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# Genetic Evaluation and Phenotypic Trend for Some Lactation Traits of Dromedary Camels

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**Abstract:** There is a paucity of published work on genetic evaluation of lactation traits in camels using modern methodologies such as MTDFREML (Maximum Likelihood Restricted by Multiple Trait Derivatives Free of Maximum). The current study aimed to estimate the genetic parameters (direct heritability, repeatability and breeding values), and to estimate the phenotypic trend. The studies were including total milk yield (TMY/kg), day milk yield (DMY/ kg) and length of lactation period (LP). Actual means of TMY, DMY and LP were 1464.90 kg, 4.00 and 418.84, respectively. LP was significantly ($P \leq 0.05$) affected by the year and season of calving. Additive heritability (h2a) estimates for TMY, DMY and LP was 0.25, 0.30 and 0.17, respectively. These are promising values for the potential of genetic improvement. Repeatability (t) values recorded a medium value for LP (0.19), while the values were high for both TMY (0.36) and DMY (0.43). The range of predicted breeding values (PBVs) of animals for TMY, DMY and LP were 143.07 kg, 1.5 kg and 113.9 days, respectively. Regression coefficients for she-camels showed a negative annual phenotypic trend (PT) of about -3.58 kg and -0.012 kg per year for TMY and DMY, respectively. A genetic improvement program should be followed to allow exploiting the higher estimates of genetic parameters by relying on animals with positive breeding values.

**Keywords:** Genetic, Phenotypic Trend, Lactation, Dromedary Camels

## 1. Introduction

The dromedary camel (*Camelus dromedarius*) is a valuable species that has evolved and adapted uniquely to hot and arid environments [1]. They are low-cost in terms of nutrition but high-yield in terms of milk, meat, wool, and assistance in transport in a variety of situations, especially for the life of a nomadic inhabitant of the Egyptian desert. Thus, the camel plays a vital role in both the food and social security of nomadic herding families [2].

In developing countries, the contribution of camels to human wellbeing is often obscured by several factors that tend to underestimate their true value, such as inaccurate population estimates due to irregular surveys and the fact that their products rarely enter an official marketing system. As a result, their influence on livelihoods and the national economy is often underestimated. So, for many years, the improvement of camels has received less attention [3].

In the same context, the total number of camels was estimated in Egypt to be 159.000 heads in 2017, while in 2020 it was 110.669 heads [4] with a decreasing percentage of approximately 30.4%.

Moreover, milk does not play a significant role in the economic importance of Egyptian camels. So far, the record for the total production of camel milk in Egypt is not available and is still underestimated [2].

In this respect, there is a paucity of published work on genetic evaluation of lactation traits in camels using modern methods, since most of these estimates were based on a small number of records and applying old methodology [5].

So, the best way to raise the productivity of camels is through reliable and accurate genetic evaluation [6, 7], along with a study of non-genetic factors of economic traits, that allow camel breeders to determine the efficiency of selection for these traits and the best selection method to follow [8].

The present work aims to: 1) evaluate non-genetic effects (year and season of calving) on lactation performance in terms of total milk yield, average daily milk yield, and length of the lactation period. 2) To estimate the phenotypic trend that was realized for these traits across years of calving. 3) Using an animal model to estimate their variance components and genetic parameters (Heritability, permanent maternal environment, and error effects for these lactation traits of this herd. 4) to predict the breeding values for animals of this herd.

# 2. Materials and Methods

### *2.1. Experimental Animals and Experimental Design*

During the period from December 2012 to April 2021, records of dromedary she-camels were collected from Matrouh Camel Studies and Production Development Center, Animal Production Research Institute (APRI), Egypt, which is located in Marsa Matrouh Governorate (Northwest of Egypt, distance 500 Km from Cairo).

### *2.2. Management and Feeding*

All the animals were treated and medicated similarly, and they were raised under the same managerial and climatic conditions.

According to Banerjee, G. [9], the ration of the camels was determined. During the mating season, the average daily amounts given per head were 35 kg of Egyptian clover (*Trifolium alexandrinum*) besides 7kg rice straw.

During the dry season, each camel received around 2 kg of commercial concentrate combination, 2 kg of Egyptian clover hay and 9 kg of rice straw each day. Clean, fresh, and communally sheltered water was provided to all camels. The camels were housed in a yard with a shared feeding area and a concrete floor. In an enclosed space, the camels were free to move around.

