ENVIRONMENTAL FACTORS AFFECTING SOMATIC CELL COUNTS IN HOLSTEIN-FRIESIAN COWS

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ABSTRACT

Data for the present investigation were obtained from 3000 lactation records covering the period from 2007 to 2010, at Dina Farms which located eighty kilometers north of Cairo. This study was conducted to study the effect of some environmental factors on somatic cell counts. The data were analyzed statistically using Statistical Analysis System (SAS). The results obtained showed that, age of the cow and age at calving have significant effects on somatic cell score (SCS). the highest values for SCS were 3.19 and 3.15 which obtained at 56 months and older age and 50 months and above, respectively.

Regarding to order of lactation and stage of lactation both of them have significant effects on somatic cell score. The maximum scores were 3.12 and 3.09 which were obtained at the fifth parity and over and during the late lactation, respectively. In addition, total milk yield, 305-day Mature Equivalent (ME) and test-day milk yield have significant effects on somatic cell score. The highest trend of somatic cell scores for both of total milk yield and 305-day (ME) were obtained at high production level (7401 kg and over) and (8060-9880), respectively. However, the greatest score was 3.44 which obtained at the lowest test-day milk yield (less than 30 kg).

Furthermore, season of calving has a highly significant effect on somatic cell score. The maximum value was 3.11 obtained at Summer months, while, the minimum values were 3.01 and 3.04 which were obtained at Spring and Autumn months, respectively. However, dry period and number of services per conception have non-significant effects on somatic cell score. Scores of somatic cells within the same trend during different classes of dry period and services per conception.

In conclusion, somatic cell counts data should be routinely recorded in order to study the effect of some environmental factors such as age of the cow, age at calving, order of lactation, stage of lactation total milk yield, 305-day Mature Equivalent, test-day milk yield, dry period, days open, number of services per conception and season of calving on somatic cell counts in milk .

INTRODUCTION

Milk somatic cells are primarily leukocytes (White blood cells) and some epithelial cells sheded from the lining of the mammary gland. Indeed, the leukocytes are derived from blood and consist of macrophages, lymphocytes,

and polymorph nuclear cells **(Smith and Harmon, 2001)**.

Somatic cell counts are widely used as a marker to determine the mammary health status of quarters and cows and quality of milk **(Dang and Anand, 2007)**, the suitability of milk for human consumption and monetary losses to producers due to mastitis **(De Graves and Fetrow, 1993)**.

Age at calving, parity of lactation, calving season and lactation stage are the most important factors affecting somatic cell counts in milk as reported by **Sarikaya and Bruckmaier (2006)**.

The present study was conducted to investigate the environmental factors influencing somatic cell counts such as age of the cow, age at calving, order of lactation, stage of lactation total milk yield, 305-day Mature Equivalent, test-day milk yield, dry period, days open, number of services per conception and season of calving.

MATERIAL AND METHODS

Data Source, Herd History, and Herd Management:

Data for present study was obtained from 3000 lactation records, covering the period between 2007 and 2010. The data were taken from the milk records of U.S. Holstein cows belonging to Dina Farms (The Modern Agricultural Development), located about 80 km in Cairo-Alexandria Desert Road. The original herd of U.S. Holstein cows was established between 1987 and 1996 by importation U.S. Holstein cows. All animals were kept in an open system or under open sheds allover the year round, supplied with a cool spraying system during hot climate. Animals had free access to clean water. The animals allover the year were fed on total mixed ration (TMR). All cows are machine-milked, three times with 8 hrs interval between milkings. Cows were dried-off about 60 days before expected calving date or abruptly at 210 days of pregnancy. Also, cows producing 7 kg/day or less milk were dried-off. Cows and heifers eligible for breeding were artificially inseminated using frozen semen from the best 100 total predicted index (T.P.I) Holstein bulls in U.S.A and Canada. Heifers were bred for the first time when their body weight became 375 kg.

