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Effect of some non-genetic factors on 305-day milk yield and lactation persistency in Holstein Friesian cows

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ABSTRACT

This study was performed on productive data collected from private farm of Holstein Friesian cows. The objective of this study was to evaluate the effect of days in milk (DIM), peak milk yield (PMY), dry period (DP), calving interval (CI), parity, and season of calving on 305-day milk yield (305-DMY). And the effect of 305- day milk yield (305-DMY), peak milk yield (PMY), days in milk (DIM), parity, and season of calving on lactation persistency. We found that DIM, parity, and PMY had significant effect on 305-DMY, the highest milk production was obtained when DIM more than 357 days and in the 1st lactation. Moreover, PMY, 305-DMY, and season of calving had significant effect on lactation persistency. In addition, average estimated breeding value (EBV) for 305-DMY, PMY and CI was higher in sire than in cow and dam. Also, Average estimated breeding values for lactation persistency, DP, and DIM were higher in dam than in cow and sire.

1. INTRODUCTION

In Egypt, dairy industry represented about 35% of the total animal production sector. Accordingly, considerable emphasis had been directed to importation of large Friesian herds from Europe and USA as important dairy animals in Egypt (Shalaby et al., 2001). Friesian cows were introduced to Egypt to improve the productivity of local cows by crossing and grading. Friesian cows spread in Egypt and became famous and desirable among breeders due to they are examples of a dual purpose breed, known as the world's highest-production dairy animals, a fast growing and beef animals (Hassan et al., 2018).
Persistency is usually the rate of decline in milk production after the peak or the ability of a cow to maintain high milk production (Cole and Null, 2009). This indicates that a cow with a flatter lactation curve is more persistent than a cow with the same total yield but with a lactation curve that decreases rapidly after the peak yield (Sahinler, 2009). Various environmental factors can affect the lactation persistency such as genetic group, herd management, lactation number, feeding, gestation length, parity, and season of calving of animals (Koloi et al., 2018). There are several methods of estimation of persistency. These can be broadly classified into three categories: Ratio method, variation of yields method and Mathematical lactation curve model. The Rao and Sundaresan method (Rao and Sundaresan, 1982) and Khmel'Nit skii method (Khmel'Nit skii, 1974) are considered examples of ratio methods. While Solkner and Fuchs method (Sölkner and Fuchs, 1987) and Gengler and co-worker method (Gengler, 1996) are different types of variation of yield methods. Wood's gamma function (Wood, 1968) is one of the examples of Mathematical lactation curve model. Among these, the estimation of persistency derived from ratio method is considered to be most effective as compared to other methods (Kaushal et al., 2016) .
The objective of this study was firstly to estimate the effect of days in milk (DIM), peak milk yield (PMY), dry period (DP), calving interval (CI), parity and season of calving on 305-day milk yield (305-DMY). Secondly to estimate the effect of 305-day milk yield (305-DMY), peak milk yield (PMY), days in milk (DIM), parity, and season of calving on lactation persistency and finally to estimate breeding values for some productive and reproductive traits.

2. MATERIAL AND METHODS

2.1. Animals
Productive data of 1480 records were collected from private farm of Holstein Friesian cattle belonged to DINA Farms for Agricultural investment, located at Km 80 in Cairo-Alexandria desert road.

2.2. Herd Management
All animals were kept in open system and under open sheds all over the year, they were supported by a cool spraying system during the summer season. The animals all over the year were fed on total mixed ration (T.M.R) with four different groups of rations for pre-freshening, freshly

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calved, high producing and low producing cows depending on dry matter intake (DMI).

2.3. Ethical approval
The current work was approved by the Committee of Animal Care and Welfare, Benha University, Faculty of Veterinary Medicine, Egypt (BUFVTM: 04-07-20).

2.4. Estimation of lactation persistency
The formula for estimation of persistency (P) through Khmel'Nit skii method was given as below.

$$p = \frac{\text{peak milk yield}}{\text{305 day milk yield}} X\,100$$

2.5. Statistical analysis
The effect of some non-genetic factors was analyzed using a one-way analysis of variance with days in milk, peak milk yield, dry period, calving interval, parity and season of calving as a fixed effect in a general linear model (GLM) using the SAS software ver.9.1.3 (SAS Institute Inc, Cary, NC, USA) SAS (2001) for model 1 and 2 and using (MTDFREML) program of Boldman et al. (1995) for model 3.