In most cases, camels are sexually active from October to March. Natural mating has been applied for all she-camels and the calving season continues from November to April. She-camel were mated for the first parity at suitable weight and age (48 months of age or 350-400 kg live body weight), then the following parities She-camels were mated 60 days after parturition. Rectal palpation was used to determine pregnancy 60 days after the last mating.

### *2.3. Milking Procedure*

Born calves were allowed to suckle colostrum from their dams for the first seven days then, milk yield was measured. Hand milking was performed for lactating she-camels twice/day at 8 a.m. and 8 p.m., and the amount of milk yield was calculated individually for each animal and recorded to the nearest 0.1 kg.

### *2.4. Data and Studied Traits*

A total of 302 complete lactations for 33 she-camels (the total number of females annually according to the carrying capacity of the Matrouh Camel Studies and Production Development Center), fathered by five sires and mothered by 11 dams were used). The study included the following traits: Total milk yield: the amount of milk (kg) produced during the normal lactation period. Daily milk yield: Total milk yield (kg)/ Lactation period (day).

### *2.5. Statistical Analysis*

#### *2.5.1. Non-genetic Effects*

The following statistical model was used to analyze the data using the general linear model (GLM) procedure [10]:

$$Y_{ijkl} = \mu + Y_i + SE_j + e_{ijk},$$

where:

$Y_{ijk}$: either TMY, DMY and LP.

$\mu$= Overall mean for the studied traits,

$Y_i$= Fixed effect of $i^{th}$ year of calving i, (i=2012…., 2021),

$SE_j$= Fixed effect of $j^{th}$ season of calving j, (j=1, 2… 4), were 1= Autumn, 2= Winter, 3= Spring and 4= Summer,

$e_{ijk}$ = random residual assumed to be independent and normally distributed with mean zero and variance $\sigma^2$e. Significant differences between means were done according to Duncan's multiple range test [11] at $P \leq 0.05$. The interaction was not considered due to the absence of some of them through fixed effects.

#### *2.5.2. Genetic Parameters*

For estimation of variance components, repeatability single-trait animal model of traits using MTDFREML programs of Boldman *et al.* [12] were used depending on variances obtained by REML (Restricted maximum likelihood) method of VARCOMP procedure [10] as starting values. The following general model was used to conduct the analyses:

$$y = Xb + Z_a + W_{pe} + e,$$

Where y is the vector of phenotypic observations; b is the vector of fixed effects; a is the vector of random additive genetic effects of the she-camel; pe is the vector of random permanent environmental effects of the dam; e is the vector of residual effects; and X, Z, and W are incidence matrices relating the phenotypic observations to fixed, random additive genetic, and permanent environmental effects, respectively. It was assumed that random effects are independent and normally distributed:

a ~N(0, A $\sigma^2_a$ ), pe ~ N (0, I $\sigma^2_{pe}$) and e ~N(0, I $\sigma^2_e$ ), Where A is the numerator relationship matrix, I is the identity matrix, $\sigma^2_a$ is the direct additive genetic variance, $\sigma^2_{pe}$ is the random permanent environmental variance, and $\sigma^2_e$ is the residual variance.

Phenotypic variance was calculated as $\sigma^2_p = \sigma^2_a + \sigma^2_{pe} + \sigma^2_e$.

Direct heritability ($h^2_a$) was calculated as $h^2_a = \frac{\sigma^2 a}{\sigma^2 p}$.

Repeatability ($t$) was calculated as the ratio of variances by summing additive genetic and permanent environmental ($\sigma^2_{pe}$) to total phenotypic variance according to: $t = \frac{\sigma^2 a + \sigma^2 pe}{\sigma^2 p}$

Estimation of phenotypic trend (PT) was calculated for each trait by regressing the least square mean on the calving year.

# 3. Results

### 3.1. Descriptive Statistics for Lactation Traits

Means, standard deviation (S.D), minimum, maximum, and coefficients of variation (CV %) for lactation traits of dromedary she-camels are given in Table 1.

Means of TMY, LP, and DMY were 1464.90 kg, 418.84 days, and 4.00 kg, respectively. Moreover, the magnitudes of CV% of TMY, LP, and DMY in the current study were medium to high, ranging from 15.01 (TMY) to 43.87 (DMY)% (Table 1).

*Table 1. Descriptive statistics for lactation traits of dromedary she-camel.*

| Lactation traits* | Mean | S.D | Minimum | Maximum | CV% |
|---|---|---|---|---|---|
| TMY (kg.) | 1464.90 | 221.15 | 890.63 | 1903.03 | 15.01 |
| LP (day) | 418.84 | 141.79 | 73 | 720 | 33.65 |
| DMY (kg.) | 4.00 | 1.76 | 0.45 | 8.89 | 43.87 |

TMY=total milk yield LP=lactation period DMY=daily milk yield.

