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Genetic and phenotypic impacts of calf gender on productive and reproductive traits in Friesian cattle under Egyptian farm conditions

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ABSTRACT

This study was implemented to evaluate utilizing sexed semen that favors female births for enhancing milk production and herd replacements. 4913 calf records from 1047 Friesian cows between 1975 and 2020 at Sakha Farm were analyzed to estimate the impacts of calf gender and some environmental factors on the productive traits: lactation period (LP), total (TMY) and 305-day (305MY) milk yields and reproductive traits: age at first calving (AFC); gestation length (GL); days open (DO) and calving interval (CI). Fixed effects were parity; calving year and season (SC). Genetic (r_g) and phenotypic (r_p) correlations were estimated using BLUPF90 software. Results showed highly significant effects (P<0.001) of the fixed factors on all studied traits, except SC (P< 0.05) on LP and TMY, (P< 0.01) on 305MY and DO, but non-significant effects on reproductive traits. Calf gender presented strongly meaningful effects (P<0.001) regarding CI plus (P<0.05) for other traits, except AFC and genders on DO. Moderate positive r_g estimates were found from 0.29 to 0.32 for female births with productive traits; weak values were found with reproductive traits, except 0.14 with GL. The corresponding r_p estimates ranged from 0.26 to 0.36 with productive traits; from 0.11 to 0.19 with reproductive traits, except for weak values with DO and CI. It can be strongly encouraged to alter calf gender in females to diminish the generation interval, maximize milk production, and increase the genetic superiority of replacements.

Introduction

The standard level of milk yield is considered one of the major essential issues within the dairy industry since it is the main source of income on dairy farms. Therefore, the deterioration in milk production will significantly affect the income of the dairymen. Not only the exterior impacts such as nutrition, raising and administration are necessary to determine productivity, but also internal elements such as genetic merit and calf sex can have an important impact on the dairy farm's income (Hess *et al.*, 2016). Also, the economic impact of sex-biased milk production under the opportunity of applying sexed sperm could be of pronounced significance in the dairy industry sector (Sawa *et al.*, 2014; Chegini *et al.*, 2015a; Ettema and Ostergaard, 2015; Gillespie *et al.*, 2017).

Modest to greater effects of calf gender on milk production would have significant impacts on the dairy business with increased profit for producers if management practices were changed accordingly. Moreover, Chegini *et al.* (2015b) mentioned that it was necessary to consider calf sex in the analytical models for achieving a more accurate genetic evaluation of cows for milk yield and calving interval during the prediction of cows' breeding values. Wherever selection might presently be prejudiced (Hayr *et al.*, 2015; Hess *et al.*, 2016).

Calf sex influence on cow milk production has been highlighted in several studies (Yudin *et al.*, 2013; Hinde *et al.*, 2014; Chegini *et al.* ,2015a; Hess *et al.*, 2016;Gillespie *et al.*, 2017; Beirao, 2018 ;Kramarenko and Kramarenko, 2021; Djedovi´c *et al.*, 2021), whereas others found no association (Atashi *et al.*, 2012; Dallago *et al.*, 2018). Besides the variation in the economic worth of female or male progeny within business farms, this could be a major factor in maximizing profits (Chegini *et al.*, 2015a). Calf gender could possibly affect milk production through conception; otherwise, even the subsequent delivery and any favorable manipulation of a single sex above others in the progeny could result in obvious consequences for the value and widespread use of semen and embryo sexing (Healy *et al.*, 2013). Moreover, using sex sorted semen opens new insights on the economic impacts that enhance farm productivity and supports a collection of advantages such as extra female replacements, smoother calving plus extra opportunities for more genetic improvement (Beavers and Van Doormaal, 2014).

Hinde *et al.* (2014) pointed out that sex-biased milk production in cows favors female births, for producing significantly more milk than males, suggesting that the fetal sex effects can interact dynamically across parities; enhance or diminish the milk production during the lactation and the first parity has persistent consequences for milk synthesis with considerable and continued conditioning of the udder purpose through the progeny sex in the uterus during the subsequent lactation.