Data Handling:

Holstein first, second, up to the tenth lactations with six consecutive test-days (TD) that had both milk yield and somatic cell count reported were selected.

Monthly test-day observations of SCC (expressed in thousands per ml of milk) per lactation for each cow were obtained after 30 days post calving. Because of the skewed distribution of SCC and the importance of normally distributed data when estimating variance components.

The monthly test-day SCC was log-transformed into monthly test-day Somatic Cell Score (SCS) as: SCS= loge (SCC/100) +3 according to **Ali and Shook (1980)**.

The somatic cell count was determined with a Fossomatic machine (Fossomatic 5000, type 71300) (Foss Electric, Hillerod, Denmark). SCC determination were performed in the Dairy Services Unit, which belongs to the

Animal Production Research Institute, Sakha, Kafr El-Sheikh Governorate, Egypt.

Data Statistical Analysis:

The mathematical model:

To analyze the factors affecting the charact-ers studied in the present investigation, the following model was assumed using Statistical Analysis System Package (SAS, 2002).

Yijklmnopqrst= μ + ACOi + ACAj + LACTk + SLl + TOTm + 305-MEn + TDMo + DPp + DOq + NSCr + Ss + eijklmnopqrst.

Symbols in the model are defined as following:

Yijklmnopqrst : is the observation on the cow.

μ : is an effect common to all cows in the population.

ACOi : is an effect due to age of the cow; i = (i.e. 1 = less than 41 months, 2 = 41 to 55 months, 3 = 56 months, and over).

ACAj : is an effect due to age at calving; j = (i.e. 1 = less than 28 months, 2 = 28 to 49 months, 3 = 50 months, and over).

LACTk : is an effect due to lactation order; k = (i.e. 1 = the first, 2 = the second, 3 = the third, 4 = the fourth, and 5 = the fifth or higher lactation).

SLl : is an effect due to stage of lactation; l = (i.e. 1 = early (2-3), 2 = middle (4-6), 3 = late (7 months and over)).

TOTm : is an effect due to total milk yield; m = (i.e. 1 = low (less than 4330 kg, 2 =moderate (4330 to 7400 kg, 3=high (7401kg and over)) .

305-MEn : is an effect due to 305- day mature equivalent(ME); n=(i.e. 1=low (less than 8060kg), 2=moderate (8060 to 9880 kg), 3 = high (9881kg and over)).

TDMo : is an effect due to test- day milk yield; o = (i.e. 1 = low (less than 30), 2 = moderate (30 to 39), high (40 kg and over)).

DPp : is an effect due to dry period; p = (i.e. 1 = less than 60, 2 = 60 to 75, and 3 = 76 days and over).

DOq : is an effect due to days open; q = (i.e. 1 = less than 76, 2 = 76 to 179, and 3 = 180 days and over).

NSCr : is an effect due to number of services per conception; r = (i.e. 1 = less than 3, 2 = 3 to 5, and 3 = 6 times and over).

Ss : is an effect due to season of calving; s = (i.e. 1= Winter (December to February), 2= Spring (March to May), 3= Summer (June to August), 4= Autumn (September to November)).

Eijklmnopqrst : is a random element associated with the individual observation (p = is the residual effect for each observation).

RESULTS AND DISCUSSION

Non-genetic factors affecting somatic cell count in milk:

Table (1) showed the least squares means, standard errors and test of significance of differences among means for different environmental factors affecting somatic cell score (SCS). Age of the cow had a significant effect ($P \leq 0.05$) on somatic cell score. The highest value for SCS was 3.19 which obtained at 56 months and older age, while the lowest value was 2.99, which obtained at cows less than 41 months and 41 - 55 months age. This result can be attributed to the protective mechanisms in udder gland which may deteriorate with advancing age leading to increase SCC trend, as the age of the cow advances indicate the increases of the chance of the cow to be

susceptible to intra-mammary infection and increase the level of SCC in milk. Moreover, an increase in the cellular content of milk with advanced age even for cows that were not infected at the time of testing is the main cause for increasing the somatic cell concentration.

