STUDY REGARDING THE INFLUENCE OF THI ON THE LAST PERIOD OF GESTATION ON CALVES BIRTH WEIGHT AND THEIR SUBSEQUENT DEVELOPMENT

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Abstract. *The aim of this study is to analyse the effects of thermal stress in the last part of cows' pregnancy on the calving weight of calves and on their post-partum weight growth. The data were structured by THI intervals and cow parity and values of the statistical estimators were calculated using the package SAVC and SPSS 16.00 for Windows. It was found that for different THI there are differences for calving bodyweight, from 46.45 to 42.52 kg in pluriparous case and from 45.13 to 40.89 kg for primiparous. For this trait there are significant differences between THI>65 and THI<45 respectively 55≤THI<65.*

Keywords: THI, dairy calves, birth weight, daily gain.

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1. Introduction

One of the biggest challenge at the moment facing agriculture and therefore the dairy farming sector is climate warming and finding optimal solutions to reduce heat stress. Instrumental observations reveal a pronounced global warming during the past 150 years [7]. In the specialised literature, there are a multitude of scientific studies about the effects of the combined action of temperature and humidity on the productive and reproductive performance of dairy cows.

During high temperature periods such as the summer period, dairy cows direct most of their energy to thermoregulate the body in conditions of feed intake decreases. Animals experience a state of stress determined by the action of environmental factors (temperature, humidity), which causes an increase in the level of cortisol in the blood, with direct effects on the immune system. A concise definition of thermal stress was formulated in 2009 by Dikmen and Hansen who says that it can be defined as "the sum of all environmental effects that affect an animal and induce an increase in its body temperature causing a physiological response " [3].

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The effects of heat stress are easy to notice because the animal shows specific behavior by which it tries to adapt (panting, standing, reduced rumination time), its physiological parameters has modified (body temperature, pulse, etc.) [5], milk production decrease and it increases the body's availability to diseases because the immune system is affected. In temperate climates, some studies note appearance of adaptation behavior at an average temperature of 120 or an average THI of 56 or more [6]. Much more exposed to heat stress are cows from specialized breeds, with high milk productions which, in addition to adapting to the ambient temperature, must also dissipate own heat produced because of their intense metabolism.

In the last period of gestation, the greatest development of the fetus takes place, in the last 2 months it achieves 60% of its birth weight. The cow's ingesting capacity is naturally reduced during this period and its metabolism is directed in order to provide the nutrients necessary for the intense processes taking place.

Due to the stressful action that temperature and humidity factors have on dairy cows during this period, their body is primarily affected, but also the development of the fetus and implicitly its organs [8, 2, 9].

The birth weight of these calves will be lower compared to those whose dams were not exposed to heat stress during the latter part of gestation. The research carried out revealed that due to the thermal stress endured during the last 2 months of uterine life, these calves have a somewhat poorer health and, under conditions of proper management, achieve a lower daily weight gain (DWG) after the colostrum period. Also, the remanence of the heat stress action during this period is also found in the performance of the first lactation of the young female [6].

2. Materials and methods

The farm is located in NE of Romania, the animals being raised and exploited in an intensive system. The batch for which the study was carried out consists of female calves from the Holstein, calved between June 2022 and December 2023 and for which measurements were made at birth, at the age of 7 days and 30 days. Calves slaughtered up to 30 days, those that had a negative evolution of the DWG and those that were sick during the reference period (30 days) were not taken into account.

The calves rearing technology involves separating them from the mother cow after calving and raising them until the age of 3 months (weaning) in individual cages on straw bedding. The colostrum period lasts up to 6 days and the first dose of colostrum is administered within a maximum of 8 hours after calving to ensure the transfer of IgG and the formation of passive immunity necessary in the first part of life. For calves feeding it is used only colostrum with a minimum value of 22 degrees BRIX which has been determined with the refractometer [1,4].