Model 1:
To analyze the factors affecting on 305-DMY, the following model was assumed.

$$Yijklmno = \mu + DIMi + PMYj + DPk + CIl + Pm + Sn + b\,(AFC) + eijklmno.$$

Symbols in the model are defined as the following:

$Y_{ijklmno}$: The observed value; (i.e. 305-DMY).

μ : The overall mean.

DIM_i : The effect of the ith days in milk; (i= 1, 2, 3, and 4: where 1= less than 211 days; 2= 211-357 days, and 3=more than 357 days).

PMY_j : The effect of the jth peak milk yield; (j=1, 2, and 3: whereas 1=less than 35 kg; 2= 35-43 kg, and 3=more than 43 kg).

DP_k: The effect of the kth dry period; (k=1, 2, and 3: whereas 1=less than 54 days; 2=54- 61 days, and 3=more than 61 days).

CI_l : The effect of the lth calving interval; (l=1, 2, and 3: whereas 1= less than 13 months; 2=13 - 15 months, and 3=more than 15 months).

P_m : The effect of the mth parity; (m= 1, 2, 3, and 4: where 1=first parity; 2=second parity; 3=third parity, and 4= fourth parity or more).

S_n: The effect of the nth season of calving; (n=1, 2, 3, and 4: whereas 1= winter season; 2= spring season; 3=summer season, and 4=autumn season).

b (AFC): partial linear regression coefficients of $Y_{ijklmno}$ on age at first calving.

$e_{ijklmno}$: random error.

Model 2:
To analyze the factors affecting on lactation persistency, the following model was assumed.

$$Y_{ijklmn} = \mu + L_i + PMY_j + DIM_k + P_l + S_m + e_{ijklmn}.$$

Symbols in the model are defined as the following:

Y_{ijklmn}: The observed value; (i.e lactation persistency).

μ : The overall mean.

L_i : The effect of the ith level of production (305-DMY); (i=1, 2, and 3: whereas 1= less than 8643 kg; 2=8643-10440 kg, and 3=more than 10440 kg).

PMY_j : The effect of the jth peak milk yield; (j=1, 2, and 3: whereas 1=less than 35 kg; 2= 35-44 kg, and 3=more than 44 kg).

DIM_k : The effect of the kth days in milk; (k=1, 2, and 3: whereas 1=less than 156 days; 2= 156-370 days, and 3=more than 370 days).

P_l : The effect of the lth parity; (l= 1, 2, 3, and 4: where 1=first parity; 2=second parity; 3=third parity, and 4= fourth parity or more).

S_m: The effect of the mth season of calving; (m=1, 2, 3, and 4: whereas 1= winter season; 2= spring season; 3=summer season, and 4=autumn season).

e_{ijklmn}: random error.

Model 3:

Breeding values of studied traits were estimated with derivative free restricted maximum likelihood (DFREML) procedures using (MTDFREML) program of Boldman et al. (1995). The assumed model was:

$$Y = Xb + Za + e$$

Y: Is the vector of the observed trait.

X: Is the incidence matrix of fixed effect.

b: Is the vector of fixed effect.

Z: Is the incidence matrix of random animal effect.

a: Is the vector of random animal effect.

e: Is the vector of random residual effect.

3. RESULTS

3.1. Effect of non-genetic factors on 305-day milk yield (305-DMY)
The least squares means and standard errors for different factors affecting 305-day milk yield (305-DMY) were shown in table 1. Days in milk had a significant effect ($P\leq 0.05$) on 305-DMY. The maximum milk yield was 9438 kg when DIM was more than 357 days, while the lowest yield was 8153.88 kg obtained when DIM was less than 211 days. Parity had a highly significant effect ($P\leq 0.01$) on 305-DMY. First season of lactation showed the maximum amount of milk (9175.83 kg) followed by the second parity (9161.34 kg) then the third parity (8897.94 kg), and finally the fourth lactational season or more showed the lowest yield (8543.39 kg). Also, peak milk yield had a highly significant effect ($P\leq 0.01$) on 305-DMY. The maximum milk yield was 9559.25 kg when peak milk yield was more than 43 kg daily, while the lowest yield was 8193.43 kg that obtained when peak milk yield was less than 35 kg .daily

Dry period had a non-significant effect on 305-DMY. The highest value of 305-DMY (9049.92 kg) was recorded when DP was between 54-61 days and lowest yield (8751.79 kg) was showed when DP was less than 54 days. Also, season of calving and CI had a non-significant effect on 305-DMY.

