SZENT ISTVÁN UNIVERSITY

EXAMINATION OF SOME ENVIRONMENTAL FACTORS INFLUENCING THE CHANGE OF SOMATIC CELL COUNT

THESIS OF DOCTORAL DISSERTATION

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1. PRELIMINARIES, OBJECTIVES

In the developed regions of the world, as in Hungary, there have been an extreme restraint in the milk and food quality requirements. The basis of the increased demand on milk quality is that milk and dairy products are essential human foodstuffs, consequently they play an important role in the food-supply of the population.

In order to satisfy the demand of consumers, milk industry qualifies raw milk by grading. Classifying the raw milk, its organoleptic, chemical and physical characteristics, as well as public and animal health requirements are taken into consideration. In the case of the latter, somatic cell count is of high priority. Grading and quality, determined on the basis of the former, are of high importance as the EU has regulated the quality of milk produced in the Member States in a uniform system since 1989 and Hungary, following this from February 2003, will regard milk as food, shown in Table 1. Accordingly, Hungarian production facilities will be able to sell only milk meeting these strict quality requirements.

Table 1
Hygienic requirements of raw milk currently valid in Hungary

Somatic cell count ($1000/cm^3$)	<400
Number of microbes (cfu/ cm^3)	<100
Inhibitory material	Cannot be provable by the accepted test methods
Number of *Staphylococcus aureus*	n=5, c=2, m=$5x10^2$, M=$2x10^3$

Consequently, decreasing the somatic cell count on herd level is not only an economic constraint, but it is an essential condition to be on the market. In order to improve milk quality, decrease of somatic cell count is a very important task.

Somatic cells (SC in shortened form) are white blood cells from the bloodstream and their increase in the milk is due to many factors.

From among these factors, possibly mastitis, the disease of dairy cattle causing one of the most significant economic damage, resulting not only in the increase of somatic cell count, but the decrease of milk quantity as well as its fat, casein and in smaller extent, sugar content, is the most important. At the same time the amount of other inflammatory markers, certain serum proteins, such as albumin and a_1- anti trypsin and sodium and chloride ions, as well as the activity of some enzymes, like the N-acil glucose aminidase also increases. Furthermore genetic, physiological, keeping technological, feeding and climatic effects can significantly influence the increase of somatic cell count.

This is why the examination of somatic cell count is of greater and greater importance in the quality development of cattle breeding realized by more and more refined methods.

It is not by chance that somatic cell count is included in the domestic and foreign breeding value estimation as selection element.

Because of its low heritability, environment has a significant effect on somatic cell count. In order to improve udder health and milk quality, it is of importance to have a more comprehensive knowledge of environmental factors. In view of the above facts, my tests were concentrated on the environmental factors that have no uniform results in the technical literature and no or few domestic research results were available.
Therefore I resolved to examine the effect of the following environmental factors made on the somatic cell count:
-    part of the day, and
-    temperature and humidity.

1.   Effect of the part of the day on the change of somatic cell count

   ▪   Examining the effect of the part of day, that is difference between somatic cell count in the milk from the morning and evening milking, I tried to get answer to the question, whether in the case of a milking system applied according to the Hungarian practice, there will be a change in the quantity of somatic cell count as a function of the part of the day.

- Moreover I resolved to determine, the difference in the length of milk production time span (2hrs) considered typical in the Hungarian milking practice, will have an influence on the formation of somatic cells and the absolute quantity of their shedding.

2. Effect of temperature and humidity on the change of somatic cell count

- The aim of my test was to observe, whether under the average Hungarian farm conditions, the typical change in temperature and humidity in Hungary will affect the development of somatic cell count.
- I had the intention of getting answer on the question, whether the heat stress produced by warm weather, will influence the ratio of somatic cell count and the actual number of somatic cells, respectively.

It was an essential element of the trials to consider milk quantity, lactation stage and mastitis from the factors influencing the somatic cell count, which may inevitably influence the comparability of somatic cell count from the morning and evening milking. In order to determine mastitis I used the Californian Mastitis Test and the examination of the adaptability of this Test was also the aim of my investigation.

