al., 1969; Rutter et al., 1971, 1972; Bryant et al., 2007).

Jersey is dairy cattle of which mean birth weight is 20 kg and it has good adaptation ability to high temperatures. One of undesirable traits of Jersey calves is their being weak and vulnerable (Alpan, 1992). In previous studies on Jersey calves, mean birth weight is reported to be lower than optimum and environmental conditions such as season and parity have more effect on birth weights of Jersey calves than genetic variance (Akdag et al., 2011). Jersey cattle was firstly brought to Karaköy Agriculture Enterprise (41^o 34`N and 35$^o$ 55`E), which is near Samsun-Bafra, from USA in 1958 and started to be raised. Samsun Karaköy Enterprise is the most prominent company to provide breeding need of Jersey cattles and have the property of being a gene center for this strain. In Karaköy Agricultural Enterprise cattles are sheltered in half-open barn through year and so they are exposed to high temperatures in summer as well as wind and rain in winter. Objective of this study is to determine the effect of temperature- humidity index, cold index and length of dry period on birth weight of the calves of Jersey cows.

Material and Methods

Constructing data set

In this research were used pedigree records of 551 Jersey calves which were born between 2000 and 2004 in Samsun Karaköy Agriculture Enterprise. The calves were from breeding cow pedigree. Birth weights of calves and dry period length records belong to the cow in pedigree records were used. In order to calculate temperature-humidity index and cold stress index, daily highest, lowest and mean temperature, daily precipitation, mean relative humidity and wind speed values for Samsun-Bafra between 2000 and 2004 years were provided by General Directorate of Meteorology.

These data were classified for dry period length, temperature-humidity index and cold stress index values. Dry period length were classified as DPL-1(≤60), DPL-2 (60-90) and DPL-3 (90≤).Daily temperature-humidity index and daily cold stress index were calculated along dry period length of each cow for to be compose to groups of temperature humidity index and cold stress index. Cold stress index was classified as CSI-1(≤832), CSI-2 (833-946) and CSI-3 (947≤) (Bryant et al., 2007). Using for climatic data was provided by General Directorate of Meteorology. Temperature-humidity index (THI)=(0.8 x maximum ambient temperature)+[% relative humidity/100 x (mean ambient temperature-14.4)]+46.4 formula reported by Davis et al. (2003) was used where CSI= [11.7+(3.1*mean wind velocity 0.5))*(40-mean ambient temperature)+481+(418 x (1-e$^{0.04}$ x mean daily precipitation) formula which was reported by Donelly (1984) was used for the calculation of cold stress index.

Statistical analysis

Using a factorial design, for statistical analysis of variances in birth weight with respect to temperature-humidity index, cold stress index and length of dry period groups, one way analysis of Duncan's multiple comparison tests was used. Temperature-humidity index, cold stress index for the seasons one way analysis of Duncan's multiple comparison tests was used. Also, temperature-humidity index x dry period and cold stress index x dry period length interactions was analyzed (SAS, 2009).

Results

Mean precipitation, relative humidity, wind velocity and temperature values determined according to the meteorological data between 2000 and 2004 are presented in Table 1. A decrease in precipitation amount is seen from January to June but increase from August to December. It is determined that mean relative humidity is lowest in November (72.23%), highest in April (80.55%). In addition, wind velocity is highest in December (3.01 m/s) and lowest in September (1.39 m/s) where mean temperature is lowest in January (5.60°C) andhighest in July (23.55°C) (Table 1).

In regard to seasons, temperature-hunmidity index, cold stress index and birth weights are presented in Table 2. According to season, between of temperaturte-humidity index and cold stress index groups difference was significant in regard to statistically. It was determined that temperature humidity index was the highest for summer, cold stress index was the highest for winter. The lowest birth weight belongs to the calves of which dry period of cows coincide with the winter months and it was determined as 20.75 kg. However, difference in mean birth weights of groups which are dry period of cows in different seasons were in regard to statistically insignificant (P>0.05).

