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EVALUATION OF NON GENETIC FACTORS AFFECTING MILK PRODUCTION TRAITS OF HOLSTEIN CATTLE

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ABSTRACT

This study was carried out to evaluate the effects of age at calving (AC), parity, days in milk (DIM), calving interval (CI), days open (DO), dry period (DP), number of services per conception (NSC), season of calving on peak milk yield (PMY), time to attain peak milk yield (TPMY), 305 day mature equivalent (305- DMY) and total milk yield (TMY). Age at calving had significant effect ($P \leq 0.05$) on all traits studied except TPMY. DIM had a highly significant effect ($P < 0.001$) on PMY (37.14- 39.18 kg), TPMY (99.29- 194.08days), 305-DMY (8692.86 - 9760.65 kg) and TMY (4552.82- 12416.95 kg) respectively. Furthermore, DO and DP had a highly significant effect on PMY (33.72- 40.29 and 31.81- 41.08 kg, respectively), TPMY (152.01- 165.14 and 139-165 days, respectively), 305-DMY (8613.83- 9606.83 and 7266.76- 9699.76 kg, respectively) and TMY (8057.51- 8865.18 and 6682.97- 8850.30 kg, respectively). NSC had a highly significant effect ($P < 0.001$) on all traits studied except PMY. On the other hand, parity had no significant influence ($P \geq 0.05$) on all traits studied except PMY. CI had no significant effect on all traits studied except 305-DMY. Moreover, season of calving had no significant effect on all traits studied. In conclusion, these factors should be accounted for genetic evaluation process. At farm level, management decisions such as selection and culling, and feeding should made putting these factors into consideration in order to achieve more reliable evaluation results.

INTRODUCTION

Holstein cows are predominant dairy breed in the world because of their high milk production. In order to enhance productivity of a dairy animal, it is necessary to optimize the factors affecting its milk production **(Dědková and Němcová., 2003).** Management, nutrition, age, year and season in which lactation started are the leading environmental factors affecting lactation performance in cattle. Beside these factors, the persistency level of the highest milk production period reached on lactation is a significant factor. Also, lactation performance in dairy cattle depends upon genetic and environmental factors. Genetic background, climate, diseases, feeding, year and season of calving have been reported to affect milk production, lactation length and dry period, Breed, age, stage of lactation, parity and milking frequency also influence performance production **(Msanga et al., 2000 and Epaphras., 2004).** The aim of this study is to evaluate non genetic factors affecting milk production traits of Holstein cattle in Egypt.

MATERIALS AND METHODS

2.1. Source of data:

Production and Reproduction records of Holstein Friesian cattle were utilized in this study. Recording sheets of individual cows from a private dairy herd on the road of Mansoura- Gamasa at the period of 2010 to 2014. The data comprised of 2065 lactation records of 1575 dairy cows.

2.2. Herd management:

Animals were housed free in shaded open yards, grouped according to their average daily milk yield and fed adlibitum on total mixed ration (TMR) included alfalfa if available all year around. TMR composed of 25% corn silage, 20% alfalfa, 13.5% corn, 6% Gluten, 6.4% linseed meal, 4.6% soya bean meal, 3% cottonseed meal, 1.3% wheat bran, 1.2% hay, 0.4% calcium carbonate, 0.3% sodium bicarbonate and 0.3% sodium chloride and contained 18% crude protein. Feeding allowances were offered according to milk production and physiological status as recommended by **NRC (1989).** In general, cows were artificially inseminated during the first two heats which occurred after 60 days post partum using imported frozen semen. Heifers were artificially inseminated for the first time in the first two heats once they attained 350 kg of live body weight. Pregnancy diagnoses were carried out routinely at 60 days after service by rectal palpation. If conception did not occur or the cows were seen in estrus, the cows were inseminated again. The cows were machine milked three times daily at 06.00h and 14.00h and 22.00h.The calves born were artificially suckled after calving to weaning excluding colostrums' period.

2.3. Statistical analysis:

Various non genetic factors affecting milk yield were analyzed using General Linear Model (GLM) procedure of SAS **(SAS Institute, 2009).**

Statistical model used was:

$$\mathbf{Y_{ijklmnopq} = \mu + AC_i + P_j + DIM_k + CI_l + DO_m + NSC_n + DP_o + S_p + e_{ijklmnopq}}$$

Where,

$Y_{ijklmnopq}$: An observation of each trait.

