THE CHANGES OF THE MILK QUANTITY AND QUALITY IN DAIRY COWS EXPOSED TO SOLAR RADIATION

MODIFICĂRI CANTITATIVE ȘI CALITATIVE ALE LAPTELUI OBȚINUT DE LA VACI EXPUSE RADIAȚIILOR SOLARE

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The purpose of the study was to observe the changes of the milk quantity and quality in cows exposed to solar radiation during the hot summer days. The study was carried out in the period May-October 2000-2005 on groups of cows, belonging to Romanian Simental breed, during the III-rd and IV-th lactation, bread in different conditions: on the pasture or in the stable. The determined parameters were: the total milk production to characterise the milk quantity and the milk quality was characterised by: electric conductivity, the protein, the lactose, the fat content and the milk cells. These parameters were correlated with THI index during the summer days when it exceeds the value of 72, which is considered the limit of heat stress in cows.

It was encountered a decreasing of the total milk production with 26.46% in August, compared to May (p<0.01) which was considered the reference month, when the cows started grazing. The reduced milk production is correlated with THI values, between them being established a reverse proportional variation. In cows exposed to sun it was recorded a reduction of the milk electric conductivity with 12.42% compared to the values obtained in the morning, being reverse proportionally correlated with THI values. In cattle exposed to heat stress are recorded changes in milk composition, meaning the reducing in fat content (12.97%, p<0.05) and in protein content (12.25%, p<0.05). The fat and the protein contents variations are close correlated with THI, between them being a reverse proportional relation. The number of the somatic cells in milk is growing in cows exposed to caloric solar radiation, recording an increasing of 42.96% in August compared to May. The increased number of somatic cells is directly correlated with THI.

Key words: dairy cows, solar radiation, milk quantity and quality

Introduction

The objectives of the present study are to reveal the losses induced by the intense solar radiation on the milk quantity and the changes in the quality of milk in dairy cows exposed to the direct solar radiation, on the pasture, during the sunny days of summer. The changes induced by the solar radiation in the quality of the milk are both regarding its physical and chemical properties.
Different authors noticed that, in the case of the milking cows exposed to direct solar radiation during the sunny days of summer, there are observed quantitative changes of the milk. There were recorded significant decreasing of the milk production (with losses up to 20-22%), in cows belonging to European breeds exposed to environmental temperatures higher then 27-28°C [10, 7, 9, 3, 4, 5, 6]. The decreasing of the milk production is more significant when the cow is a good milk producer and when the number of the days with increased temperature is higher. The qualitative changes of the milk are also very important; they are represented by the significant decrease of fat and total protein [1]. It is also noticed a decreasing of the mineral and vitamin A quantity and these are corroborated with the increasing of the somatic cells in milk. [2, 7].

**Materials and methods**

The study was carried out in the period May-October 2000-2005 on groups of cows, belonging to Romanian Simental breed and bred in different conditions: on the pasture or in the stable. There were also recorded the main meteorological parameters such as the temperature and the relative humidity, in order to calculate the Temperature Humidity Index (THI) and the intensity of solar radiation. The meteorological data were provided by the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca where a meteorological station provides data regarding the total solar radiation, temperature, relative humidity at each 15 minutes. The Temperature Humidity index was calculated using classical formulas [3]:

The experiments regarding the influence of the caloric radiation on milk quantity were made in two stages. The first stage consists in determination of the milk production during the period May-September. The determinations were made on a group of 10 cows, belonging to the Romanian Simental breed, during the third and the fourth lactation, bred in a private farm. The cows were grazing on the pasture during the daytime and were kept in the stable for the night time. The second part of the observations was made during the days 20-th – 24-th of August, on the same group of cows, but they were divided into two subgroups of 5. One group was maintained on pasture, without any shadow, from 7.00 a.m. to 7.00 p.m. The other group was maintained in stable and fed with green grass. The determination of the milk conductivity was made on a group of Romanian Simental, during lactation period, in August. The cows were maintained on pasture during the day and in the stable during the night. The determination of the milk conductivity was made using Universal Conductivimeter- pH-meter, C 532 type. The main chemical components of the milk were determined on milk samples preserved in K₂Cr₂O₇. The samples were prelevated in three consecutive days in May and also three in August, each time after the cows were returning from the pasture. The determinations were made using LactoScope Analyser™ IR.
The somatic cells were determined on the same samples with Somatic Cell Counter MT-02.