Temperature-humidity index, cold stress index and length of dry periods were classified and according to this classification mean birth weights of the calves are presented in Table 3. When mean birth weights of three groups formed in accordance with cold stress index compared, variance between groups in terms of mean birth weight was found statistical-

Table 1
Mean values of meteorological data 2000-2004 with respect to months

Month	Precipitation, mm	Mean relative humidity, %	Wind velocity, m/sn	Mean temperature, °C
January	3.41±0.57	74.10±1.21	2.93±0.16	5.60±0.34
February	2.32±0.37	75.03±1.21	2.54±0.13	6.06±0.35
March	2.20±0.37	75.69±1.18	2.22±0.10	7.84±0.36
April	2.11±0.44	80.55±1.00	2.19±0.08	10.76±0.28
May	1.75±0.35	77.66±0.75	1.72±0.06	15.20±0.19
June	2.01±0.41	74.32±0.69	1.63±0.07	19.67±0.16
July	0.64±0.27	74.29±0.52	1.85±0.06	23.55±0.16
August	1.51±0.49	75.57±0.44	1.48±0.05	23.43±0.14
September	2.42±0.55	78.30±0.60	1.39±0.05	19.83±0.20
October	2.60±0.51	78.26±0.88	1.14±0.07	15.77±0.28
November	2.97±0.73	72.23±1.21	2.11±0.11	11.98±0.32
December	3.82±0.59	73.10±1.24	3.01±0.16	7.11±0.30

Table 2
Mean temperature humidity index, cold stress index and birth weight and standard errors in regard to season

Seasons	n	THI	CSI	Birth weight, kg
		***	***	N.S.
Winter	158	51.96±0.31[a]	1056.89±4.23[d]	21.41±0.19
Spring	135	65.82±0.61[c]	896.80±6.75[b]	20.75±0.17
Summer	101	75.60±0.37[d]	793.61±4.16[a]	20.91±0.27
Autumn	157	58.54±0.49[b]	985.55±5.74[c]	20.94±0.15

a,b,c,d: Meanswithin a colonwithdifferntsuperscriptsignificantlydiffer (P<0.001); N.S: non-significant (P>0.05).
***: P<0.001.

Table 3
Calf birth weights and standard errors according to dry period length, temperature humidity index and cold stress index groups

Traits	n	Birth weight, kg	% V
Temperature-humidity index (THI)		N.S	
THI-1	390	21.12±0.11	10.40
THI-2	81	20.67±0.25	10.88
THI-3	80	20.88±0.26	11.45
Cold stress indeksi (CSI)		*	
CSI-1	126	20.77±0.21[b]	11.41
CSI-2	121	20.63±0.18[b]	9.73
CSI-3	304	21.27±0.12[a]	10.51
Dry period lengtht (KRD)		N.S.	
DPL-1	160	20.82±0.14	9.37
DPL-2	320	21.06±0.12	10.81
DPL-3	47	21.46±0.41	13.20
Total	551	21.02±0.09	

a,b: Means within a colon with differnt superscript significantly differ (P<0.05); N.S: non-significant (P>0.05). *: P<0.05.

ly significant (P<0.05). Also, it found that variance between birth weight of temperature-humidity index and dry period length groups were statistically insignificantly (P>0.05). Calf birth weight was higher than other THI and CSI groups when temperature-humidity index was lowest (THI-1) or cold stress index was highest (CSI-3). Calf birth weight have increased with increasing to dry period length.

The mean calf birth weight according to comparision among temperature-humidity index x dry period lenght and cold stress index x dry period lenght intreaction is presented in Table 4. It determined that effect of temperature-humidity index x dry period lenght interaction was significant (P<0.05) on calf birth weight. Especially, calf birth weight of DPL-1 groups lower(P<0.05) than other DPL groups when calf birth weights comparison according to dry period length groups in THI-3 group. It determined that in regard to statistical effect on calf birth weight of cold stress index x dry period length interaction was insignificant (P>0.05).

Discussion and Conclusion

Precipitation amount and wind velocity were low in summer when meteorological data belong to the research period were analyzed. In addition, temperature was highest in summer. Contrary, cold stress index may be effect in winter months (Table 1). It was an expected trend, in regard of region climatic. Thus, it seen that according to season the calculated temperature humidity index and cold stress index values were supported (Table 2). It determined that in regard of temperature-humidity index and cold stress index values were as statistically significant (P<0.001) (Table 2). It defined that temperature humidity index was the highest for summer, that of the lowest for winter, also cold stress index was the highest for winter, that of the lowest for summer. According to season, calf birth weight that of for other season, but it was insignificant instead of statistically. In other words, it determined that lowest birth weight belongs to the calves of dry period of cows coincide with the winter months (Table 2). Cold stress index was generally used measurement of temperature loss for sheep. It reported that the upper threshold of cold stress index was as 1300 kJ m^{-2} h^{-1} for dairy cattle (Bryant et al., 2007). It determined that cold stress index was no overcome upper threshold value (Table 2). It determined that the mean of calf birth weight was significant for cold stress index, also lowest birth weight belongs to the calves of dry period of cows coincide with the winter months (Table 2) when according to the mean temperature–humidity index, cold stress index and dry period groups are assessed. It stated that cold stress was no detrimentally affected development of conceptus and subsequently the calf when feeding with high energy feed (HironakoPeters, 1969; Jordan et al., 1968). Also, it stated that calf birth weight belongs to the calves of dry period of cows coincide with the winter months was decreased when feeding level is insufficient or protein is deficient (Bull et al., 1978). Decreasing of calf birth weight belongs to the calves of dry period of cows coincide with the winter months may be depend on to insufficient feeding in the present study. Also, it can say that birth weight decreases with increasing heat stress, however it is insignificant in regard of statistically in this study (Table 3). Armstrong (1994) stated that heat stress begins when temperature- humidity index is 72 or higher. It is reported that in dairy cattle's, yields are not affected by temperature-humidity index 70 and lower than 70, however affected negatively by 75 and higher values (Buffington et al., 1981). It is known that in