After the colostrum period, the basic food for calves until weaning is whole milk, being given 8 liters daily, distributed in two meals. They are also provided with ad libitum access to concentrates and bulk fodder (alfalfa hay). (Fig.1)

Fig. 1. Aspects of the calf sector (original foto)

Their body weight (BW) was estimated in kilos using the eWeight application, which, through the algorithm used, estimates the weight of the animal based on the measured chest circumference. It was estimated the BW at birth (BWb), at 7 days (BW7) after colostrum period and at 30 days (BW30) For the thoracic perimeter, three successive measurements were made in the same time, the one that was repeated being recorded and used in the application. Based on BW it was calculated the daily weight gain (DGW) at 7 days (DGW7) and at 30 days (DGW30) which was expressed also in kilos.

Temperature-humidity index values were grouped as follows: 1) THI <45; 2) 45≤THI<55; 3) 55≤THI<65 and 4) THI ≥ 65. The formula used for THI:

THI = (0.8* Tm + Hm/100)* (Tm - 14.4) + 46..... (1)

where Tm is the medium temperature of the day and Hm is the medium humidity. THI values were calculated every time for those 60 days included.

The data were structured by ranges of THI values and by categories of cows (primiparous and multiparous).

For the statistical processing of the data, the following computer programs were used: SAVC (Statistics Analysis of Variant and Covariance) respectively SPSS 16.00 for WINDOWS. Thus, a series of statistics were determined such as: the

arithmetic mean ($\overline{X}$), the error of the arithmetic mean ($\pm s_{\bar{x}}$), standard deviation (s), coefficient of variability (V %), graphical representation of the regression line, Pearson correlation, Chi-Square Tests, ANOVA Test, Significance test p. and confidence interval (C.I.).
The statistics, respectively the parameters, which characterize a normal distribution, are on the one hand the mean or median, and on the other hand the dispersion indices represented by the variance and the standard deviation of the observed character. Statistics are written in Latin letters: the arithmetic mean ($\overline{X}$), variance (S^2), standard deviation (s), and parameters with Greek letters: theoretical mean (μ), variance ($ó^2$) and standard deviation (ó).

Arithmetic mean ($\overline{X}$) is the first and most important numerical characteristic of a series of observations and represents the value around which the studied character varies and on the basis of which the participants can be divided into two groups: plus-variants and minus-variants.

Variance (S^2) is one of the measures of variability that corresponds to the size of the variation of the property or the studied phenomenon. The number that is the basis of this quantity is the sum of the squares of the deviations from the mean resulting from the relation:

$$\sum \left(X - \overline{X}\right)^2 \tag{2}$$

The standard deviation or standard deviation (s) is the most used characteristic of the dispersion, it is the main measure or estimate of the variability and the degree of dispersion of the variables around the mean. The standard deviation is an absolute figure and is measured with the same unit as the corresponding variable and is determined by the relation:

$$s_{\bar{x}} = \sqrt{\frac{S^2}{N}} = \frac{s}{\sqrt{N}} \tag{3}$$

The coefficient of variation (V%) directly indicates the relative variability of the population compared to the average, i.e. the degree of homogeneity of the population and is calculated as follows:

$$V\ \% = \frac{s}{\overline{X}} \times 100 \tag{4}$$

The statistical test is a decision method that helps us to validate or invalidate with a certain degree of certainty a statistical hypothesis. The Fischer test (F) is used to verify the equality of dispersions of two normally distributed independent variables. The Tukey test is the most commonly used multiple comparison

procedure, also called the honest significant difference test, usually used in conjunction with ANOVA statistical models.

The test result p, provided as a number between 0 and 1, represents the probability of making an error if we reject the hypothesis H0. If p is lower than the significance threshold α chosen - usually α=0.05 - we reject the H0 hypothesis and accept the H1 hypothesis as true.

The ANOVA test compares the means of several samples at the same time.