***Table 2.** Least-squares means (LSM) ± standard errors (SE) for non-genetic factors affecting lactation traits.*

| Item | No. | TMY (kg) | LP (day) | DMY (day) |
|---|---|---|---|---|
| Year of calving | | | | |
| 2012 | 31 | 1421.28±67.06 | 409.6±48.49$^{ab}$ | 3.96±0.63 |
| 2013 | 29 | 1369.90±72.43 | 498.32±52.37$^{a}$ | 2.80±0.68 |
| 2014 | 28 | 1527.60±79.35 | 429.6±57.37$^{ab}$ | 4.26±0.74 |
| 2015 | 30 | 1399.85±59.14 | 316.51±42.76$^{b}$ | 5.12±0.55 |
| 2016 | 32 | 1420.55±62.73 | 408.6±45.36$^{ab}$ | 3.53±0.59 |
| 2017 | 30 | 1514.30±56.11 | 510.64±40.57$^{a}$ | 3.03±0.52 |
| 2018 | 32 | 1475.70±62.06 | 448.42±47.00$^{a}$ | 3.40±0.57 |
| 2019 | 29 | 1350.74±59.14 | 434.7±42.76$^{ab}$ | 3.42±0.55 |
| 2020 | 31 | 1407.80±62.73 | 388.7±45.36$^{ab}$ | 4.60±0.59 |
| 2021 | 30 | 1388.64±69.35 | 453.9±50.14$^{ab}$ | 3.44±0.65 |
| Significant | | NS | * | NS |
| Season of calving | | | | |
| Autumn | 59 | 1423.79±59.14 | 403.27±42.76$^{ab}$ | 3.79±0.55 |
| Springer | 91 | 1425.40±38.76 | 421.16±42.26$^{ab}$ | 3.95±0.36 |
| Sumer | 27 | 1382.20±58.44 | 401.36±28.02$^{b}$ | 3.29±0.55 |
| Winter | 125 | 1479.20±30.64 | 493.85±22.15$^{a}$ | 3.97±0.28 |
| Significant | | NS | * | NS |

Data are presented as means ± SE. a-b: Means with the different superscripts in the same column, differ significantly ($p \leq 0.05$).

[*] Significant at ($P \leq 0.05$) [NS] Non-significant

### 3.2. Non-genetic Effects

Table 2 represents the least-squares mean (LSM) and standard errors (SE) for fixed effects of year and season of calving affecting TMY, DMY, and LP.

Concerning the effect of the year of calving on lactation performance, data presented in Table 2 revealed that only LP was significantly ($P \leq 0.05$) affected by the year of calving. Moreover, the highest values for TMY were 1527.6 and 1514.30 kg, these values were reached during 2014 and 2017, respectively. On the other hand, the lowest TMY (1350.7 kg) was noticed during 2019.

This trend was accompanied by LP, where, the longest LP (510.6 days) was in 2017. Whilst, the highest value for DMY was recorded during the year 2015. Also, table 2 revealed that the values of all traits were inconsistent and fluctuated from one year to another.

Regarding the calving season, the season of calving followed in its influence the same trend as that of the year of calving, affecting only LP ($p \leq 0.05$) and did not have significant effects either on TMY or DMY.

Although there was no significant statistical effect, the highest values were recorded during the winter season for all traits under study. Moreover, the lowest values were recorded in the summer.

### 3.3. Estimates of Genetic Parameters

Table 3 presents estimates of variance components, direct heritability ($h^2_a$) and repeatability (t) for TMY, DMY and LP.

Direct heritabilities and permanent environmental effects ($pe^2$) for the majority of milk traits were moderate (Table 2), ranging from 0.17 to 0.30 for $h^2_a$ and from 0.02 to 0.13 for $pe^2$. The smallest value was for LP either for $h^2_a$ (0.17) or $pe^2$ (0.02). The $t$ values recorded a medium value LP (0.19), while the values were high for both TMY and DMY (0.36 and 0.43, respectively).