**Results and discussions**

We have to mention that in the whole studied period the value of THI in July and August was higher than 72, which is considered the limit of stress in cows. When the values of THI are higher than 72, different authors demonstrated that the cows are submitted to heat stress [10, 11].

The first measured parameter was the milk production. The mean values of the milk production obtained for the first group of cows, during the period May - September, and the THI values are presented in Table 1.

<table>
<thead>
<tr>
<th>Mean milk production (l / day)</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12.75 ± 0.245</td>
<td>10.02 ± 0.121</td>
<td>9.09 ± 0.231</td>
<td>8.64 ± 0.413</td>
<td>9.06 ± 0.512</td>
</tr>
<tr>
<td>THI max</td>
<td>69.90</td>
<td>73.59</td>
<td>72.91</td>
<td>78.03</td>
<td>67.21</td>
</tr>
</tbody>
</table>

Examining the data presented in Table 1, it is observed a decreasing with 26.46% of the milk production in August compared to May (p<0.01). In August was recorded the lowest milk production for the entire studied period.

Analysing the THI values it can be noticed that in June and July there were exceeded the values of maximum THI, over THI = 72, which represents the maximum limit for the thermal comfort in cows.

Comparing the mean values of the milk production for the studied period with the THI values, it can be established a reverse correlation, which means that with the increasing of THI index the milk production decreases.

The results of the second part of the experiment (acute phase) were presented in Table 2.

Analysing the data regarding the milk production obtained in cows exposed to direct solar radiation it can be noticed that it was recorded a decreasing of the milk production with 0.9 l / head during the 5-th days (p<0.001) the obtained data being very statistically significant.
The mean values of the milk production during the 5-th days of the experiment in cows in shelter and on pasture (August)

<table>
<thead>
<tr>
<th>Group \ Day</th>
<th>Day I</th>
<th>Day II</th>
<th>Day III</th>
<th>Day IV</th>
<th>Day V</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (on pasture)</td>
<td>9.6±</td>
<td>9.2±</td>
<td>9.0±</td>
<td>8.8±</td>
<td>8.7±</td>
<td>9.06±</td>
</tr>
<tr>
<td>Group II (in shelter)</td>
<td>9.7±</td>
<td>9.6±</td>
<td>9.6±</td>
<td>9.7±</td>
<td>9.6±</td>
<td>9.64±</td>
</tr>
</tbody>
</table>

In the group II the mean values of the milk production does not vary significantly. In the group I, exposed to solar radiation it was recorded an increasing of the rectal temperature from 38.71°C (±0.088) to 39.51°C (±0.208), during the five days of the observation, so a difference of 0.8°C, and the milk production decreasing was 0.9 l/head. Some authors consider that an increasing of the rectal temperature with 1°C determine a decreasing of the milk production with 11[7].

The mean value of the milk production was 9.06 l/head (±0.358) in cows exposed to solar radiation, compared to a mean value of 9.64 l/head (±0.055) in sheltered cows, which represents a decreasing of the milk production with 6.4% during the studied five days.

The decreasing of the milk production may be produced by different factors, among them more significant are:
- the reduction of the volunteer fodder consumption;
- the energetic consumption for thermolysis;
- intensification of sweating for thermolysis and increasing of the dehydration;
- decreasing of the secretion of the thyroid hormones;

The obtained values for the milk conductivity are presented in Table 3.

The obtained mean values (X±sX) for the milk conductivity (mS)

<table>
<thead>
<tr>
<th>Day</th>
<th>A.M.</th>
<th>P.M.</th>
<th>A.M.</th>
<th>P.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.716 ± 0.307</td>
<td>4.117 ± 0.307</td>
<td>4.586 ± 0.332</td>
<td>4.029 ± 0.312</td>
</tr>
</tbody>
</table>

The mean values recorded during the morning and evening, presented in Table 3 show a decreasing of the milk conductivity with 12.42% after the exposure to solar radiation, compared to the obtained values in the morning (p<0.01), being reverse correlated with THI values. The decreasing of the milk conductivity is, probably, due to the intensification of perspiration and sweating in order to produce the thermolysis in warm environment.