3.2. Effect of non-genetic factors on lactation persistency

The least squares means and standard errors for different factors affecting lactation persistency were shown in table 2. Peak milk yield had a highly significant effect (P≤ 0.01) on lactation persistency. The cow was more persistent for lactation (0.57) when peak milk yield was more than 44 kg daily milk yield. Also, 305-DMY had a highly significant effect (P≤ 0.01) on lactation persistency. The cow was more persistent for lactation (0.55) when the milk production (305-DMY) was less than 8643 kg of milk. Season of calving had a significant effect on lactation persistency. Animals that calved in winter season had more lactation persistency than the cows calved in other seasons. But DIM and parity had a non-significant effect on lactation persistency.

3.3. Estimation of breeding values for some productive and reproductive traits.

The average estimated breeding values (EBV) for 305-DMY, PMY, and CI were higher (3500, 1.8 and 3.5, respectively) in sire than in cow and dam as shown in table 3. Also, Average estimated breeding values for lactation persistency, DP and DIM were higher (1.2, 1.5 and 1.1, respectively) in dam than in cow and sire.

Table (1): Least-squares means (±SE) of various factors affecting 305-day milk yield (305-DMY).

Classification	N	L.S.M ± S.E
1. Days in milk		
<211	144	8153.88[b] ±572.50
211-357	283	9241.90[ab] ±100.89
>357	292	9438.09[a] ±96.95
2. Peak milk yield (daily)		
<35	258	8193.43[c] ±213.23
35-43	190	9081.21[b] ±227.23
>43	271	9559.25[a] ±216.29
3. Dry Period (days).		
<54	220	8751.79 ±223.90
54-61	274	9049.92 ±218.03
>61	225	9032.17 ±214.52
4. Calving of interval (months)		
<13	281	9421.05 ± 112.64
13-15	308	9584.69 ± 107.53
>15	292	9596.60 ± 110.49
5. Parity.		
The 1[st] lactation	279	9175.83[a] ±211.95
The 2[nd] lactation	203	9161.34[a] ±222.95
The 3[rd] lactation	142	8897.94[ab] ±233.49
The 4[th] lactation and more.	98	8543.39[b] ±259.34
6. Season of Calving.		
Winter	162	8747.05 ±230.45
Spring	113	9146.43 ±250.24
Summer	217	8935.37 ±226.21
Autumn	227	8949.65 ±213.04

Within the same classification, the appearances of least square means with the different letters are significantly different (p ≤ 0.05). Otherwise, they do not.

Table (2): Least-squares means (±SE) of various factors affecting lactation persistency.

Classification	N	L.S.M ± S.E
1. 305 DMY		
<8643	22	0.55[a] ±0.02
8643-10440	24	0.43[b] ±0.02
>10440	24	0.35[c] ±0.02
2. Peak milk yield (daily)		
<35	22	0.34[c] ±0.02
35-44	28	0.42[b] ±0.01
>44	20	0.57[a] ±0.02
3. Days in milk		
<156	24	0.45 ±0.02
156-370	22	0.43 ±0.02
>370	24	0.45 ±0.02
4. Parity.		
The 1[st] lactation	14	0.41 ±0.02
The 2[nd] lactation	19	0.45 ±0.02
The 3[rd] lactation	22	0.45 ±0.02
The 4[th] lactation and more.	15	0.45 ±0.02
5. Season of Calving.		
Winter	21	0.47[a] ±0.02
Spring	5	0.45[ab] ±0.03
Summer	24	0.43[b] ±0.01
Autumn	20	0.43[ab] ±0.02

Within the same classification, the appearances of least square means with the different letters are significantly different (p≤ 0.05). Otherwise, they do not.

Table (3): Estimated breeding value for different studied productive traits, reproductive traits and persistency for Cow, Sire and Dam.