Moreover, Meier *et al.* (2010) explained that the female birth is positive for milk production as superior dairy producing cattle commonly consume extra body condition fitness with a high frequency of female' gestation. Also, Chegini *et al.* (2015a) reported that cows delivering females have a greater and longer persistency for milk plus fat yields with a longer lactation length. While male births cause shorter calving intervals with an overall longer reproductive life and a higher occurrence of dystocia, which significantly reduces the whole lactation milk yield, cow fertility and increases veterinary costs (Hess *et al.*, 2016; Vieira-Neto *et al.*, 2017; Atashi and Asaadi, 2019)

The current paper aimed to investigate the impact of calf gender and some environmental factors on total milk production in single and across all lactations and on some productive and reproductive traits to test the possibility of applying sexed semen for female births. Evaluate the genetic and phenotypic correlations between female calve gender and productive and reproductive traits across all lactations in Friesian cows.

Materials and methods

Dataset

Data were collected from 4913 Friesian calves born between 1975 and 2020 in the experimental herd of Sakha Experimental station belonging to the Animal Production Research Institute , Ministry of Agriculture and Land Reclamation. Calf gender was grouped into male plus female assigned to 0 and 1, respectively (Table 1).

Statistical analysis

To avoid over-parameterization in the model, the systematic environmental effects on traits of interest were evaluated by fitting the linear models of these effects as fixed. The genmod procedure (logistic regression) of SAS (2014) was used to test the magnitude of these ecological influences: These fixed effects included parity (1 to 6), year of calving (5 classes of years each), season of calving (cold season from November to April and warm season from May to October) and sex of calf (male and female).

The linear model was installed as presents:

$Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + e_{ijklm}$

Wherever,

Y_{ijklm}: the phenotype record of a provided trait for each animal

μ: the overall mean of each particular trait;

A_i: the fixed effect of i^{th} parity (i= 1, 2...6);

B_j: the fixed effect of j^{th} calving year (subclass j= 1, 2...5);

C_k: the fixed effect of k^{th} calving season (k =1(cold season); 2(warm season) ;

D_l: the fixed effect of l^{th} sex (L=I males and 2females);

e_{ijklm}: random remainders are supposed to be separated normally, divided with average zero and variation σ^2_e. The meaningful fixed effects were applied to create contemporary groups (CG) for each trait that were contained in heritable and phenotypic correlation evaluations.

Genetic and phenotypic correlations were estimated using a model utilizing BLUPF90 software (Tsuruta and Misztal, 2006). The model was a bivariate animal pattern fitting all records available for the calculation of genetic and phenotypic correlations for the investigated traits. The model was characterized in matrix notation as follows:

$y = X\beta+Z1a+Z2pe+e$

Where,

y is a vector of observations,

β: a vector of fixed effects with an incidence matrix *X*,

a: a vector of randomly animal effects with incidence matrix *Z1*,

pe: a vector of randomly permanent environmental effects with incidence matrix *Z*2,

e: a vector of randomly remainder effects with average equals zero and variance σ^2_e.

The vector of additive (animal) effects (a) was supposed to be $N\sim(0, A\,\sigma^2_a)$, where A is the numerator relationship matrix within animals in the parentage file and σ^2_a is direct genetic variation.

The vector of randomly permanent environmental effects (*pe*) was supposed to be $N\sim(0, I_c\,\sigma^2_{pe})$, where I_c is the identity matrix of order equivalent to the cows numbers, and σ^2_{pe} is the permanent environmental effects variation. The vector of remaining (environmental) effects *(e)* was supposed to be $N\sim(0, I_n\,\sigma^2_e)$, where I_n was the identity matrix of order equivalent to the records numbers, plus σ^2_e was the environmental variation

Results

Environmental effects and calf gender

Table 2 presents the least squares means (SE) of levels of the environmental factors of parity, YC, SC and calf gender and their significance on productive and reproductive traits.

Effects of parity (PR) and year of calving (YC)

In the present study, PR and YC have highly significant ($p<0.001$) influences on LP, TMY and 305MY and similarly on GL, DO and CI.

Effect of season of calving (SC)

Longer LP and higher 305MY and TMY production were observed in winter and spring compared to summer and fall due to comfortable weather and the high availability of green fodder. Our study evidenced a considerable influence ($p<0.001$) of SC for 305MY and worthy effects ($p<0.05$) on other production traits.

SC evidenced a non-significant influence on the studied reproductive traits, except DO ($p<0.001$).

Table 1. Explanatory statistics, averages and standard deviation of evaluated variables.