3. Per udder quarter screening examination of cows producing extra quality milk by means of Californian Mastitis Test

Many authors report on the fact, that animals producing extra milk, may also have udder quarter that is not healthy. This raises the question, whether the composite milk sample represents the real udder health status of the animal.

However no test including the percentage of diseased udder quarter of animals otherwise considered as healthy on the basis of somatic cell count of their composite milk sample, is available. The question has also come up, whether it is a difference between the susceptibility of the individual udder quarters.

Therefore my objective was to carry out by udder quarter the Californian Mastitest screening examination of cows producing milk with somatic cell count below 400,000 /ml.
Considering the above facts, my aim was to determine the following:

- in the case of typical Hungarian farms, what is the percentage of mastitis diseased udder quarters in animals with composite milk samples below 400,000/ml SCC,
- as for cows with composite milk samples below 400000/ml SCC, considered otherwise healthy in the farm practice, whether contagious bacterium can be found (*Satphylococcus aureus*), or there is any difference in the mastitis susceptibility of individual udder quarters.

4. Bacteriological screening test of each udder quarter of cows producing milk of extra quality

- My aim was to provide bacteriological data for the susceptibility of front and rear udder quarters in order to make proposal for the development of a future udder health index.
- In addition, I tried to determine the development of somatic cell count increase in animals afflicted with sub-clinical mastitis, but proved to be negative for pathogens and the causes inducing the disease of animals and the increase of somatic cell count in these cases.
- It was my special aim to support by data, whether differences exist between somatic cell count increases caused by different pathogens.
- I had the intention to get reply on the question during the test, whether bacterial infection and in what proportion can be found in the milk of cows considered healthy in the farm practice and producing milk that contains somatic cell count below 400000/ml, with special regard to the contagious bacteria, and at the same time looking for the answer, whether the somatic cell count of composite milk sample is reliable for the evaluation of the udder health status.

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2. MATERIAL AND METHOD

2.1. SELECTION OF THE EXPERIMENTAL AREA

I made the observation of climatic factors related to the development of somatic cell count at the Nagykorös Aranytej Kft.'s 300 cow dairy in 2000. The average climate and parallel with this the biggest possible extremes characteristic of our country were important aspects in choosing the area of testing. This is the reason for choosing the Alföld (Great Hungarian Plain) characterized by much sunshine and the resulting strong insolation and emission.

In Hungary this area has the warmest summer and the coldest winter, as well as here appears the strongest tendency for frost late in the spring and early in the autumn. The number of cloudy days is not considerable and the humidity is relatively low, therefore the daily and annual fluctuation of temperature is the greatest in the country. Not only the low precipitation, but its fluctuating amount are also characteristic of this area.

Average farm production, keeping and milking technology representing the Hungarian situation were also aspects of the selection.

In order to avoid false establishments, owing to feed problems, I regularly sampled every kind of feedstuffs. Test of samples was carried out at the central feed testing laboratory of the National Institute for Agricultural Quality Control.

2.1.1. Measurement of the meso and micro climate

During the experiments, in the spring and summer months, I used the climate data measured at the Agrometeorological Station of Kecskemét, while in February, representing the winter months, temperature and humidity were separately measured in the stables.

I placed the instruments used for the inner measurement at head-height of the animals (Urbán, 1983), but at a height where they can be easily read and their safety is no more endangered by the feeder, or slurry removing tractors and machines.

However the distance of the instruments from drinker and feeder must not have an effect on the accuracy of the measurement.

2.1.2. Milk sampling and testing

In order to examine the effect of climatic factors, I used TRU TEST, introduced by the Animal Breeding Performance Testing Ltd. (Állattenyésztési Teljesítményvizsgáló Kft., ÁT Kft.), for milk sampling according to the method determined by the cattle performance testing CODE.

Milk sampling carried out at the farm of Aranytej Kft. included all the animals in testing. Accordingly, shown in Table 2, I retained samples from the morning and evening milking including 116 cows in February and 94 in May on four occasions every month. In July-August sampling of 93 cows was carried out on five occasions.