Salsberg et al. (1984) reported that the somatic cell counts at both the lactation and test-day level increased with age up to approximately ten years and thereafter slowly decreased. This result could be explained as the decrease in the SCC for cows greater than 10 years of age, that if cows of this age are still present in the milking herd, they are likely to be good milk producers that have encountered minimal problems during their lactations and this may be then be reflected in their lower counts. However, **Fadlelmoula et al. (2008)** showed that there was a significant effect of age of the cow on SCC. As the age of the cow advances, there is an increase in the chance of the cow to be susceptible to intramammary infection and increase the level of SCC in milk.

Age at calving had a significant effect on somatic cell score ($P \leq 0.05$). The greatest score is 3.15 was obtained at older age at calving (50 months and above), however, the lowest score is 3.08 was obtained at less than 28 months and 28 - 49 months age at calving. As older cows at calving become more susceptible to infection which lead to increase in somatic cell concentrations and increase the incidence of clinical mastitis.

The effect of age at calving resulted in an increase in level of SCC with advanced age from 0.73×10^3 cells/ml (20 months of age) to 1.39×10^3 cells/ml (42 months of age) and 1.0×10^3 cells/ml for calving at 30 months of age **(Samoré at al., 2003). Juozaitiene and Juozaitis (2005)** reported that the effect of calving age on SCC level was found to be statistically non-significant, when they studied the influence of somatic cell count in milk on reproductive and productive traits of Black and White cows.

Order of lactation had a significant effect on somatic cell score ($P \leq 0.05$). The maximum score (3.12) was obtained at the fifth parity and over, while, the minimum score (3.00), (3.01) were obtained in the first and second lactation order, respectively. These results could be explained as deformations in the udder gland and normal enhancing milk production capacity are main reasons of elevated SCC. In addition, relatively higher log-SCC values were determined with advancing lactation order.

Erdem et al. (2010) reported that deformations in the udder gland and increase in milk production capacity are the main reasons of elevated SCC. In spite of relatively higher log SCC values were determined with advancing parity in their study. However, **Schukken et al. (1990)** calculated number of SCC during all parities to be ranged from 300,000 to 375,000 cells/ml in Dutch dairy farms in Netherland.

Stage of lactation had a significant effect on somatic cell score ($P \leq 0.05$). The highest value are 3.08 and 3.09 which were obtained during early and late lactation, respectively. However, the lowest value is 3.00 which was

obtained during mid-lactation. As elevation of SCC in milk in late gestation and for a few weeks following calving regardless of infection status as SCC elevation appears to be a part of cow's natural immune system response in preparation for calving, to enhance the mammary gland defense mechanisms at this critical parturition time.

Erdem et al. (2010) indicated that the latest stage of lactation group had the highest log SCC value, elevated SCC calculated in the third stage of lactation can be explained by the elevation of corroded or injured udder cells towards the end of the lactation. However, **Erdem et al. (2007)** reported that the effect of stage of lactation on SCC was not significant ($P > 0.05$).

Regarding to total milk yield and 305-day Mature Equivalent (ME), both of them had significant effects on somatic cell score ($P \leq 0.05$). The highest trend of somatic cell scores for both of total milk yield and 305-day Mature Equivalent were obtained at high production levels (7401 kg and over) and (8060-9880 kg), respectively. High yielding are linked to high somatic cell concentration and high mastitis level, because high yields cows are more susceptible to infection, which would activate cow's natural immune system leading to increase somatic cell counts in milk as a protective mechanism.