The correlation coefficient takes values between –1 and +1, inclusive, with the significance of positive/negative association after the sign of the coefficient and of lack of association for $r_{xy} = 0$. Statistical significance (approximate) is obtained by applying a Student test with statistic.

3. Results and discussions

Table 1. Statistics for analised traits related with THI levels for multiparous

THI level	*Traits*	*n*	$\overline{X}$	$\pm s_{\bar{x}}$	*s*	*V%*	*Minim*	*Maxim*
THI<45	BWb	16	46.45	1.136	4.544	9.782	39.3	53.6
	BW7	16	51.23	1.108	4.431	8.65	45.3	62.8
	BW30	16	64.41	1.261	5.043	7.829	57.1	73.9
	DWG7	14	0.78	0.123	0.462	59.271	0.2	1.87
	DWG30	16	0.6	0.05	0.2	33.48	0.42	1.05
45≤THI<55	BWb	19	46.2	1.281	5.585	12.089	35.2	55.4
	BW7	14	49.96	1.232	4.608	9.225	42.3	57.2
	BW30	16	60.11	1.426	5.706	9.493	46.9	70.8
	DWG7	12	0.87	0.099	0.341	39.288	0.43	1.47
	DWG30	16	0.47	0.03	0.12	25.52	0.24	0.63
55≤THI<65	BWb	26	45.05	1.048	5.345	11.866	30	53.6
	BW7	24	50.79	1.082	5.299	10.434	40.8	60.9
	BW30	26	61.88	1.48	7.546	12.195	45.3	77.2
	DWG7	22	0.8	0.084	0.393	49.148	0.21	1.59
	DWG30	26	0.56	0.036	0.186	33.18	0.21	1.01
65≤THI	BWb	35	42.52	0.999	5.911	13.902	30	51.9
	BW7	32	47.88	1.018	5.759	12.027	36.5	59
	BW30	26	60.8	1.066	5.434	8.938	53.5	72.9
	DWG7	31	0.85	0.076	0.423	49.94	0.24	1.9
	DWG30	26	0.59	0.029	0.149	25.194	0.23	0.88

In the case of multiparous, based on the values of the estimators presented in table no. 1, it can be concluded:

- regarding the birth weight of the calves, the highest value of the average is 46.45 kg and the maximum weight of 53.6 kg which corresponds to the THI level <45; the lowest average of the character, of 42.52 kg and of the maximum weight at calving is found if the THI values are above 65. The analyzed batch of calves is characterized by homogeneity for THI <45 being medium homogeneous in the other cases.

- after the colostrum period and at the age of 30 days, following the determination of the weight of the calves (BW7 and BW30), it is found for both characters that the highest average values reach the calved calves if THI <45 and the lowest for values of THI>65. The amplitude of the variation strings registers for BW7 a maximum of 62.8 kg in the first case and 59 kg in the second case, which is not the smallest value of the maximum. For BW30 the maximum weight achieved is 73.9 kg if THI has values <45, and for THI>65 the maximum weight of calves at this age is 72.9 kg, both mentioned values not being the lowest and the highest of the character in the studied group. The batch of calves analyzed is characterized by homogeneity in terms of performances for the two characters (BW7 and BW30). However, it expresses a homogeneous medium variability for BW30 and THI values between 55 and 65 and for BW7 and THI values>65.

- the average daily gain is a character that refers to the performance of individuals over a period of time in terms of weight gain and in the case of the calf lot analyzed, it is very heterogeneous for both DWG7 and DWG30. From the values of the estimators, the highest average value of DWG7 of 0.87 kg/day is recorded for 45≤THI<55 and the lowest of 0.78 kg if THI has values below 45. In the case of DWG30, the maximum the average is 0.6 kg/day if THI<45 and the calculated minimum is 0.47 kg/day when THI has values between 45-55. The highest individual weight gain was 1.9 kg/day (THI>65) for BW7 and 1.05 kg/day (THI<45) for BW30.