Table 2
Dates of milk sampling

Month of sampling	February		May		July-August	
Date of sampling	4^{30} a.m.	15^{30} p.m.	4^{30} a.m.	15^{30} p.m.	4^{30} a.m.	15^{30} p.m.
Day of sampling	2 February 2000		8 May 2000		25 July 2000	
	9 February 2000		11 May 2000		1 August 2000	
	16 February 2000		18 May 2000		10 August 2000	
	23 February 2000		23 May 2000		15 August 2000	
					22 August 2000	

I put the samples in standard plastic sampling vials used for this purpose and in order to avoid the quality deterioration, preservative was added to the milk. I delivered the samples to the accredited milk laboratory of the Animal Breeding Performance Testing Ltd. within 24 hrs for the purpose of analysis.

Testing of milk samples covered:

- the milk quantity,
- the butterfat,
- the milk protein,
- the milk-sugar (lactose), and
- the somatic cell count.

2.2. MILK TESTS CARRIED OUT IN OTHER FARMS FOR THE CALIFORNIA MASTITIS AND BACTERIOLOGICAL TESTS

I carried out milk tests for the observation of climatic effects solely at the farm of Aranytej Kft.

However as a result of data obtained through the additional California Mastitis Test (CMT) and the bacteriological examinations, I was inclined to carry out CMT and bacteriological examinations not only in the originally intended, but also other farms to have the most possible data for making sure of the assumptions I came to during my tests carried out at the Aranytej Kft.

For this reason two other farms were involved in the sampling procedure.

On 10th November 2000, then in August 2001 I carried out Mastitest and bacteriological test at the farm of Tolditej Kft. with milk from the udder quarters from 224 and 220 cows, respectively.

I carried out the mastitis-diagnostics screening examination covering all the lactating animals at the farm of the Enying Agrár Rt. in March 2000 and 2001 in such a way that Mastitest proof was executed by milk from all the udder quarters of each animal, then aseptic samples of those showing positive response – probably with high SCC value, considered to suffer in sub-clinical mastitis - were sent for bacteriological examination to the bacteriological laboratory of the National Institute of Animal Health.

In addition to this I collected the individual somatic cell count data of composite milk samples obtained at the ÁT Kft. next to the date of the screening test (about 1 week), as well as in the four months preceding and the two months following the test.

2.2. 1. California Mastitis Test (CMT)

At all the three farms I carried out the California Mastitis Test on each udder quarter of animals involved in the test by means of Mastitest[R] reagent produced by Phylaxia-Sanofi Co. Plastic tray made for that particular purpose was used to perform the proof. I milked the first milk flows in to the bowl of 4 rims in the tray, then by putting the intermediate spaces of the tray in vertical position, I left 2-2 ml milk in the bowls.

I added 2-3 ml Mastitest reagent to the milk samples, then homogenised by elliptical moving. When performing the proof, the ratio 1: 1,5, corresponding to the instructions of the manufacturer was used. I considered the so called one-cross milk samples, showing the just distinguishable change as negative, in order to decrease the number of false positive cases, caused by subjectivity.

2.2.2. Microbiological tests

In the case of all the three farms (Aranytej Kft., Tolditej Kft., Enying Rt.) I carried out the microbiological tests. Bacteriological tests included animals only with somatic cell count above 400,000, as well as those fell ill with mastitis in the case of Aranytej Kft., udder quarters randomly of animals proved to be positive for the Mastitest proof at the farm of Tolditej Kft., and all udder quarters proved to be positive for the Mastitest in the case of Enying dairy-farm.
Following the recommendations of Honkaken-Buzalski and Seune (1995) as well as Quinn et. al. the laboratory processing and the identification of pathogen micro-organisms were executed at the National Institute of Animal Health.