There is a substantial evidence to suggest that high yields are linked to high mastitis levels, although this relationship is complex and inter-relates management, genetics and feeding as reported by **Rajala and Grohn (1998)**. While, **Fadlelmoula et al. (2008)** found that SCC in milk had a significant effect on milk yield, with two folds increase in SCC, there was more than 3.5 kg decrease in milk yield. Moreover, **Hagnestam et al. (2007)** estimated a reduction in 305-day milk yield between 0.0 - 902 kg (11%) due to elevation in SCC depending on parity.

Concerning to test-day milk yield, there was a highly significant effect on somatic cell score ($P \leq 0.01$). The greatest score is 3.44 which was obtained at low test-day milk yield (less than 30 kg), however, the lowest score is 2.58 which was obtained at high test-day milk yield (40 kg and over). This can be explained as during high test-day milk yield there is a small amount of somatic cell counts in large amount of milk (dilution effects), while, if the same somatic cell counts present in low test-day milk yield appear as high somatic cell concentration (no dilution effects).

Daily milk production per cow lowered from the first to the fifth class SCC for 5.40 kg (19.39 %) **(Marija et al., 2003)**. In addition, Hagnestam et al. (2009) stated that daily milk loss at SCC of 500,000 cells/ml ranged from 0.7 to 2.0 kg (3 to 9 %) in primiparous cows, depending on stage of lactation, but in multiparous cows, corresponding loss was 1.1 to 3.7 kg (4 to 18%).

Table (1): Least Squares Means, Standard Errors of Various Environmental Factors Affecting Somatic Cell Score (SCS).

Classification	No.	mean	±	S.E.
Age of the cow (months)				
Less than 41.	581	2.99^{b}	±	0.04
41 – 55.	612	2.99^{b}	±	0.04
56 – and overall.	808	3.19^{a}	±	0.03
Age at calving (months)				
Less than 28.	670	3.08^{b}	±	0.04
28 - 49.	714	3.08^{b}	±	0.03
50 - and overall.	617	3.15^{a}	±	0.03
Order of lactation				
The first.	740	3.00^{c}	±	0.03
The second.	559	3.01^{c}	±	0.03
The third.	318	3.08^{b}	±	0.03
The fourth.	178	3.07^{b}	±	0.04
The fifth and higher lactation.	206	3.12^{a}	±	0.04
Stage of lactation (months)				
Early (2–3).	1075	3.08^{a}	±	0.02
Middle (4–6).	672	3.00^{b}	±	0.02
Late (7– and over all).	254	3.09^{a}	±	0.03
Level of production (kg)				
Low (less than 4330).	184	3.05^{b}	±	0.03
Moderate (4330 – 7400).	513	3.03^{b}	±	0.02
High (7401 and over all).	1304	3.08^{a}	±	0.02
305-day mature equivalent(ME) (kg)				
Less than 8060.	443	3.04^{b}	±	0.02
8060 – 9880.	447	3.07^{a}	±	0.02
9881– and overall.	1111	3.05^{ab}	±	0.02
Test- day milk yield (kg)				
Low (less than 30).	407	3.44^{a}	±	0.02
Moderate (30–39).	550	3.15^{b}	±	0.02
High (40 and over all).	1044	2.58^{c}	±	0.02
Dry period (days)				
Less than 60.	564	3.01^{a}	±	0.02
60 – 75.	605	2.97^{a}	±	0.02
76– and overall.	218	2.99^{a}	±	0.02
Days open (days)				
Less than 76.	195	3.03^{b}	±	0.03
76 – 179.	780	3.07^{a}	±	0.02
180– and overall.	1026	3.06^{a}	±	0.02
Services per conception (number)				
Less than 3.	642	3.06^{a}	±	0.02
3 5.	752	3.05^{a}	±	0.02
6 and overall.	607	3.05^{a}	±	0.03
Season of calving				
Winter.	713	3.06^{b}	±	0.02
Spring.	178	3.01^{c}	±	0.03
Summer.	288	3.11^{a}	±	0.03
Autumn.	822	3.04^{bc}	±	0.02

Within the same classification, the appearance of the same letter with two means signifies that they do not differ significantly (5% level). Otherwise they do.