***Table 3.** Estimates of variance components and genetic parameters for lactation traits of she-camel.*

| Item* | TMY | DMY | LP |
|---|---|---|---|
| $\sigma^2_a$ | 3106.2 | 3224 | 1105.6 |
| $\sigma^2_{pe}$ | 1350.5 | 1712.8 | 147.4 |
| $\sigma^2_e$ | 8103.2 | 7304.5 | 5307 |
| $\sigma^2_p$ | 12560 | 12241.3 | 6560 |
| $h^2_a$±SE | 0.25±0.07 | 0.30±0.18 | 0.17±0.03 |
| $pe^2$±SE | 0.11±0.03 | 0.13±0.14 | 0.02±0.01 |
| $e^2$±SE | 0.65±0.07 | 0.60±0.18 | 0.81±0. 03 |
| $t$ | 0.36 | 0.43 | 0.19 |

*$\sigma^2_a$= additive genetic variance, $\sigma^2_{pe}$= maternal permanent environmental variance, $\sigma^2_e$= residual variance, $\sigma^2_p$ total phenotypic variance, $h^2_a$= direct heritability, $pe^2$= fraction of phenotypic variance due to maternal permanent environmental effects, $\sigma^2_e$ fraction of phenotypic variance due to residual effects and $t$ = repeatability.

### 3.4. Predicted Breeding Value (PBV) of Animals for Lactation Traits

Minimum, maximum, range, standard errors (SE), and accuracy ($r_A$) of animals (she-camels, sire, and dam) PBV for TMY, DMY, and LP are presented in table 4. The present results showed that the ranges of PBVs for animals (she-camels, sire, and dam) were 143.07 kg for TMY, 1.5 kg for DMY, and 113.9 days for LP. Moreover, the percentages of animals that have positive estimates of PBV were 52.33, 64.03, and 45.67% (an average of 54.1%), for TMY, DMY and LP, respectively.

***Table 4.*** *Range of PBVs of animals for lactation traits, standard error (SE), accuracy ($r_A$), and percentage of animals with positive values (%P).*

| Traits[+] | Minimum | | | Maximum | | | Range | %P |
|---|---|---|---|---|---|---|---|---|
| | PBV | SE | $r_A$ | PBV | SE | $r_A$ | | |
| TMY | -69.01 | 1.99 | 0.65 | 74.063 | 1.98 | 0.66 | 143.07 | 52.33 |
| DMY | -0.79 | 0.56 | 0.84 | 0.712 | 0.63 | 0.79 | 1.5 | 64.03 |
| LP | -54.5 | 0.86 | 0.71 | 59.41 | 0.76 | 0.78 | 113.9 | 45.67 |

[+] Traits were defined in Table 1.

### *3.5. The Phenotypic Trend for Lactation Traits (PT)*

The annual phenotypic trend is the sum of the changes in both additive genetic merit and environmental change per year [13]. In other species, such as cattle, there is a continuous requirement for estimation of the genetic and phenotypic parameters and trends in dairy cattle, to monitor whether the parameters and trends are desirable for each trait or not [14].