Item	Number of records	Average	Standard deviation
Base animal (without pedigree) No.	464		
Non-base animal No.	1608		
Total animal No.	2072		
Sire No.	211		
Dam No.	1047		
Studied traits:			
Lactation period (days)	4413	319.9	17.5
Total milk yield (kg)	4408	3228.1	146.1
305-day milk yield (kg)	3217	3140.1	107.4
Age at first calving (years)	4913	2.7	0.39
Gestation length (months)	4913	9.3	0.38
Days open (days)	2776	159.6	40.7
Calving interval (days)	4217	274.8	6.1
Calf gender	4913		

Table 2. Least square means (SE) for environmental factors affecting productive and reproductive traits in Egyptian Friesian.

Factors	Levels	Traits						
		LP	TMY	305MY	AFC	GL	DO	CI
Parity	1	336.3 (4.9)a	3127.8 (39.7)b	2951.7 (33.4)b		9.36 (0.01)a	177.0 (2.9)a	273.5 (0.2)c
	2	334.4 (5.6)a	3305.0 (44.7)a	3165.6 (37.6)a		9.23 (0.01)c	163.6 (3.3)b	274.9 (0.2)b
	3	317.1 (6.6)ab	3398.1 (52.9)a	3298.6 (44.0)a		9.26 (0.01)bc	144.1 (3.8)cd	275.4 (0.2)ab
	4	305.4 (7.9)bc	3317.3 (63.7)a	3256.2 (54.8)a		9.24 (0.02)c	151.8 (4.8)bc	275.3 (0.3)ab
	5	292.9 (10.1)c	3244.6 (80.9)ab	3281.5 (68.8)a		9.26 (0.02)bc	148.1 (6.0)c	275.6 (0.3)ab
	≥6	271.3 (8.9)d	2922.72 (71.9)c	3218.4 (71.0)a		9.28 (0.02)b	133.6 (5.8)d	275.9 (0.3)a
	p-values	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
YC	1 (1975-1984)	370.4 (7.2)a	3739.3 (58.2)a	3478.7 (46.6)a	2.56 (0.01)d	9.26 (0.01)c	150.5 (4.3)b	272.6 (0.3)c
	2 (1985-1994)	324.9 (5.7)b	2683.3 (46.6)d	2547.0 (36.1)c	2.68 (0.01)b	9.22 (0.01)d	160.6 (3.5)ab	274.5 (0.2)b
	3 (1995-2004)	318.8 (4.7)bc	3327.0 (38.2)b	3258.8 (30.8)b	2.76 (0.01)a	9.23 (0.01)cd	159.8 (2.7)ab	275.6 (0.2)a
	4 (2005-2014)	302.5 (6.1)cd	3394.1 (49.2)b	3499.7 (46.1)a	2.69 (0.01)b	9.34 (0.01)b	167.9 (3.8)a	275.6 (0.2)a
	5 (2015-2020)	288.0 (9.1)d	3007.5 (73.2)c	3205.3 (79.4)b	2.62 (0.02)c	9.52 (0.02)a	155.5 (5.6)b	274.6 (0.3)b
	p-values	<.0001	<.0001	<.0001	<.0001	<.0001	0.00	<.0001
SC	1 (Nov. to April)	320.5 (4.1)a	3273.3 (32.8)a	3184.2 (29.8)a	2.69 (0.01)Ns	9.28 (0.01)Ns	125.5 (2.5)b	275.1 (0.1)Ns
	2 (May to Oct.)	299.2 (4.4)b	3074.6 (35.5)b	3088.3 (31.7)b	2.68 (0.01)Ns	9.27 (0.01)Ns	154.3 (2.7)a	274.5 (0.2)Ns
	p-values	0.04	0.03	0.01	0.37	0.58	0.00	0.43
Calf Sex	1 (Male)	268.9 (4.1)b	2699.2 (33.7)b	2740.9 (30.4)b	2.68 (0.01)Ns	9.30 (0.01)a	162.9 (2.5)Ns	275.2 (0.1)a
	2 (Female)	318.9 (4.3)a	3227.0 (34.5)a	3139.3 (31.0)a	2.68 (0.01)Ns	9.06 (0.01)b	156.4 (2.6)Ns	244.4 (0.1)b
	p-values	0.05	0.05	0.02	0.83	0.01	0.09	<.0001

LP: lactation period; TMY: total milk yield; 305MY: 305-day milk yield; AFC: age at first calving; GL: gestation length; DO: days open; CI: calving interval ;PR: parity; YC: year of calving; SC: season of calving.