Trait	Estimated Breeding Value								
	Cow			Sire			Dam		
	Min	Max	Average	Min	Max	Average	Min	Max	Average
DIM	-84.1	141.5	-13.5	-122.8	104.7	-3.5	-40.2	82.7	1.1
CI	-2.2	4.4	-0.19	-1.7	2.5	3.5	-1.6	3.1	1.4
DP	-3.4	4.2	-0.4	-2.9	2.9	-1.8	-2.1	2.1	1.5
305ME	-6900	4200	30	-4400	1500	3500	-4600	2500	-2200
PMY	-22.5	13.4	0.14	-16.6	9.9	1.8	-15.4	8.6	-1.1
Persistency	-0.1	0.13	-0.0002	-0.1	0.04	-3.5	-0.1	0.20	1.2

4. DISCUSSION

This study aimed to evaluate the effect of some non-genetic factors (days in milk (DIM), peak milk yield (PMY), dry period (DP), calving interval (CI), parity, and season of calving) on 305-DMY and lactation persistency. Days in milk had a significant (P≤ 0.05) effect on 305-DMY. This result was in accordance with Fouda et al. (2017) and Sevinc et al. (2020) who stated that days in milk significantly affect the 305-DMY, where cows having middle lactation length tend to produce the middle amount of milk, while the ones having high lactation length produce a high amount of milk in of Holstein Friesians. This result disagreed with Abd-El Hamed and Kamel (2021) who reported that the highest 305-DMY values were attained at DIM 301-330 days then milk yield decreased. Parity had a highly significant effect (P≤ 0.01) on 305-DMY. Where, first season of lactation showed the maximum amount of milk (9175.83 kg). The obtained results were in the same line of those obtained by Bolacali and Öztürk (2018) who stated that the maximum amount of 305-DMY was in the 1st and 2nd parity in Simmental cattle, this might be due to the presence of many number of secretory cells in mammary gland, which maintain their secretory activity for longer time in first lactation as compared to subsequent lactations and within later parities, the cow exposed to subsequent mammary infection so lead to decrease milk production (Koloi et al., 2018). These results disagreed with Manzi et al. (2020) who found that the lowest milk yield was obtained in first parity cows with an increase till the fourth parity .

Regarding PMY, it had a highly significant effect (P≤ 0.01) on 305-DMY. In agreement with present study, Stephen (2016) found that peak milk yield had a significant effect (P≤ 0.05) on 305-DMY in Holstein Cows. Dry period had a non-significant effect on 305-DMY. In a similar study, Kiyici et al. (2020) noted that dry period had a non-significant effect on 305-DMY, the highest milk yield (7808.6 kg) was obtained from DP group with more than 71 days, and the lowest milk yield (7529.4 kg) was obtained from DP group with lower than 40 days in Holstein Cows. The reason for low milk yield in cows with short DP may be due to the smaller number of udder epithelial cells in these cows. As, the DP provides an opportunity to repair the damage to the mammary gland of the cow and the cells of both alveolar and canal system, in addition cows store mineral and vitamin for the next lactation during dry period (Kiyici et al., 2020). In disagreement with Boujenane (2019) who stated that dry period had a significant effect on 305-DMY in Holstein cows and maximize milk yield at dry period of 40 to 80 days.

Season of calving had a non-significant effect on 305-DMY. The maximum milk yield was 9146.43 kg obtained in spring season, which might be due to uniformity in the availability of fodders and feed all over the year. That is in agreement with Bolacali and Öztürk (2018) and Manzi et al. (2020) who found that season of calving had a non-significant effect on 305-DMY in Simmental cattle and in Ankole crossbreds. The season of calving effect for a trait that is measured over a long time, e.g., 305-DMY, is the result of combination of a succession of seasons over 10 months, not only the actual calving season. This might be the reason of why the effect was diluted for 305-DMY (Manzi et al., 2020). In contrast, Abd-El Hamed and Kamel (2021) noted that season of calving had a significant effect on 305-DMY and the maximum milk yield was obtained in winter season.