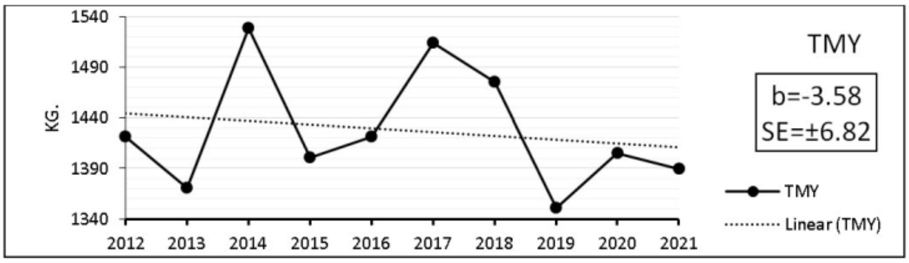


***Figure 1.*** *The phenotypic trend for TMY.*

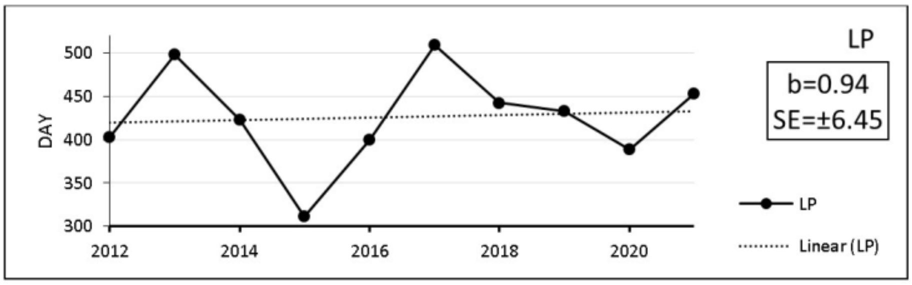


***Figure 2.*** *The phenotypic trend for LP.*

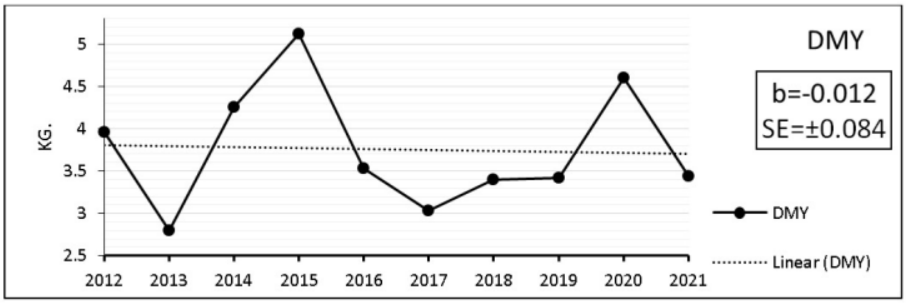


***Figure 3.*** *The phenotypic trend for DMY.*

PT, of the studied traits, are graphically displayed in figures from 1 to 3. In this respect, regression coefficients (b) for she-camels showed unfortunately a negative annual PT of about -3.58 kg, -0.012 kg per year for TMY and DMY. While PT was a low positive about 0.94 days per year for LP. Considerable fluctuations were observed in the PT trends over the study period for all traits.

# 4. Discussion

In the present study, the means for lactation traits of dromedary camels generally fall within the range of those estimates obtained in most Egyptian studies [15-19], whose estimates for TMY ranged between 1207 and 1500 kg. While it was lower than that reported by Khalil *et al*. [20] for Saudi camels under intensive production conditions (2373 kg, 5.23 kg, and 449 days for TMY, DMY, and LP, respectively), 1559 kg for TMY, and 4.6 kg for DMY, reported by Zaky *et al*., [21] and 1907 kg for TMY, reported by Musaad *et al*. [22].

In addition, the magnitudes of CV% of TMY, LP, and DMY in the current study were medium to high (Table 1). The literature indicates that phenotypic differences between breeds in milk traits are of great importance [6, 23, 24]. However, these estimates show that improving these traits through phenotypic selection is quite possible.

In this regard, there is a substantial range in the averages of lactation traits such as yield or LP, this is accompanied by a large CV% in various nations or even within the same geographical area, which may be attributable to the approaches employed to determine yield, high genetic variation between individuals, breeds, feeding, management conditions, nature of work, milking regularity, age of the animal, persistency of lactation, lactation number and phase of lactation [1, 25-27].

Also, Ayadi *et al.* [28] noted that the rate of secretion of the milk is affected by the practice of milking using a machine or by hand, milking frequencies per day, and milking intervals between milking operations.

Concerning the effect of non-genetic effects on lactation performance, our results (Table 2) revealed that only LP was significantly ($P \leq 0.05$) affected by the year and season of calving. The same trend was observed for the significant effect ($p \leq 0.05$) for the year of calving by Aslam *et al.* [29].

On the contrary, Farrag *et al.* [30] reported that the year of calving had a non-significant effect on TMY and LP. The same authors added that the fluctuations in milk production from year to year were partly related to the genetic makeup of the animals kept under varying environmental, nutritional, and management conditions as well as the number of animals during the period under study.

Concerning the calving season, the season did not have significant effects either on TMY or DMY. Although there was no significant statistical effect, the highest values were recorded during the winter season for all traits under study. Moreover, the lowest values were recorded in the summer.

With a similar result, Almutairi *et al.* [8] reported that the calving season had no significant effects on milk production. They attributed the absence of the season's effect to the stability of managerial procedures (intensive system) and keeping the animals inside the sheds throughout the year and providing them with the necessary feeding.

In this respect, Bekele *et al.* [31] reported that camels calved during winter had a longer LP (409 days), while camels that calved in the short rainy season (March -April) or the short dry season (May -June) had a shorter LP (292 and 287 days, respectively).

Moreover, Musaad *et al.* [22] reported that the shorter LP in camels born in the hot season could be linked to the gestational status because the interval between calving and the re-mating was shorter, resulting in a new pregnancy early in the lactation period.

Concerning genetic parameters, current estimates are consistent with previous research, although, heritability estimates for lactation traits in camels are very scarce. Working on Saudi camels, Khalil *et al.* [7, 20] reported $h^2_a$ ranged from 0.08 to 0.25 for annual milk yield, LP, and DMY, and estimates of $pe^2$ ranged from 0.16 to 0.23. The same authors stated that Saudi camels are subject to high variabilities due to permanent environmental influences. Also, camels were not exposed to a comprehensive selection process.