- by applying significance tests, significant differences were found for calving weight ($P < 0.05$) in the case of samples with THI values between 45-55 and >65 with a mean value difference of 3.93 kg in favor of the first case and between samples for which 55≤THI<65 and THI>65, heavier calves being born in the first case by 3.68 kg on average.

The thermal stress suffered by cows during the last period of gestation influences the intrauterine development of fetuses, which causes their lower birth weights. The subsequent, extrauterine development of calves is also determined by the action of other factors, which were not analyzed in the present study, but whose action on their performance is known: the feeding level [10] and the chemical composition of the feed, the microclimate conditions, the inherited genetic base, etc.

Table 2. Statistics for analized traits related with THI levels for primiparous case

THI level	*Traits*	*n*	$\overline{X}$	$\pm s_{\bar{x}}$	*s*	*V%*	*Minim*	*Maxim*
THI<45	BWb	20	45.13	0.91	4.07	9.018	37.9	55.4
	BW7	19	49.76	0.946	4.122	8.284	40.8	59
	BW30	19	60.69	1.457	6.349	10.461	45.3	72.9
	DWG7	18	0.71	0.093	0.393	55.115	0.21	1.61
	DWG30	20	0.42	0.107	0.48	114.871	0.05	0.78
45≤THI<55	BWb	13	44.46	0.969	3.494	7.858	40.8	51.9
	BW7	10	48.25	0.972	3.073	6.368	43.8	53.6
	BW30	9	58.29	1.556	4.667	8.007	50.2	64.7
	DWG7	9	0.59	0.096	0.288	48.466	0.24	1.1
	DWG30	10	0.26	0.22	0.696	270.925	0.16	0.8
55≤THI<65	BWb	19	42.46	0.954	4.159	9.793	36.5	51.9
	BW7	18	47.39	1.056	4.48	9.452	37.9	55.4
	BW30	18	58.56	1.302	5.522	9.431	46.9	66.7
	DWG7	19	0.35	0.323	1.409	404.906	0.2	1.61
	DWG30	19	0.43	0.098	0.428	98.787	0.22	0.81
65≤THI	BWb	18	40.89	0.884	3.749	9.167	32.6	46.8
	BW7	16	48.09	0.798	3.194	6.642	43.8	51.9
	BW30	18	57.73	0.785	3.332	5.772	51.9	64.7
	DWG7	18	0.26	0.506	2.147	813.488	0.21	1.76
	DWG30	18	0.56	0.037	0.158	28.047	0.27	0.88

A similar analysis was also carried out in the case of primiparous cows to see the differences in relation to multiparous cows, also taking into account the fact that the heifers have not completed their body development when they are introduced to breeding.

Table 2 presents the results obtained through statistical processing of the primary data and, based on them, we can conclude the following:

- the average weight at calving of the products registers a decrease from lower to higher THI values, so that if THI>65 the calved calves have an average weight of 40.89 kg less than those calved in the interval THI<45 who on average weigh 45.13 kg. The character shows homogeneous variability for all considered THI intervals.

- regarding the BW7 and BW30 averages, they are higher for THI<45 being 49.76 kg and 60.69 kg respectively and lower in the case of THI>65, the values being 48.09 kg and 57 respectively 57.73 kg. It can be observed, however, that for BW7

the lowest value of the average is 47.39 kg when the THI values are between 55-65. In the case of primiparas, the group of analyzed calves is characterized by homogeneity in the case of both characters, for all considered THI intervals.

- calculation of DWG for the age of 7 days and 30 days, respectively, reveals performances between 0.2 - 1.76 kg/day and between 0.05 - 0.88 kg/day, respectively. For DWG7, the lowest mean value is 0.26 kg/day for THI>65 and the highest 0.71 kg/day is recorded for THI<45. In the case of DW30 the situation is reversed, the highest average value of 0.56 kg/day being registered in the case of THI>65 and for THI values lower than 45 the average is 0.42 kg/day, with the remark that the average the lowest is recorded if 55≤THI<65. The values of the coefficients of variability V% are for these characters are over 20% which means that the batch of calves is very heterogeneous.