Effect of calve gender

Individual milk production and across all lactations

As presented in Figure 1, through individual lactation milk yield, female births were associated with higher TMY in dams compared to males. Also, with regard to across all lactations, the differences were in favor of female birthing compared to males.

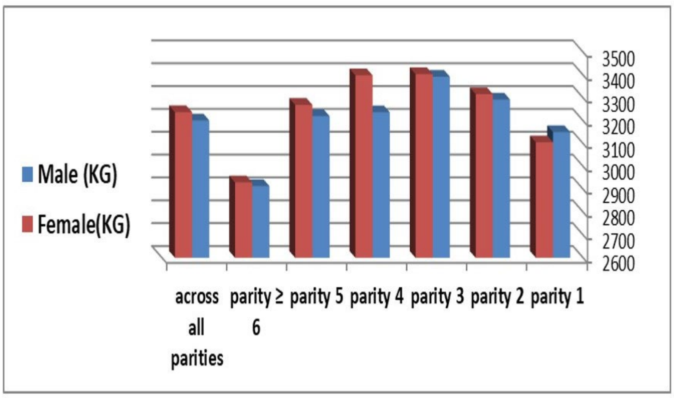

Fig. 1. Effects of calve gender on total milk yield in individual and across all lactations in Friesian cattle.

Productive traits

Calf gender had significant effects (p<0.05) on all studied productive traits (Table 2). The highest 305MY and TMY were achieved jointly with female birthing compared to males (p<0.05).

Reproductive traits

The effects of calf gender on GL and DO were significant (P<0.05); highly meaningful (P <0.001) on CI, but meaningless on AFC. CI was shorter for female births than males (p<0.001).

Genetic and phenotypic correlations

Genetic and phenotypic correlations among female calf gender and productive and reproductive traits are shown in Table 3.

Between female calf gender and productive traits

Positive moderate r_g estimates (Table 3) of 0.29 ±0.07; 0.31 ±0.04 and 0.32±0.07 were found between female gender births with LP; TMY and 305MY, respectively. Our corresponding r_p estimates were positive and moderate for female birth with LP; TMY and 305MY being 0.26; 0.33 and 0.36, respectively.

Table 3. Genetic - and phenotypic correlations between female calf gender with productive and reproductive traits and their standard errors in Friesian cattle.

Traits	Female gender	
	r_g	r_p
LP	0.29 (0.07)	0.26 (0.11)
TMY	0.31 (0.04)	0.33 (0.08)
305MY	0.32 (0.07)	0.36 (0.12)
AFC	0.014 (0.01)	0.11 (0.04)
GL	0.14 (0.01)	0.19 (0.02)
DO	0.004 (0.001)	0.007 (0.003)
CI	0.006 (0.002)	0.008 (0.002)

LP: lactation period; TMY: total milk yield; 305MY: 305-day milk yield; AFC: age at first calving; GL: gestation length; DO: days open, CI: calving interval; SE: standard error in parentheses.

Between female calf gender and reproductive traits

For female calve gender ,moderate r_g estimate of 0.14 ±0.01with GL, but low estimates of 0.014±0.01; 0.004±0.001 and 0.006 ±0.002 with AFC; DO and CL ,respectively were obtained. The r_g estimate between female births and DO was almost zero. On the other hand, the corresponding r_p estimates for female births were low to moderately positive (0.11 and

0.19 with AFC and GL, respectively and 0.007 with DO and CI).

Discussion

LP, TMY and 305MY were affected (p<0.001) by PR in accordance with the results of Faid-Allah (2015); Salem and Hammoud (2016b) and Farrag *et al*. (2020) for LP and TMY; Dörstelmann *et al*. (2018) for 305MY and TMY; Abu El-Naser *et al*. (2019); Kassahun *et al*.(2020) and Djedovi´c *et al*. (2021) for TMY; Safaa and Gharib (2017); Kamal El-den, *et al*.(2020) and Sanad *et al*.(2020) for the studied productive traits.