Almutairi *et al.* [8] noted that $h^2_a$ estimates were 0.24 for milk yield at 305 days indicating that these traits are moderately heritable, and *t* estimates were 0.28. Depending on moderate t in their study, they supposed that a small number of recordings would be enough for an appropriate judgment of camels. Furthermore, the same authors noted that *t* estimate for test-day yield was 0.66, attributing high magnitude to the higher impact of the permanent environment, which may be explained by intensive herd management, high persistence of lactation, or the small data set.

Mehta *et al.* [32] applying sire valuation on Indian camels, reported *t* estimates of 0.40 for DMY. The moderate estimates of $h^2_a$ obtained in the current study with regarding the previous studies mentioned above demonstrated that improvement of milk traits of dromedary she-camels could be possible.

Moreover, due to the high estimates of *t*, there is a possibility of depending on a single production record to conduct the selection procedure for the females of the herd under study. About PBVs, the range in the current study is lower than the 1436 kg, 3.044 kg, and 282 days for TMY, DMY, and LP, respectively, obtained by Khalil *et al.* [7, 20] for Saudi camels.

Almutairi *et al.* [8] reported that the ranges of PBVs were from −431 to 621 kg for milk yield during 305-day lactation, or the range from -1.64 to 1.61 kg, for test-day yield. The same authors clarified the low genetic gains of milk traits in camels to the absence of any genetic selection. In addition, replacement animals intended for milk production were selected on their body weight, conformation, not on their dairy ability or the productivity data of their female relatives.

Despite the lower range of PBV compared to what was recorded in the previous studies mentioned above (rare studies), the percentages of animals that had positive estimates of PBV were 52.33, 64.03, and 45.67%(averaged 54.1%), for TMY, DMY and LP, respectively.

The result of this herd indicates that the top 54% of the animals had positive PBVs values, and therefore, an early selection of camels according to positive PBV could be an effective way to improve such traits in future generations while being careful to increase the amount of genetic variance.

Khalil *et al.* [7, 20] reported that the proportions of animals with favourable breeding value estimations for TMY, DMY, and LP in Saudi camels were 54.3, 56.3, and 53.3%, respectively, with an average of 56.1%. For PT, regression coefficients (b) for she-camels showed, unfortunately, negative annual PT, with considerable fluctuations were observed over the study period for all traits.

Estimates of the phenotypic trend of lactation traits in camels are extremely rare. Therefore, and based on similar studies in dairy cattle under Egyptian conditions and other regional areas, Shehab El-Din [33] working on Friesian cattle, showed a negative annual PT of about -48.14 kg, -48.01 kg, and -1.58 days, per year for TMY, 305-DMY, and LP, respectively.

In parallel, Abou-Bakr [34] represented a negative phenotypic trend of 305-DMY with an overall rate of -91.6 ± 35.16 kg /year. Also, Katok and Yanar [35] on Friesian cattle, came to the same result of the negative trend of 305-DMY and the rate of decline was -17.73±9.64 kg/ year.

Moreover, Hossein-Zadeh [36] in Iranian Holsteins cows reported that there were decreasing phenotypic trends for LP, and this could result in lower milk yields compared to the populations with the positive phenotypic trends for LP.

Javed *et al*. [37] denoted, phenotypic decrease in milk yield may mainly be attributable to environmental factors as different diseases like foot and mouth and other threats arise during different years.

In this regard, several studies working in dairy cattle have presented several interpretations of changes from one year to the next [14, 34] reported that this is due to, changes in the age of animals, attacks on various diseases such as FMD, mastitis, inadequate animal feed, severe climatic, geographical conditions and changes in management practices implemented from one year to another, such as changes in feed availability, quality, and prices.

# 5. Conclusion

In conclusion, based on the obtained results, the herd of camels under study has promising genetic abilities. This is demonstrated by some observations, such as moderate estimates of heritability and higher estimates of repeatability, which allow for improved lactation traits. Genetic improvement through a well-organized structure of usage of animals of higher breeding value and facilitation of the quick spread of superior genotypes in future generations are required to attain optimal performance efficiency of such a herd. To avoid bias in the results due to insufficient data or pedigree structure, further research on the same trait using a large data set is required to reveal a more accurate and reliable genetic and environmental assessment.

# Author Contribution

Mohamed Ibrahim Shehab El-Din, Statistical genetic analysis, all authors shared in writing, reviewing and approving the final manuscript.

# Data Availability

All data generated or analyzed during this study are included in this published article.