2.3. STATISTICAL ANALYSES

Besides the somatic cell count (SCC), somatic cell score (SCS) and lactation somatic cell score (LSCS), that are well known from the technical literature, I also applied a new transformation method of somatic cell count, that is the actual somatic cell count (Tot SCC) and its logarithmic form (Tot log SCC), respectively. I used it for the purpose of determining and comparing the actual somatic cell count in the milk produced by the animals involved in the test.
The formula used for the computation is as follows:

Tot log SCC = (SCC x Milk kg) x 10^3 illetve 10 log((SCC x Milk kg) x 10^3), respectively

Butterfat, milk protein and milk sugar data obtained by milk sample test - where I calculate in their daily averages - were considered with weighted values, computed on the basis of the following formula (presented for butterfat).

Fat kg x 100/ daily milk kg

where

Butterfat kg = morning milk kg x morning butterfat % + evening milk kg x evening butterfat %

I applied the SPSS 9.0 statistical program for the statistical evaluation of data. The method GLM Repeated Measures was used for data processing. Compared with the commonly used linear regression method, this program has the advantage that it makes the correct statistical evaluation of the panel sampling method possible.
The method also makes the examination of zero-hypothesis on the factors within and between the animals possible, also considering their effect made on each other.

The following basis formula was used:

$$y = \beta_o + \beta_1 X_1 + \beta_2 X2_1 + \beta_n X_n + e$$

$$y_{ijklm} = \mu + N_i + Sz_j + L_k + M_1 + V_m + e_{ijklm}$$

N_i = effect of sampling days (day 1,2,3,4,5), Sz_j = time of milking (a.m. and p.m.), L_k = lactation stage, M_1 = effect of the California Mastitest result, V_m = effect of tested animals, e_{ijklm} = other determinant factor.

Milk quantity, butterfat content, milk protein content, milk sugar content, somatic cell count, actual somatic cell count, logarithmic form of the two latter were the dependent (y) variables.

3. RESULTS

3.1. Effect of the part of the day on the change of somatic cell count

Rate of somatic cell count was always higher in the evening samples. It can be laid down that the rate of somatic cells in the samples from the evening milking was 18 % higher at $P<0,001$ significance level in February, 8 % in May (non-significant) and 13 % at $P<0,05$ significance level in July / August.
However it is remarkable that by the technology of the dairy farms involved in the test, 13 hours passed prior to morning, and 11 hours prior to the evening milking.
Thus the obtained results confirm those earlier research findings (Nader-Filho et. al. 1995; Kégl, 1994) that somatic cell count is inversely proportional to the quantity of produced milk and the time between milking.

Besides the changing of the rate of somatic cells, I examined the development of the actual somatic cell count, showing a very slight change in the comparison of morning and evening milking.

In the average of each sampling day, the actual somatic cell count (Tot SCC) is slightly lower in the evening than the morning milking, that refers to the fact that the getting of somatic cells to the mammary gland is roughly continuous and proportional to the length of the time passed. My tests satisfactorily prove that the existing difference of 2 hrs in the milk production period, does not result in significant difference in the absolute amount of somatic cells.

On the basis of samples from the afternoon milking, 0,84 % increase of the actual somatic cell count at $P<0,05$ significance level was found in the tests carried out in February, while the actual somatic cell count in the samples retained in May, July- August, proved to be equally 0,1 % lower in the milk from the evening milking in both periods.

Examining the effect of the part of the day, that is the difference in the somatic cell count in the milk from the morning and evening milking, it was proved that in the case of milking order applied in conformity with the Hungarian practice, no change in the numerical extent of shedding of somatic cells caused by the effect of the part of the day can be demonstrated.

Based in the obtained results it is also provable that notwithstanding the ratio of somatic cells - similarly to the fat and protein index numbers - shows a close correlation with the milk quantity per milking (r=-0,75), the existing difference of 2 hrs in the length of milk production time spans does not significantly influence the formation and absolute quantity of somatic cells.

3.2. Effect of temperature and humidity on the somatic cell count

Similarly to the quantitative and composite values of milk, there was no significant difference in the somatic cell count in February and May, representing the winter and spring seasons, respectively. The results justify that the animals do not respond with significant milk quantity, composition and somatic cell count deviation to changes arising in 3-18 ^{o}C temperature and 59-75 % humidity points, corresponding to the average Hungarian conditions.