PR has highly significant (p<0.001) influences on GL, DO and CI in agreement with the results of Nogalski and Piwczyński (2012); Fitzgerald *et al*. (2015); Vieira-Neto *et al*.(2017) and Hoka *et al*.(2019) for GL; with El-Awady *et al*. (2016) ; Sanad and Hassanane (2019) and Abu El-Naser *et al*.(2019) for DO and CI and with Faid-Allah, (2015); Salem and Hammoud, (2016 b) and Sanad *et al*. (2020) for DO. While, Hermiz and Hadad (2020) and Sanad *et al*. (2020) revealed a non-significant influence of PR on CI and on GL by Potdar *et al*. (2017).

YC had greatly meaningful (p<0.001) effects on overall studied productive traits ,similar to the findings of El-Awady *et al*. (2016) ; Salem and Hammoud (2016 a;b) and Kassahun *et al*.(2020) for 305MY ,TMY and LP; Sanad and Afify (2016) and Ebrahim (2019) for LP; Dörstelmann *et al*.(2018) for 305MY and TMY ; Abu El-Naser *et al*. (2019) and Quaresma *et al*.(2020) for 305MY ; Safaa and Gharib (2017); Kamal El-den *et al*.(2020) and Sanad *et al*. (2020) for all studied productive traits. Conversely, non-significant effects of YC on TMY and LP were clarified by Usman *et al*. (2012) and on LP by Sanad and Hassanane (2019) and Hermiz and Hadad (2020).

Also, it presented superior meaningful effects (p<0.001) on the studied reproductive traits, confirming the outcomes of El-Awady *et al*. (2016) ; Abu El-Naser *et al*. (2019) and Sanad *et al*. (2020) on DO and CI ; Salem and Hammoud (2016a;b) on AFC ;Sanad and Hassanane (2019) on CI. Moreover, Setiaji and Oikawa (2020) proved highly significant effects (p<0.001) of YC on AFC and GL and Potdar *et al*. (2017) on GL. While, Kumar *et al*. (2016) evidenced non- significant influence of YC on GL and Salem and Hammoud (2016a) on DO.

Longer LP and higher 305MY and TMY were observed in the winter and spring seasons compared to the summer and fall due to comfortable weather and the high availability of green fodder. Considerable influence (p<0.001) of SC was shown for 305MY and worthy effects (p <0.05) on other production traits in accordance with the results of Chegini *et al*. (2015a) on LP and TMY; Sanad and Afify (2016); Safaa and Gharib (2017) and Dörstelmann *et al*.(2018) on 305MY and TMY; Abu El-Naser *et al*. (2019) on TMY; Salem and Hammoud (2016a;b) ;Ebrahim (2019) and Kassahun *et al*.(2020) on LP; Kamal El-den, *et al*.(2020) and Sanad *et al*.(2020) on all studied productive traits. However, a non-significant influence of SC on TMY was found by Salem and Hammoud (2016b) and Kassahun *et al*. (2020) and on 305MY by Djedovi´c *et al*. (2021). Moreover, Abu El-Naser *et al*. (2019) and Hermiz and Hadad (2020) revealed a non-significant influence of SC on LP.

For reproductive traits, SC evidenced a non-significant influence, except DO (p<0.001) similar to that of Salem and Hammoud (2016a; b) for DO. The shortest DO was noticed during the winter and spring compared to the summer and fall due to weather temperature disturbance, causing an accretion in the uterus temperature, a reduction in blood movement and consequently a reduction in reproduction's function (Ealy *et al*., 1993). However, Abu El-Naser *et al*. (2019) and Sanad *et al*. (2020) revealed a non-significant influence of SC on DO.

These results concur with those of Setiaji and Oikawa (2020) and Hermiz and Hadad (2020) who reported that SC has no influence on AFC and also, with Abu El-Naser *et al*. (2019); Sanad *et al*. (2020) on CI; Nogalski and Piwczyński (2012); Potdar *et al*. (2017) and Elmetwally *et al*. (2019) on GL. However, Vieira-Neto *et al*. (2017); Kašna *et al*. (2020) and Setiaji and Oikawa (2020) revealed a highly significant influence of SC (p<0.001) on GL.

Different from the above, Farrag *et al*. (2020) detected significant effects of SC on DO, CI and AFC. Faid-Allah (2015) and Salem and Hammoud (2016a; b) detected the same significant effect of SC on AFC. Chegini *et al*. (2015a); Sanad (2016) and Sanad and Hassanane (2019) evidenced significant effects (p< 0.01) of SC on CI.