# Ethics Approval

The study's ethical approval was granted by the Research Committee of the Animal Production Department, Faculty of Agriculture, Al-Azhar University, and Animal Production Research Institute, Dokki, Giza, Egypt.

# Conflict of Interest

The authors declare no competing interests.

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# References

[1] Raziq, A., Younas, M., & Kakar, M. A. (2008). Camel a potential dairy animal in difficult environments. Pak. J. Agri. Sci., 45 (2), 263-267.

[2] *Sallam, A. M. (2020).* Future opportunities for genetic improvement of the Egyptian camels. Egyptian journal of animal production, 57 (suppl. Issue), 39-45.

[3] *Njiru, GK, (1993).* Economics of camel production. In: S. P. Simpkin (Ed.): Camel Production. A series of lectures given by FARM-Africa at Nairobi University, Nairobi, Kenya.

[4] *FAOSTAT, (2022).* Status of Animal Genetic Resources. Food and Agriculture Organization of the United Nations, Rome, Italy. https://www.fao.org/faostat/en/#data/QCL

[5] *Hermas, S. A. (1998).* Genetic improvement and the future role of the camel in the Arab World: Problems and opportunities. In Proceedings of the Third Annual Meeting for Animal Production under Arid Conditions. Volume 2: 56-68.

[6] *Hermas, S. A., Abushuashi, H., and Abusaud, F. (1998).* A primary investigation on heritability of growth measures in the Magrabi camel in Libya. Proceedings of the 3rd Animal Production under Arid Conditions, 1, 65-70.

[7] *Khalil, M. H., Al-Sobayil, K. A., Al-Jobeile, H. S., Mohamed, K. M., & Salal, S. A. (2006).* Quantitative genetic analysis and evaluation lactation traits in Saudi camels. In Proccedings of the International Scientific Conference on Camels (pp. 9-11).

[8] *Almutairi, S. E., Boujenane, I., Musaad, A., and Awad-Acharari, F. (2010).* Genetic and nongenetic effects for milk yield and growth traits in Saudi camels. Tropical Animal Health and Production*, 42 (8), 1845-1853.*

[9] *Banerjee, G. (1988).* Feeds and Principles of Animal Nutrition. Oxford and IBH Publishing, New Delhi, India.

[10] *SAS, (2003).* Statistical analysis system. SAS Release 9.1.3. For windows, SAS Institute Inc. Cary, NC, USA.

[11] *Duncan, D. B. (1955).* Multiple range and multiple F tests. Biometrics, 11 (1): 1-42.

[12] Boldman, K. G; Kriese, L. A; Van Vleck, L. D; Van Tassell, C. P. and Kachman, S. D. (1995). A manual for the use of MTDFREML. ARS, USDA, Clay Center, NE, USA.

[13] *Powell, R. L. (1972).* Estimation of genetic trends and effect of genetic trends on sire evaluation "Retrospective Theses and Dissertations. 4769. https://lib.dr.iastate.edu/rtd/4769

[14] *Amimo, J. O; Wakhungu, J. W; Inyangala, B. O. and Mosi, R. O. (2007).* The effects of non-genetic factors and estimation of genetic and phenotypic parameters and trends for milk yield in Ayrshire cattle in Kenya. J. Livest. Res. Rural Dev., 19 (1): 1-9.

[15] Mustafa, I. A. R. (2008). Camel reproduction and production in Egypt. WBC / ICAR 2008 satellite meeting on camelid reproduction, 12-13 July 2008, Budapest, Hungary.

[16] *Seioudy, A. F. H. (2013).* Some productive traits in Maghrebi she-camels. M.Sc. Thesis, Faculty of Agriculture, Ain Shams University, Egypt.

[17] *Musaad, A. M.; Faye, B. and Al-Mutairi, S. E. (2013a).* Seasonal and physiological variation of gross composition of camel milk in Saudi Arabia. Emir. J. Food Agric. 25 (8): 618-624.

[18] *Abdallah, E., A. Ashmay, M. Farouk, O. Salama, F. Khalil and A. Seioudy (2015).* Milk production potential in Maghrebi she-camels. Small Rumin. Res, 123 (1): 129-135.

[19] Ashour, A. M., Zeidan, A. E. B., Badr, M. I., Abd El-Hamid, A. A and Aboul-Rayat, M. T. A. (2019). Milk yield and its composition of the Maghrebi she-camels in the different parities. Egypt. J. of Appl. Sci., 34 (9) 30-43.