In responding to factors affecting lactation persistency, peak milk yield had a highly significant effect (P≤ 0.01) on lactation persistency. This result was in accordance with Pereira et al. (2021) who observed that peak milk yield had a significant effect on lactation persistency in dairy Gyr cattle. However, Mostert et al. (2008) observed that cows with very high production at peak would have a steeper slope in lactation curve than low producing cows so less persistency of milk yield. Also, Torshizi et al. (2019) found that persistency was related with low peak yield and selecting cows for peak yield improved persistency and lactation curve traits in dairy cows.

305-DMY had a highly significant effect (P≤ 0.01) on lactation persistency. The obtained results were in agreement with those obtained by Atashi et al. (2006) who showed that 305-DMY had a significant effect on lactation persistency in Holstein cows. In contrast, Pereira et al. (2012) noted that selection for 305-DMY does not improve persistency of milk yield in Holstein-Friesian cattle. Season of calving had a significant effect on lactation persistency. Cows that calved in winter season had more lactation persistency than the cows calved in other seasons. The reason may be due to availability of green fodder during winter season. This result was in accordance with Yilmaz and Koc (2013) and Koloi et al. (2018) who noticed a significant effect of season of calving on persistency, where cows calved during summer season were less persistent which may be due to high temperature with high humidity. While Badri et al. (2011) and Garudkar et al. (2018) found that there was no significant effect of calving season on persistency measured in dairy cattle. Tekerli et al. (2000) obtained the highest persistency in cows that calved during summer and autumn. Parity had a non-significant effect on lactation persistency. This result disagreed with Hermiz and Hadad (2020) who stated that parity had a significant effect on the persistency, where it declines from 70.149 % in the first parity to 55.853% in the fourth parity.

The breeding values for DIM and DP traits of the cows were ranged between -84.1 and 141.5 and between -3.4 and 4.2 days, respectively. While the corresponding values for sires were between -122.8 and 104.7 and between -2.9 and 2.9 days, respectively. Moreover, the values for dams were between -40.2 and 82.7 and between -2.1 and 2.1 days, respectively. The range of breeding value for DIM for sire obtained in the present study was higher (-5.44 and 6.30 days) than those reported by Jadoa and Abdulrada (2011). Also, the range for DIM between (-303.4 and 350.8 days), (-7.1 and 5.7 days) and (-2.4 and 3.2 days) for cow, sire and dam, respectively was mentioned by Hammoud and Salem

(2013). Abdel-Hamid et al. (2017) stated that cow, sire and dam breeding values for DIM were ranged between (-70.82 and 86.27 days), (-69.31 and 62.98 days) and (-37.97 and 62.02 days), respectively in Holstein Friesian cows.
Sire breeding value for DP was ranged between -15.95 to 49.60 days (Jadoa and Abdulrada, 2011) and between -78 and 116 days was recorded by Rehman and Khan (2012). Also, the range of sire breeding value for DP (34.62 day), for dams (29.35 day) and (53.71day) for cows was reported by Mariz .(2014)
The breeding value for 305-DMY and PMY of cows was ranged between -6900 and 4200 and between -22.5 and 13.4 kg, respectively. Moreover, values for sires were between -4400 and 1500 and between 16.6 and 9.9 kg, respectively. The breeding value of persistency for cows ranged between -0.1 and 0.13, for sires ranged between -0.1 and 0.04 and for dams was between -0.1 and 0.20 %. The breeding values for 305-DMY of cows were higher than those reported by El-Awady et al. (2011) who reported that the range of predicted sire breeding values ranged from -391 to 700 kg for 305-DMY. Moreover, the sire breeding value for peak milk ranged between -8.34 and 11.68 kg in Holstein Friesian Cows (Radwan et al., 2015). The range of the cow breeding values for a trait in a given herd indicated the amount of genetic variation among cows. The wider the range is the wider the genetic variation and this gives the opportunity for improving the considered trait through selection according to the superiority of the cow breeding value (Abdel-Hamid et al., 2017).

5 .CONCLUSION

This study revealed that the effect of non-genetic factors must be taken into consideration when evaluating dairy cows. The highest milk production was obtained when DIM more than 357 days and in the 1st lactation. Cows that had high peak milk yield produced greater milk yield and had more lactation persistency. Also, cows that calved in winter season had more lactation persistency than the cows calved in other seasons. Higher range of the sire breeding values than either cows or dams for 305-DMY, PMY and CI revealed a wider genetic variation and a good chance of selecting the superior sires.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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