μ : The overall mean,

AC_i: The effect of age at calving (i: <28, 28- 49 and ≥ 50 months of age).

P_j: The effect of parity (j: The 1st, 2nd, 3rd and $\geq 4^{th}$).

DIM_k: The effect of days in milk (k: < 200, 200-305 and ≥ 351 days).

CI_l: The effect of calving interval (l: < 390, 390-500 day and ≥ 501 days).

DO_m: The effect of days open (m: < 100, 100-185 and ≥ 186 days).

DP_n: The effect of dry period (n: <45, 45-60 and > 60 days).

NSC_o: The effect of of services per conception (o: <3, 3-5 and ≥ 6 services).

S_p: The effect of the calving season (p: Cold Season (from October to March), Hot Season (from April to September).

$e_{ijklmnopq}$: random sampling error.

Table (1): Least Square Means, Standard Errors (LSM ±S.E.) of Various Non-Genetic Factors Affecting Peak Milk Yield (PMY, kg), Time to Attain Peak Milk Yield (TPMY, days), 305 - Day mature Equivalent Milk Yield (305-DMY, kg) and Total Milk Yield (TMY, kg).

Classification	No	PMY	TPMY	305-DMY	TMY
Age at calving (months)					
Less than 28	728	38.42±0.59^{ab}	157.68 ±3.03^{a}	9242.07±161.34^{a}	8658.77±179.60^{a}
28– 49	768	38.50±0.43^{a}	158.47±2.22^{a}	9285.02±118.25^{a}	8687.42± 131.6^{a}
≥ 50 months	559	36.71±0.47^{b}	157.47±2.41^{a}	9019.25±128.46^{b}	8326.91±143.01^{b}
Order of lactation (Parity)					
The first	936	37.47±0.42^{b}	155.79 ± 2.17^{a}	9170.40±115.78^{a}	8535.32±128.89^{a}
The second	535	37.35±0.42^{ab}	155.13± 2.17^{a}	9086.62±115.67^{a}	8336.85±128.76^{a}
The third	324	38.57±0.59^{a}	160.76± 3.01^{a}	9243.58±160.43^{a}	8696.48±178.59^{a}
≥ The fourth	260	38.10±0.69^{ab}	159.82 ± 3.56^{a}	9227.87±189.46^{a}	8662.15±210.90^{a}
Days in milk (days)					
Less than 200	764	39.18±0.30^{A}	99.29 ±1.53^{C}	8692.86±81.39^{C}	4552.82±90.60^{C}
200 – 350	840	37.14±0.29^{B}	180.25±1.51^{B}	9092.84±80.37^{B}	8704.34±89.47^{B}
≥ 351 days	451	37.31±0.36^{B}	194.08±1.84^{A}	9760.65±98.09^{A}	12416.95±109.20^{A}
Calving interval (days)					
Less than390	435	40.27±0.35^{a}	161.47±2.44^{a}	9271.66±101.54^{C}	8451.95±174.98^{a}
390-500	379	40.60±0.38^{a}	161.63±2.62^{a}	9595.36±108.78^{B}	8888.02±187.46^{a}
≥ 501 days	298	41.06±0.42^{a}	156.77±2.95^{a}	9958.42±122.68^{A}	8946.07±211.40^{a}

Table (1) Continue:

Classification	No	PMY	TPMY	305-DMY	TMY
Days open (days)					
Less than 100	433	40.29±0.36^{A}	1617±1.86^{B}	9325.68±98.96^{B}	8750.42±110.163^{B}
100 –185	846	39.61±0.29^{B}	165.14±1.48^{A}	9606.83±78.74^{A}	8865.18±87.65^{A}
≥ 186 days	776	33.72±0.32^{C}	152.01±1.63^{C}	8613.83±86.81^{C}	8057.51±96.64^{C}
Service per conception					
Less than 3	853	37.62±0.31^{a}	152.43±1.59^{C}	9060.52±85.30^{C}	8155.05±94.40^{C}
3-5	681	37.78±0.32^{a}	161.87±1.60^{B}	9254.92±85.78^{B}	8487.35±94.94^{B}
≥ 6 services	466	38.53±0.38^{a}	162.78±1.92^{A}	9342.25±103.06^{A}	9270.48±114.07^{A}
Dry period (days)					
Less than 45	37	31.81±1.17^{B}	139±8.42^{B}	7266.76±343.59^{B}	6682.97±597.11^{B}
45-60	266	40.23±0.44^{A}	165±3.14^{A}	9481.84±128.15^{A}	8850.30±222.69^{A}
> 60 days	808	41.08±0.25^{A}	159±1.80^{A}	9699.76±73.53^{A}	8793.89±127.77^{A}
Season of calving					
Winter	1404	37.55±0.19^{a}	151.43±1.47^{a}	9063.89±51.85^{a}	7969.50±99.15^{a}
Summer	661	37.57±0.26^{a}	151.14±2.05^{a}	9118.33±69.64^{a}	7896.55±143.71^{a}