[20] *Khalil, M. H., Al-Sobayil, K. A., Al-Saef, A. M., Mohamed, K. M., & Salal, S. A. (2007).* Genetic aspects for milk traits in Saudi Camels. Journal of Camel Practice and Research, 14 (1), 55.

[21] Zaky, M. S., Abdel-Khalek, A. E., Mostafa, T. H., Gabr, S. A., & Hammad, M. E. (2020). Productive and Reproductive Characterization, Breeding Season and Calving Season in Reference with the Effect of Parity Order on Milk Production of Camel in Egypt. Journal of Animal and Poultry Production, 11 (12), 573-581.

[22] *Musaad, A., B. Faye, B. and Abu-Nikhela, A. (2013b).* Lactation curves of dairy camels in an intensive system. Trop. Anim. Health Prod. 45: 1039–1046.

[23] *Ismail, M. D. and Al-Mutairi, S. E. (1991).* Production parameters of Saudi camels under improved management systems. In: Proceedings of International Conference on Camel Production and Improvement. Tabruk, 10-13 December 1991, Libya, 159-172.

[24] *Wardeh, M. F., Zaied, A. A and Horier, H. S. (1991).* Camel breed types in North Africa. In International Conference on Camel Production and Improvement, Tobruk (Libyan Arab Jamahiriya), 10-13 Dec 1990. ACSAD.

[25] *Khan, B. B and Iqbal, A. (2001).* Production and composition of camel milk. Review. Pakistan Journal of Agricultural Sciences, 38, 64-68.

[26] *Musa, H. H., Shuiep, E. S., Ibtissam, El Zubier, E. M. and Chen, G. H., (2006).* Some reproductive and productive traits of camel (Camelus dromedarius) in Western Sudan, Journal of Animal and Veterinary Advances, 5, 590-592.

[27] *Abdel-Aziz, B. E., Elbasheir, H. M., Elbashir, M. H. M and Altigani, M. A. (2016).* Estimating of some productive traits of Sudanese Arabi camel (Darfur ecotype) reared under intensive management system. SUST Journal of Agricultural and Veterinary Sciences. 17 (1); 15-24.

[28] Ayadi, M., Hammadi, M., Khorchani, T., Barmat, A., Atigui M. and Caja, G, (2009). Effect of milking interval and cisternal udder evaluation in Tunisian Maghrebi Dairy Dromedaries (Camelus dromedarius L.), Journal of Dairy Science, 92, 1452–1459.

[29] *Aslam, M.; Nawaz, M.; Ali, M. and Zia–ur–Rahman, M. A. (2002).* Determination of productive and reproductive traits in mountain camel, Appl. Livest. Prod. 30: 549-552.

[30] *Farrag, F. H. H.; N. A. Shalaby; T. H. Moustafa; A. M. Abdel-Salam and Shahdan A. Ismail (2019).* Evaluation of productive, reproductive, longevity and lifetime traits of camel in Egypt's. Animal and Poultry Prod., Mansoura Univ., Vol. 10 (7): 203-214.

[31] *Bekele, T.; Zeleke, M. and Baars, R. M. T. (2002).* Milk production performance of the one humped camel (*Camelus dromedarius*) under pastoral management in semi-arid eastern Ethiopia. Livestock Prod. Sci., 76: 37-44.

[32] *Mehta, S. C., Yadav, S. B. S., Singh, S., and Bissa, U. K. (2014).* Sire evaluation and selection of Indian dromedary females for milk production: Issues and strategies. J. Camel Pract. Res, 21, 93-98.

[33] Shehab El-Din, M. I. (2020). Genetic evaluation for some productive and reproductive traits of Friesian cattle raised in Egypt. PhD thesis, Fac. Agric., al-Azhar Univ, Nasr city-Cairo, Egypt.

[34] *Abou-Bakr, S. (2009).* Genetic and phenotypic trends of 305-day milk yield of Holstein cows raised at commercial farm in Egypt. Egypt. J. Anim. Prod., 46 (2): 85-92.

[35] Katok, N. and Yanar, M. (2012). Milk traits and estimation of genetic, phenotypic and environmental trends for milk and milk fat yields in Holstein Friesian cows. Int. J. Agric. Biol., 14 (2): 311-314.

[36] *Hossein-Zadeh, N. G. (2012).* Genetic parameters and trends for lactation length in the first three lactations of Holstein cows. Arch. Anim. Breed., 55 (6): 533-539.

[37] *Javed, K; Babar, M. E. and Abdullah, M. (2007).* Within-herd phenotypic and genetic trend lines for milk yield in Holstein-Friesian dairy cows. J. Cell Anim. Bio. 1 (4): 66-70.