Female births were coupled with higher TMY in dams compared to males. This was occurred between parities 2 to 6 probably due to the short GL and long LP and was in agreement with the results of Beavers and Van Doormaal (2014) on 305MY in individual lactation; Hinde *et al*. (2014) on 305MY in the first 3 PR (P<0.001) ; Hayr *et al*. (2015) on TMY at first 3 PR; Chegini *et al*. (2015a) on TMY and 305MY (p < 0.001 and p < 0.05 ,respectively) through the first 4 PR; Djedovi´c *et al*. (2021) on 305MYfor the first 2 PR (p <0.01) under high and low production levels. Sawa *et al*. (2014) showed that TMY at first PR depended on calf sex at the 1st and 2nd pregnancies and the peak (p<0.01) was placed in heifers carrying a female fetus .However, this disagrees with the current results, which illustrated low TMY at first PR that is associated with female birth and probably marks milk outputs for the rest of the cow's life through altering the hormonal profile to influence mammary development.

Moreover, other studies showed higher 305MY after female birthing in the first PR only (Barbat *et al*., 2014) and in the second PR (Hess *et al*., 2016) in French and New Zealand Holstein-Friesians, respectively. Hinde *et al*. (2014) revealed that the primary conception in feminine fetus enhances milk yields in the 2 following parities and defends versus the adverse consequences of the second conception in male embryos.

Controversially, after male birthing, Wang (2014) recorded higher 305MY than females (p<0.001) in parities from 2-6 in Dutch Friesian. Græsbøll *et al*. (2015) proved that having two successive male births results in a 0.52% increase in milk production compared to females in the first two PR. Gillespie *et al*. (2017) obtained a marginally greater milk yield in the primary PR for female births, but the highest was in the second PR for male births. Barbat *et al*. (2014) suggested that more milk production for male births in the first 3 PR could be due to management practices in various geographical regions, farmhouses and delivering a male tracked by a female calf will have the largest optimistic influence on production.

In spite of this, Chegini *et al*. (2015a) revealed that next to the third calving, the motherly milk yield was separated from the calve sex, which may be linked to the bigger pelvic sizes of the elder cows and the lesser occurrence of dystocia . This however, disagrees with our results that female births have a great effect on milk production between parities 2 and 6. Contrary to all the above findings, Atashi *et al*. (2012) and Quaresma *et al*. (2020) claimed non-significant effects of calf gender on 305MY.

With regard to TMY across all lactations (Fig.1), the differences were in favor of female birthing compared to male birthing, and this was confirmed by the results of Hinde *et al*. (2014) and Hess *et al*. (2016) that female birth in the first PR tended to rise (p <0.001) the production due to increasing the energy value of milk and reducing the negative effect of gestating a male in the next pregnancy. While, Wang (2014) obtained the opposite trend through favoring male birthing (p<0.001) at the first sex PR.

Significant effects of calf gender (p<0.05) on the studied productive traits were paralleled to the outcomes of Sawa *et al*. (2014) for TMY and LP of the first PR.; Chegini *et al*. (2015a) for TMY and LP ;Hess *et al*. (2016) for 305MY and LP; Beirao (2018); Hoka *et al*. (2019); Baradar *et al*.(2019) and Hermiz and Hadad (2020) for LP ; Yudin *et al*. (2013); Freitas *et al*.(2014) and Djedovi´c *et al*. (2021) for 305MY.

Hayr *et al*. (2015); Chegini *et al*. (2015a); Hess *et al*. (2016) and Hermiz and Hadad (2020) stated that female birth resulted in a significantly longer LP (p<0.05) and (p<0.001) between 1.1 and 3.2 days than male birth depending on the breed and PR. An opposite tendency was documented by Afzal *et al*. (2007); Hoka *et al*. (2019) who proved the non-significant influence of calf gender on LP and Coffie (2014)who detected little or no influence on LP (p >0.05).

The highest 305MY and TMY were achieved jointly with female birthing compared to males (p<0.05) and that was harmonized with the studies of Hinde *et al*. (2014); Sawa *et al*. (2014); Beavers and Van Doormaal (2014); Hayr *et al*. (2015) ;Chegini *et al*. (2015a); Hess *et al*. (2016); Beirao (2018) ;Kramarenko and Kramarenko (2021) and Djedovi´c *et al*. (2021) .