On the other hand, summer tests show substantially different results. Similarly to the quantitative and composite values of milk, there was also a significant change (P<0,05) in the somatic cell count.
The above justify the literature data, accordingly cows respond with somatic cell count increase to heat stress, which in this case the 30,7 ^{0}C average of the maximum daily temperatures.

It is an important observation that although on the effect of the heat stress (that is the 30,7 ^{o}C average daily maximum temperature) there is an increase of somatic cell count, however the actual somatic cell count does not show any significant difference. As in the case of heat stress caused by warm weather an almost same number of somatic cell shedding can be observed, consequently through the decrease of milk quantity, heat stress has only an indirect effect on the increase of somatic cell count rate.

3.3. California Mastitis Test (CMT) for each udder quarter of cows producing extra-quality milk

On the basis of the tests it can be proved that in the individual udder quarters of cows producing composite milk samples with somatic cell count below 400,000,- / ml and described as healthy in the usual udder health programs, subclinical mastitis may be also detected. 9,24 % as well as 15,18 % of cows of the two herds involved in the test had mastitis diseased udder quarters and I am of the opinion that this is a significant ratio justifying to screen and take these animals in udder health care.

Based on my experimental results, I think it cannot be avoided the regular screening test of all the udder quarters of each cow.

Screening of mastitis diseased udder quarters by means of cheap and simply feasible inflammatory marker (e.g. SCC), then identification of pathogens through bacteriological tests, would be the most advantageous way of cost-effectiveness. Using this method - in the case of professional bacteriological diagnostics - cows with udder quarters shedding contagious bacteria can be reliably identified and we are given an overall picture of other pathogens existing in the herd and occasionally responsible for severe economic damage, making the improved prevention of mastitis possible.

Among cows described as healthy, producing composite milk samples with somatic cell count below 400,000,- / ml, where sub-clinical mastitis develops in the individual udder quarters of these animals, the incidence of contagious bacterium (e.g. Staphylococcus aureus) can be established involving a serious danger for the herd and confirms that the somatic cell count of composite milk sample does not give a reliable picture of the udder health status.

Moreover the results of the California Mastitis Test verified that the occurrence of mastitis in the rear udder quarters is 50 % higher than in the front ones and in the interest of a more effective selection for mastitis resistance, one may give consideration to the weighing of somatic cell count to be carried out according to udder quarters or halves.

3.4. Per udder bacteriological test of cows producing milk of extra quality

The bacteriological screening tests clearly verify my earlier observations included in item 3.3 of Section "Results" that rear udder quarters are more susceptible to mastitis. In the present tests *Staphylococcus aureus, CNS, streptococcus,* as well as *coliform* bacteria caused disease in the fore and rear udder quarters in the ratio of 40:60 %.

Somatic cell count of cows with Mastitest positive udder quarters, that do not shed bacteria, is permanently lower than in the case of bacterium shedding cows. Moreover the slow progress, characteristic of bacterium shedding animals, cannot be observed on the basis of somatic cell count in these animals.

In light of the above it may be assumed that the non-classical mastitis of microbal origin, but the response reaction for the physical irritations (mechanical trauma, heat stress, irritations caused by milking-machine) happened to udder, as well as a slight increase of somatic cell count characteristic of the beginning and the end of lactation, exist at least in a part of cows proved to be negative for this pathogen.

This is confirmed by the fact that in the case of these cows, fore and rear udder quarters are roughly equally responsible for the increases of somatic cell count. However data at my disposal are not sufficient for exploring these additional disease causes. However from the point of view of practice I am of the opinion that despite the professional selection of sample giving cows/udder quarters and the properly effective bacteriological methodology the number of negative samples is exceeding 50 %, in this case it is worth carrying out test covering each element of the technology to find out reasons of the somatic cell count increase.

Somatic cell count increase caused by various pathogens is different. Compared to other bacteria *Coagulase Negative Staphylococcus* increase the somatic cell count significantly to a lesser degree. In spite of this fact, their adverse effect on the composite milk sample of the herd is remarkable, as they are the most frequent micro-organisms, causing sub-clinical mastitis in the farm.