The mean values obtained for the fat, protein and lactose content are presented in Table 4.
Table 4

The mean values ($\bar{X} \pm sX$) for May and August obtained for the main milk components

<table>
<thead>
<tr>
<th></th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Lactose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>May</td>
<td>August</td>
<td>May</td>
</tr>
<tr>
<td>Mean</td>
<td>3.909 ± 0.600</td>
<td>3.402 ± 0.522</td>
<td>3.182 ± 0.601</td>
</tr>
</tbody>
</table>

Analysing the data presented in table 4 it can be notice the reducing in fat (12.97%, $p<0.05$) and in protein content (12.25%, $p<0.05$) and not very significant the variation of the lactose. The mean values in August shown a reduction of fat content with 8.1% ($p<0.05$) compared to the mean value for the lactation period. It was also recorded a reduction of the protein content with 5.5% ($p<0.05$) compared to the mean value for the whole lactation period.

During the days of May, the maximum THI values were varying between 43.4 and 67.5 and in August the values where over the limit value of 72. There were recorded values variations between 78.4 and 76.4. So, it was observed that the fat and the protein contents variation are close correlated with THI, between them being a reverse proportional relation. It was also noticed that the decreasing of the fat content is strictly correlated with the decreasing of the protein content.

The variation of the somatic cells is presented in Table 5.

Table 5.

The mean values of somatic cells ($\bar{X} \pm sX$) (10$^3$ cells/ml) for months May and August

<table>
<thead>
<tr>
<th></th>
<th>May</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>179.23 ± 22.36</td>
<td>256.23 ± 12.82</td>
</tr>
</tbody>
</table>

The number of the somatic cells in milk is growing in cows exposed to caloric solar radiation, recording an increasing of 42.96% in August compared to May. The increased number of somatic cells is directly correlated with THI, the increasing of THI determining the increasing of the number of cells. For this reason when we analyse the number of cells to diagnose mammitis we also have to take into account the presence or the absence of the heat stress.

Conclusions

Our study demonstrated that the cows exposed to the solar radiation, when THI exceeds 72, are submitted to the heat stress.

In cows submitted to the heat stress there were recorded changes regarding the milk quantity as quality as follow:
1. a decreasing with 26.46% of the milk production in August compared to May (p<0.01), which is considered the reference month.
2. a decreasing of the milk production with 0.9 l/ head during the 5 days (p<0.001) in August when the dairy cows were submitted to the acute stress.
3. a decreasing of the milk conductivity with 12.42% after the exposure to solar radiation, compared to the obtained values in the morning (p<0.01).
4. the reducing in fat (12.97%, p<0.05) and in protein content (12.25%, p<0.05) and not very significant the variation of the lactose.
5. an increasing number of somatic cells with 42.96% in August compared to May.

Bibliography

Scopul prezentului studiu este să observe modificările cantitative și calitative ale laptelui obținut de la vaci expuse acțiunii radiațiilor solare în timpul zilelor toride de vară.

Studiul a fost realizat în perioada Mai - Octombrie 2000-2005 pe grupe de bovine de rasă Bălțăță Românească, în lactația a III-a și a IV-a, crescute în diferite condiții: pe pășune sau în adâpost. Parametrii determinați au fost: producția totală de lapte, pentru a caracteriza modificările cantitative și modificările calitative au fost reprezentate de: conductivitatea electrică, procentul de grăsimi, proteină și lactoză din lapte și de numărul de celule somatice. Acești parametrii au fost corelați cu indicele ITU (Indicele Temperatură – Umiditate), atunci când acesta a depășit limita 72, care este considerată valoarea limită pentru stresul termic la bovine. S-a înregistrat o scădere a producției totale de lapte cu 26,46% în luna august, comparativ cu luna mai (p<0.01), care este considerată lună de referință, atunci când se începe pășunatul. Scăderea producției de lapte este corelată cu indicele ITU, între acestea existând o relație de proporționalitate inversă.

La taurine expuse acțiunii radiațiilor solare s-a înregistrat o scădere a conductivității electrice a laptelui cu 12,42%, comparativ cu valorile obținute înainte de expunerea la soare, aceste valori fiind invers proporționale cu indicii ITU. La taurine expuse acțiunii stresului caloric s-au înregistrat modificări ale compoziției laptelui, concretizate în reducerea conținutului de grăsimi (12,79%, p<0.05) și de proteină (12,25%, p<0.05). Variațiile conținutului de grăsimi și proteină sunt invers proporționale corelate cu valorile ITU. Numărul de celule somatice este ridicat la vacile expuse acțiunii radiațiilor solare, obținându-se o creștere cu 42,96% în august față de luna mai, aceasta creșterea fiind direct corelată cu valorile ITU.

Cuvinte cheie: vaci de lapte, radiații solare, cantitatea și calitatea laptelui.