Table 4
Calf birth weights and standard errors regard to dry period length with temperature humidity index and cold stress index interactions

Traits	Temperature-humidity index								
Dry period length	THI-1			THI-2			THI-3		
	BW	N	% V	BW	n	% V	BW	n	%V
DPL-1	20.98±0.15	129	8.38	21.05±0.50	19	10.43	19.92±0.46^{b}	27	12.20
DPL-2	21.14±0.15	227	10.96	20.59±0.30	54	10.94	21.16±0.30^{a}	48	9.81
DPL-3	21.47±0.48	34	13.08	20.37±0.90	8	12.56	23.20±1.39^{ab}	5	13.42
Cold stress index	CSI-1			CSI-2			CSI-3		
	BW	n	% V	BW	n	% V	BW	n	%V
DPL-1	20.31±0.41	38	12.69	20.63±0.28	36	8.28	21.08±0.17	101	8.16
DPL-2	20.84±0.24	76	10.33	20.59±0.25	69	10.20	21.33±0.17	184	11.07
DPL-3	21.83±0.81	12	12.93	20.81±0.57	16	11.12	21.78±0.74	19	14.95

a,b : Means within a colon with differnt superscript significantly differ (P<0.05).

rats, sheep and cattles exposed to heat stress during pregnancy retrogression of fetal growing and decrease in birth weight occurs (Benson and Morris, 1971; Brown et al., 1977; Collier et al., 1982). Similarly, from this study it can be inferred that birth weight decreases with increasing heat stress (Table 3). In studies conducted for the removal of negative effects of heat stress on birth weight by shade and sprinkle on dairy cattles from Holstein strain in dry period, it is seen that birth weight decreased about 8-12% in counter groups (Collier et al., 1982; Wolfenson et al., 1988; Avendaño-Reyes et al., 2006). It determined that calf birth weight was decreased when THI was increased from <70 to 70-75 ranged at the rate of % 2.13 in this study. When results of this study are compared with results of the study on Holstein strain, it can be concluded that decrease in birth weight due to temperature-humidity index is lower than Holstein. This result is thought to be due to Jersey's better adaptation ability to hot climates (Alpan, 1992).

According to dry period lenght when calf birth weight was analyzed insignificant (P>0.05) as statisticaly. However, it can say that calf birth weight was increased when dry period lenght was increased (Table 3). In many studies, different intervals are stated for length of dry period. Some researchers report that best interval for length of dry period for dairy cattle is 45-60 days (Ozbeyaz, 2006). A study by Teke and Akdağ (2010) stated that length of dry period should be between 66 and 70 days since birth weight increases with the increase in dry removal period. In this study, difference of between dry period lengths was insignificant (P>0.05). The lowest calf birth weight was found <60 days of dry period length in cow (Table 3).

Temperature-humidity index × dry period length interaction was significant when effect on calf birth weight of temperature-humidity index × dry period length and cold stress index × dry period length interaction are assessed. It determined that calf birth weight decrease when increasing of temperature-humidity index and decreasing of dry period length (Table 4). In the last trimester of pregnancy, a large part of birth weight is composed. The highest temperature-humidity index and the shortest dry period length can occur negative impact on birth weight. It was advised that dry period length was above 60 days when temperature-humidity index was the highest in the dry periods of cow.

Consequently, as it is stated that cold stress has negative impact on birt hweight of Jersey breed. Also, it can say that birth weight tends to decrease with the increase in heat stress. In addition, calf birth weight is in an increasing trend with the increase dry period length. For Jersey breed cattles, it can be stated that dry period should be scheduled for autumn and the births should be planned to happen in winter seasons in order to have calves having high birth weight. It was determined that when dry period length was underneath 60 days temperature-humidity index and cold stress index can occur negative impact on birth weight.

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