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Data verify my earlier conclusion that the incidence of pathogen positive animals in the category of somatic cell count below 400,000,- /ml may not be neglected and it is 15,2 % in the present test. I found the following distribution of bacterial contamination:

Staphylococcus aureus	4,1 %
CNS	7,6 %
Streptococcus	1,6 %
Other	1,9 %

It justifies that the somatic cell count of composite milk sample does not give a reliable picture of the udder health status. This is the reason for making the regular screening test including the whole herd an essential element in the effective and professional prevention against mastitis, including the determination of somatic cell count by udder quarter, the bacteriological test of quarters afflicted with sub-clinical mastitis, giving special attention to the rear udder quarters.

3.5. New scientific results

3.5.1. Not the part of the day, but the time interval between milking has an effect on the development of somatic cell count. At the same time the smaller difference (2 hrs) between the milk production periods does not significantly influence the formation of somatic cells, and absolute quantity, respectively.

3.5.2. Heat stress (over 30 ^{o}C) indirectly increases the ratio of milk somatic cell count, as its unfavourable effect restricts the quantity of produced milk, while does not influence the quantity of the actual somatic cell count.

3.5.3. Contagious bacterium can be also found in the udder quarters of cows, producing composite milk sample with somatic cell count below 400,000,- /ml and described as healthy in the farm practice.

3.5.4. Somatic cell count of composite milk sample does not give a reliable picture of the udder health status of the herd.

3.5.5. Mastitis of bacterial origin is more frequent in the rear udder quarters.

3.5.6. Somatic cell count of cows with Mastitest positive udder quarters, that do not shed pathogen, is steadily lower than in the case of bacterium infected cows. In this case the increase of somatic cell count is not progressive.

3.5.7. Increase of somatic cell count caused by various pathogens shows different degree.

4. CONCLUSIONS AND PROPOSALS

4.1. Proportion of somatic cells is higher in the evening than the morning milking, that is the consequence of thinning effect of the larger quantity from the morning milking, namely the result of the time difference between milking.

4.2. The indirect, unfavourable effect of heat stress on the quantity of somatic cell count calls the attention to the necessity for the relief of heat stress caused by the warm weather.

4.3. Under Hungarian conditions, somatic cell count changes for the effect of the tested environmental factors to a smaller extent than expected, supporting the reliability of the present model used for computing the somatic cell count breeding value and the selection made on this basis.

4.4. The connection between somatic cell count and udder health status is not sufficiently close to base the udder health program merely on the somatic cell count value of the composite milk sample. Therefore it is inevitable to carry out the screening test for all the udder quarters of each cow in regular intervals.

4.5. The 400,000,- / ml somatic cell count value of the composite milk sample must not be considered as the basis for the determination of udder health limit value applied in the present farm practice.

4.6. The higher susceptibility of rear udder quarters to mastitis may necessitate to form the somatic cell count by weighting in the case of some preferred groups to provide a reliable udder health breeding value estimation.

4.7. In the case of some pathogen negative cows no mastitis of microbal origin, but a slighter somatic cell count increase exists, that may be the consequence of other technological problems.

In order to improve the udder health status, I recommend the experts involved in the practice to carry out tests including all the elements of the technology for tracing the reasons of the increase of somatic cell count.

5. LIST OF PUBLICATIONS

PUBLICATIONS ISSUED IN THE SUBJECT MATTER OF THE DISSERTATION

5.1 Publications in foreign language issued in scientific review

BALTAY, ZS. (2002): Influence of time of day the milk and season on the somatic cell count under hungarian condition. *Archive für Tierzucht.* 45. (4) 349-357.p.

JÁNOSI, SZ. ÉS <u>BALTAY, ZS.</u> (2003): Correlation among the somatic cell count of individual bulk milk, result of the California Mastitis Test and bacteriological status of the udder in dairy cows. *Acta Vet. Hung.(accepted)*

5.2. Publications in Hungarian language issued in scientific review

<u>BALTAY, ZS.</u>, BEDO, S. ÉS FARAGÓ, S. (2000): Factors influencing the somatic cell count of milk. 1.Genetic factors. *Tejgazdaság.* 60. (2) 10-15.p.