Least squares means with different small superscripts differ significantly ($P \leq 0.05$).
Least squares means with different capital superscripts differ significantly ($P \leq 0.01$).

RESULTS AND DISCUSSION

I. Non genetic factors affecting peak milk yield (PMY, Kg) and time to attain peak milk yield (TPMY, day):

Table (1) showed that age at calving significantly influenced (P≤ 0.05) PMY. The highest value was 38.50 Kg at 28– 49 months. However, the lowest value was 36.71 kg at ≥50 months of age. The significant effect of age at calving on PMY was in agreement with the findings of **Terkeli et al. (2000) and Wasike et al. (2010).** On the contrary, age at calving had no significant effect (P ≥ 0.05) on TPMY, Similar results were reported by **Wasike et al. (2010).**

Parity had no significant effect (P ≥ 0.05) on both PMY and TPMY. This finding is disagreed with **Wasike et al. (2010) and Aksakal et al. (2010)** who found significant effect of parity on PMY and TPMY and day to reach peak yield decrease with advancing parity. Highly significant effect (P ≤ 0.0001) of DIM on both PMY and TPMY. The highest PMY and TPMY were 39.18 kg and 194.08 day at > 200 and ≥ 351day, respectively. However, the lowest values were 37.14, 99.29 which obtained at 200 – 350 day and > 200day for PM and TPMY, respectively. These results were in accordance with that of **Hammoud and salem (2013).**

Calving interval had no significant effect (P ≥ 0.05) on both PMY and TPMY. Similarly, **Andersen et al. (2011)** represented that peak yield as well as peak day did not differ significantly with calving interval groups. Similarly, no significant differences between maximum milk productivity at different lactation lengths were found by **Pollot et al. (2011).**

Days open had a highly significant effect (P≤ 0.0001) on both peak milk yield (PMY) and time to attain peak milk yield (TPMY). The highest values were 40.29 kg, 165.14 days obtained at > 100 day and 100 –185 days for PMY and TPMY, respectively. However, the lowest values were 33.72 kg, 152.01 days which obtained at ≥ 186 day for PMY and TPMY days, respectively. The previous results of PMY were in consistence with previous reports **(Terkeli et al. (2000), Ali et al. (2000), Lopez-Villalobos et al. (2005), Pollot et al. (2011) and Rzewuska and Strabel, 2015).**

Effects of number of service per conception were non significant (P >0.05) on peak milk yield, while number of service per conception had a highly significant effect (P< 0.0001) on time to attain peak milk yield. The highest value was 162.78 days obtained at ≥ 6 services. The lowest value was 152.43 days and obtained at > 3. **Rzewuska and Strabel (2015)** exhibited that increase NSC by increased peak milk yield as cows with productivity require more insemination to conceive which attributed to negative energy balance of high producing cows which decrease conception rate.

Highly significant effect (P ≤0.01) of dry period on both PMY and TPMY is reported in the present study (Table 1), cows within DP classes (Standard DP) of 45-60 days had higher peak milk yield compared with those with dry period of >45 days. Furthermore, peak milk yield was achieved later in cows with 45-60days dry period than in those with dry period of >45 d. The present results are in consistence with those reported by **Atashi et al. (2013a) and Shoshani et al. (2014).** The significant effects of DP on TPMY were in accordance with **Aly et al. (2002).** The too short as well as too long dry periods have a negative effect on milk yield and this confirm previous reported results by **Winnicki *et al.* (2008), Pytlewski *et al.* (2009) and We¸glarzy (2009).**

Calving season had no significant effect (P> 0.05) on peak milk yield. Moreover, it had no significant effect on time to attain peak milk yield. **Aksakal et al. (2010)** showed non-significant effect of year and season on peak milk yield, but a significant effect on TPMY. On the other hand, the results obtained were disagreed with the findings of **Wasike et al. (2010) and Hammoud and Salem (2013).**