- distinctly statistically significant differences (P < 0.05) were found only between the mean values of the calving weight of calves for THI>65 compared to the mean value in the case of THI between 55-65 and in the case of THI<45. Thus, for THI>65 the calving weight of calves was on average 4.23 kg lower compared to that in the case of THI<45 and 3.57 kg compared to the case where 55≤THI<65.

Analysis of Pearson correlation coefficient values reveals, in the case of THI<45, very strong positive associations between BWb and DWG30 (p=0.01), then strong positive correlations between BW7 and DWG7 and moderately negative correlations between BWb and DWG7 (p=0.05)

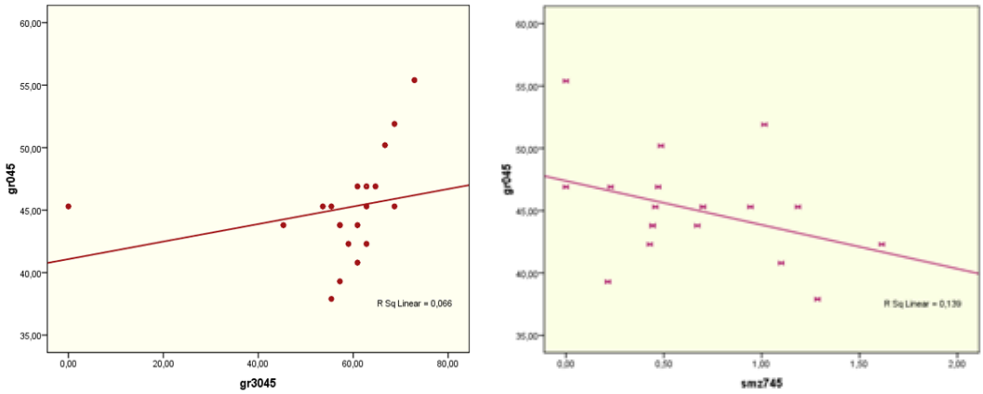

Fig. 2. Regression line for THI<45 values:
a. between BWb and BW30 **b.** between BWb and DGW7

From the graphical representation of the regression line in the case of BWb and BW30 and taking into account the THI value (Fig. 2, a) it can be seen, from the orientation of the line and the spaced arrangement of the points relative to it, that

the two characters are weakly positively correlated (0.066) so that the calves that at calving will have a higher weight will also register slightly higher values of DWG30. Figure 2, b represents the regression line for the characters BWb and DWG7 and from its orientation and the dispersion of the points on the line we can say that there is a moderate negative correlation (0.139) of these characters in the sense that the weight at calving has a weak influence on BWG7, to achieve the desired performances the main influencing factor being feeding and colostrum quality.

Conclusions

(1) In this study, the effects of thermal stress during the last period of gestation (last 60 days) of primiparous and multiparous females on the intrauterine and postpartum development of the female calves were analyzed, from the point of view of weight at calving and their weight at 7 days of age and of 20 days, with the calculation of DWG related to growth periods.

(2) Heat stress exerted on females in the latter part of gestation is an influencing factor, causing lower calf weights as occurred when THI values>65.

(3) Although there were no statistically significant differences, the subsequent development of the calves was different according to the ranges of THI values considered. In the case of this study, the action of thermal stress during the last period of gestation is not a major influencing factor of postpartum development.

(4) Weight at calving can moderately and positively influence the average daily gain achieved by animals up to 30 days and moderately negatively that of the colostrum period.

(5) The period up to weaning is critical for calves, and the colostrum period is defining for their development. After calving, the weight gain of calves is determined by internal (genetic, physiological) and external factors, related to the management of their maintenance and growth technology: the administration of the first colostrum after calving, the management of calf feeding during the colostrum period and later until at weaning, microclimate conditions, etc.

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