<u>BALTAY, ZS.</u> ÉS BEDO, S. (2000): Factors influencing the somatic cell count of milk. 2. Physiological and environmental factors. *Tejgazdaság.* 60. (2) 16-25.p.

<u>BALTAY, ZS.</u> ÉS JÁNOSI, SZ. (2001): Comparision of the ‚Californian Mastitis Test' method and the maximum 400,000 somatic cell count per ml' category in the screening of individuals with subclininal mastitis. *Magyar Állatorvosok Lapja.* 10. (123) 596-599.p.

<u>BALTAY, ZS.</u> ÉS JÁNOSI, SZ. (2002): The self defence system of the udder. *Állattenyésztés és Takarmányozás.* 51. (2) 105-115.p.

<u>BALTAY, ZS.</u> ÉS JÁNOSI, SZ. (2003): Domestic field survey to compare milk somatic cell count of morning and afternoon milkings. *Állattenyésztés és Takarmányozás.* 52. (3) 233-240.p.

5.3 Publications issued in full in conference proceedings

KOVÁCS, A. AND BALTAY, ZS. (1999): Effect of meteorological factors on the production of cattle. Poster. Animal Breeding and Feeding. 1999. 48. 6. 652-653. "Hungary at the Millennium" Strategic Researches at the Hungarian Academy of Sciences. Breaking points in the Hungarian Animal Breeding. Conference.

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5.4. Posters and publications issued in conference proceedings in the form of abstract

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BALTAY, ZS. (2001): Circadian change in the somatic cell counts in the milk. Poster MphI.14. 52nd Annual Meeting of the EAAP. Budapest, Hungary, August 26-29,2001. Proceedings, p. 137.

BALTAY, ZS. AND JÁNOSI, SZ. (2001): Comparison of the 'California Mastitis Test' method and the maximum 400,000 somatic cell count per ml category in the screening of individuals with sub-clinical mastitis. Poster MNCSP3.20. 52nd Annual Meeting of the EAAP. Budapest, Hungary, August 26-29, 2001. Proceedings, p. 154.

BALTAY, ZS. AND KOVÁCS, A. (2002): Effect of temperature and humidity on the change of somatic cell count. Poster $Á_3$. XXXIX Óvári Scientific Days, Mosonmagyaróvár. 3-4 October, 2002.

5.5 Conference papers

<u>BALTAY, ZS</u>., JÁNOSI, SZ. AND KOVÁCS, A. (2001): "California Mastitis Test" positive animals found in cow herds considered healthy on the basis of somatic cell count. Paper. 12nd Hungarian Biatric Congress. 12-14 October, 2001. 14-18.

5.6. Other publications issued in the subject matter of the dissertation

BALTAY, ZS. (2001): Warming of the globe and milk production. *Magyar Állattenyésztok Lapja.* 29. (new volume number: VI) (1) 9. p.

<u>BALTAY, ZS</u>. AND KOVÁCS, A.. (2000): Environmental factors influencing the udder health condition. *Holstein Magazin.* 7. (1) 47-49 p.

JÁNOSI, SZ. AND <u>BALTAY, ZS.</u> (2002): California Mastitis Test results of udder quarter milk of animals producing somatic cell count below 400,000 considered as healthy. *Holstein Magazin.* 10. (3) 46-47 p.

<u>OTHER PUBLICATIONS ISSUED IN SUBJECT MATTER NOT BELONGING TO THE DISSERTATION</u>

5.7. Publications in Hungarian language issued in scientific review

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BEDO, S., PÓTI, P., ABAYNÉ HAMAR, E., HOLLÓ, G. AND <u>BALTAY, ZS.</u> (2001): Drinking water consumption of wethers of different genotype. *Állattenyésztés és Takarmányozás.* 50. (6) 555-568.p.

5.8. Publications issued in full in conference proceedings

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