II. Non genetic factors affecting total milk yield (TMY) and 305 - day mature equivalent milk yield (305- DMY):

Regarding the age at calving, significant effect of AC on both TMY and 305-DMY were reported (Table1). The highest values of TMY (8687.42 kg) and 305 DMY (9285.05 kg) were obtained at 28– 49 months of age. These results are in accordance to those of **Muhamdi et al. (2012), Boujenane and hilal (2012) and Nyamushamba et al. (2014). Wasike et al. (2010)** confirms that milk yield increases with age up to maturity and decreases thereafter, increase milk yield by age due to increase body weight that increases with the age, the decline of milk after that due to degeneration of secretory tissue of mammary gland and decrease physiological activity of the body. On the other hand, the results obtained were disagreed with those reported **EL- Shalmani (2011).**

Parity had no significant effect (P ≥ 0.05) on both TMY and 305-DMY. Generally there were no significant differences between TMY and 305-DMY for all classification of parity. The results obtained were in agreement with **Aksakal et al. (2010) and Habib et al. (2003)** who found no significant effect of lactation number on actual milk yield. On the contrary, other literatures as **Faid-allah (2015), Usman et al. (2012). Boujenane and hilal (2012)** concluded that there is a significant effect of parity on TMY and 305-DMY as milk yield increased by parity. A highly significant effect of DIM on both TMY and 305-DMY. The highest milk yield were 12416.95 kg and 9760.65 kg at ≥351 days (TMY and 305-DMY, respectively). However, the lowest values were 4552.82 kg and 8692.86 kg and obtained at > 200 day (TMY and 305-DMY, respectively). The significant effect of DIM on milk yield is in agreement with that of **Wasike et al. (2010) and Nyamushamba et al. (2014).**

Calving interval (CI) had no significant effect on TMY which disagree with the findings of **Ahmed et al. (2002).** A highly significant effect (P≤ 0.0001) of CI on 305-DMY that is in accordance with **Baul et al. (2013), Atashi et al. (2013b), Němečková et al. (2015)**.

A highly significant effect (P≤ 0.0001) of DO on both TMY and 305-DMY is demonstrated (Table 1). Concerning to TMY, the highest yield was 8865.18 kg which obtained during 100 –185 day of days open, however, the lowest value of milk yield was 8057.51 kg obtained at ≥ 186 day. Regarding to 305 - DMY, the highest yield was 9606.83 kg obtained at 100 –185 day; however, the lowest milk yield was 8613.83 at ≥ 186 day. The highly significant effects are in accordance to that reported **by Ali et al. (2000, 2003) and Tekerli et al. (2000).**

Number of service per conception had a highly significant effect (P< 0.0001) on both TMY and 305-DMY. The highest value was 9270.48 and 9342.25 kg respectively obtained at ≥ 6 services. While the lowest value was 8155.05 and 9060.52 kg which obtained at >3services for total milk yield and 305 - day mature equivalent milk yield respectively (Table 1). These results are in consistence with that reported by **Sattar et al. (2005)** that high NSC resulted from either failure to conceive at a given service and/or failure to maintain pregnancy thus requiring repeated service. These significant differences might be due to variations in the management, environment and fertility status of the breeding. **Wathes et al. (2007)** revealed that influence of high milk yield on fertility and negative energy balance is associated with the accumulation of triacyloglycerols in the liver, which affects the growth hormone-insulin growth factor I axis and prolongs the interval from parturition to the first ovulation.

The effect of DP were significant ($P \leq 0.01$) on both TMY and 305- DMY (Table 1). Cows within DP classes (Standard DP) of 45-60 days had higher 305- DMY(9481.84 kg) and TMY (8850.30 kg) compared with those with dry period of >45 days (7266.76 and 6682.97 kg for 305- DMY and TMY, respectively). Similar results were reported by **Kuhn *et al.* (2005, 2007), We¸glarzy (2009), Ghavi Hossein-Zadeh and Mohit (2013), Atashi et al. (2013a), Shoshani et al. (2014).** On the other hand, **Pezeshki et al. (2008)** reported decreasing days dry from 49 to 28 day, DP had no effect on 305-d milk yield.