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الملخص العربى

العوامل البيئية المؤثرة علي عـدد الخلايـا الجسديـة في أبقـار الهولوسـتين فريزيـان

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أجريت الدراسة لمعرفة تأثير بعض العوامل البيئية على عدد الخلايا الجسدية في الأبقار. وقد جمعت بيانات هذه الدراسة من مزارع دينا الواقعة ٨٠ كم شمال القاهرة ، وقد تم الحصول على بيانات ٣٠٠٠ سجل لبن لأبقار فريزيان نقية خلال الفترة من ٢٠٠٧-٢٠١٠، وأجريت التحليلات الإحصائية للبيانات الخاصة بالدراسة اعتماداً على برنامج SAS.

وقد أظهرت الدراسة النتائج الآتية :

١- كان لعمر الحيوان و عمر الولادة تأثيرا معنويا على معدل الخلايا الجسدية، فكان أعلى معدلين للخلايا الجسدية هما٣,١٩ و٣,١٥، وقد تم الحصول عليهما خلال ٥٦ شهرا و اعلي من عمر الحيوان و خلال ٥٠ شهرا و أعلى من عمر الولادة ، علي التوالي.

٢- كان لترتيب موسم الحليب و لمرحلة الحليب تأثيرا معنويا على معدل الخلايا الجسدية، فكان أعلى معدلين للخلايا الجسدية هما٣,١٢ و ٣,٠٩، وقد تم الحصول عليهما خلال موسم الحليب الخامس و أعلى من ترتيب موسم الحليب و خلال مرحلة الحليب النهائية ، علي التوالي.

٣- كان لمستوي الإنتاج الكلي و مستوي الإنتاج خلال ٣٠٥ يوم تأثيرا معنويا على معدل الخلايا الجسدية. فكان أعلى معدلين للخلايا الجسدية هما ٣,٠٨ و٣,٠٧ وقد تم الحصول عليهما خلال أعلى مستوى إنتاج كلي (٧٤٠١ كجم و اعلي) و خلال ٨٠٦٠ - ٩٨٨٠ كجم من مستوي الإنتاج خلال ٣٠٥ يوم، علي التوالي.

٤- مستوي الإنتاج اليومي كان له تأثير معنوي على معدل الخلايا الجسدية. فكان أعلى معدل للخلايا الجسدية هو ٣,٤٤، وقد تم الحصول عليه خلال أقل مستوى إنتاج يومي (اقل من ٣٠ كجم).

٥- لم يكن هناك تأثيرا معنويا لفترة الجفاف و لعدد التلقيحات اللازمة للإخصاب على معدل الخلايا الجسدية. فكانت معدلات الخلايا الجسدية متقاربة خلال الأقسام المختلفة لكل من فترة الجفاف و عدد التلقيحات اللازمة للإخصاب.

٦- موسم الولادة كان له تأثير معنوي على معدل الخلايا الجسدية. فكان أعلى معدل للخلايا الجسدية هو ٣,١١، وقد تم الحصول عليه خلال فصل الصيف ، أما اقل معدلين للخلايا الجسدية هما ٣,٠٤ و٣,٠١ وقد تم الحصول عليهما خلال فصل الخريف و خلال فصل الربيع، علي التوالي.

من خلال هذه الدراسة يمكن استنتاج بعض العوامل البيئية التي تؤثر معنويا علي الخلايا الجسدية. وتتضمن هذه العوامل عمر الحيوان، عمر الولادة ، ترتيب موسم الحليب، مرحلة الحليب، الإنتاج الكلى، الإنتاج خلال ٣٠٥ يوم، الإنتاج اليومي، الفترة المفتوحة، وموسم الولادة. أما فترة الجفاف و عدد التلقيحات اللازمة للإخصاب فلم يكن لهما تأثيرا علي معدل الخلايا الجسدية.