Season of calving had no significant effect on both TMY and 305- DMY. These results are in accordance to the findings of **Monalisa *et al.* (2010), Nyamushamba et al. (2014) and Hammoud and salem (2013)** who observed that the season of calving had a non-significant effect on TMY and 305-DMY in Holstein Friesian cows. This result may be attributed to animals were fed on TMR ration all over the year and due to using evaporative cooling system. On the contrary of **Aksakal et al. (2010), Usman et al., 2012, Boujenane and Hilal (2012)** who reported significant effect of season of calving on milk yield.

CONCLUSION

From the results of this study, it could be concluded that days in milk, days open, dry period and number of service per conception had a highly significant effect on milk production traits. Farmers are advised to manipulate the environment in such a way that genetic potential of the cows can be expressed. Planning an effective herd breeding, feeding, and managerial programs, in addition to studying of these factors will improve productive and reproductive efficiency.

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الملخص العربي

تقييم العوامل الغير وراثية التى تؤثرعلى صفات إنتاج اللبن فى أبقار الهولشتين

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أجريت هذه الدراسة لمعرفة تأثير كل من العوامل التالية مثل العمر عند الولادة، ترتيب موسم الحليب، أيام الحليب، الفترة بين ولادتين، الفترة المفتوحة ،عدد التلقيحات اللازمة لحدوث الاخصاب ، وكذلك تأثير موسم الولادة على كل من أعلى إنتاج للبن ، الوقت الذى وصل فيه الانتاج لأعلى كمية ، إنتاج اللبن الكلى وكذلك إنتاج اللبن خلال ٣٠٥ يوم من الحليب.وقد أظهرت الدراسة النتائج التالية :

١- كان للعمر تأثيرا معنويا على جميع الصفات تحت الدراسة عدا الوقت الذى وصل فيه الانتاج لأعلى كمية، كما أظهرت أيام الحليب تأثير معنوي على جميع الصفات محل الدراسة مثل أعلى انتاج للبن حيث يتراوح من (٣٧،١٤ - ٣٩،١٨ كجم) ،الوقت الذي وصل فيه الانتاج لأعلى كمية (٩٩,٢٩ - ١٩٤،٠٨ أيام) ، وإنتاج اللبن خلال ٣٠٥ يوم من الحليب (٨٦٩٢,٨٦ - ٩٧٦٠,٦٥ كجم)، وكذللك إنتاج اللبن الكلى (٤٥٥٢,٨٢ - ١٢٤١٦,٩٥ كجم).

٢- كما أظهرت الفترة المفتوحة، وأيام الجفاف تأثير معنوي على جميع الصفات محل الدراسة مثل أعلى إنتاج للبن حيث يتراوح من (٣٣,٧٢ - ٤٠,٢٩ و٣١,٨١ - ٤١,٠٨ كجم على الترتيب) ،الوقت الذى وصل فيه الانتاج لأعلى كمية (١٥٢,٠١- ١٦٥,١٤و ١٣٩ - ١٦٥ أيام على الترتيب) ، وإنتاج اللبن خلال ٣٠٥ يوم من الحليب (٨٦١٣,٨٣ - ٩٦٠٦,٨٣ و ٧٢٦٦,٧٦ - ٩٦٩٩,٧٦ كجم على الترتيب) وكذللك إنتاج اللبن الكلى (٨٠٥٧,٥١ - ٨٨٦٥,١٨ و٦٦٨٢,٩٧ - ٨٨٥٠,٣٠ كجم على الترتيب).

٣- كان لعدد التلقيحات اللازمة لحدوث الاخصاب تاثير معنوى على كل الصفات عدا أعلى إنتاج للبن.على الجانب الاخر، لم يكن لترتيب موسم الحليب تأثير معنوى على الصفات محل الدراسة عدا الوقت الذى وصل فيه الانتاج لاعلى كمية . لم يكن للفترة بين ولادتين تأثير معنوى على جميع الصفات عدا إنتاج اللبن خلال ٣٠٥ يوم . لم يكن لموسم الحليب تاثير معنوى على جميع الصفات محل الدراسة.نستخلص من ذلك أنه ينبغى أخذ هذه العوامل فى الاعتبار خاصة فى عملية التقييم الوراثى، فعلى مستوي المزرعة ، القرارت الخاصة بالانتخاب والاستبعاد وكذلك التغذية لابد ان تجعل هذه العوامل فى الاعتبار من أجل تحقيق نتائج أكثر واقعية واكثر دقة .