Hinde *et al*. (2014) indicated that the gender bias for higher milk production may be due to the fact that calf gender affects the hormonal rates of mothers and therefore can affect the outputs. Moreover, Beavers and van Doormaal (2014) found that giving two consecutive female births resulted in the greatest positive impact on 305MY. Sawa *et al*. (2014) and Chegini *et al*. (2015a) stated that females in the prior PR had a longer and extra persistent gender -biased lactation curve, plus less stress and pain during calving compared to male births.

Contrary to the previous results, Wang (2014); Freitas *et al*. (2014); Barbat *et al*. (2014); Græsbøll *et al*. (2015); Rodrigues (2017) and Hoka *et al*. (2019) stated that bulls have confident impacts on dams' milk yield due to breed , climate , data analysis, and management practices in different geographic areas and farms. Freitas *et al*. (2014) suggested that this could be due to heavier male births or, as stated by Yudin *et al*. (2013) to the interacting differences between males and females genetic natures with mechanisms of milk synthesis in dams. Wang (2014) pointed out that in the first PR, giving a female birth produced 23.23 kg more 305MY than males (p<0.001), but the opposite trend showed 13 kg more milk for male than female birth in the 3rd PR.

In contrast to all mentioned studies, Afzal *et al*. (2007) on buffalo; Atashi *et al*. (2012); Dallago *et al*. (2018) and Quaresma *et al*. (2020) stated that the calf sex had no effect on 305MY. Meanwhile, Habib *et al*. (2010) revealed no consequence of calf gender on LP and lactation production.

To explain the sex biased milk production Beavers and Van Doormaal (2014) and Alberghina *et al*. (2015) stated that the marginal increase in production for female births might be associated with the spreading hormones, which vary in embryos' gender within dams through gestation and could pass the placenta to the mothers circulations; therefore, calf gender can influence hormonal concentrations within mothers (Barrier and Haskell, 2011; Vieira-Neto *et al*., 2017).Thus, changes in the hormones blood levels, which are concerned with lactogenesis, might affect milk, depending on the born calf 's gender (Hess *et al*., 2016).

The impacts of calf sex on GL and DO were significant ($P<0.05$); highly meaningful ($P<0.001$) on CI, but meaningless on AFC .The significant effects of calf gender on GL favoring longer ones for male than female births may be due to the male's larger body size, presence of Y antigens and the resident impervious response to the fetus testosterone (Khan *et al*., 2012). Similar to our results were the studies of Nogalski and Piwczyński (2012); Fitzgerald *et al*. (2015); Vieira-Neto *et al*. (2017); Elmetwally *et al*. (2019); Jeon and Rho (2019) and Kašna *et al*. (2020) .

Nogalski and Piwczyński (2012); Hayr *et al*. (2015); Kašna *et al*. (2020) and Djedovi´c *et al*. (2021) concluded that GL was prolonged to a range of 1.1 to 2 days for male than female fetuses . Also, Sawa *et al*. (2014) and Vieira-Neto *et al*. (2017) confirmed that female GL was shorter than males with 1.3 and 2 days for heifers and cows, respectively. Djedovi´c *et al*. (2021) reported that male pregnancy prolonged GL and thus shortened LP; therefore, the addition of LP as a variable with female births in the animal model resulted in a higher 305MY only in the second lactation. However, Kumar *et al*. (2016) and Hoka *et al*. (2019) observed a non-significant influence of calf gender on GL.

The significant effects of calf gender on shortening DO ($p<0.05$) for females exposed to male birth were in line with the findings of Hinde *et al*. (2014) and Sawa *et al*. (2014) in the first 2 PR ($P \leq 0.01$) that females suckling more milk from their dams were allowed to reach reproductive stage early. Khan *et al*. (2012) mentioned that a cow or buffalo delivering a male calf had a longer service time than females. While, Elmetwally *et al*. (2019) revealed non-significant long DO for female calves.

CI was shorter for female births than males ($p<0.001$), concurring with the results of Hinde *et al*. (2014) and Sawa *et al*. (2014). Moreover, Obese *et al*. (2013) detected that CI increased 14 days after bull birth. While, Chegini *et al*. (2015b) evidenced an opposite trend with significant influences ($p<0.0001$) of male birth on shorter CI due to the fact that female birth caused a lower rate of dystocia , stress, reduced body energy balance, and consequently increased CI with increasing milk production.

Moderate r_g estimates were found between female births with LP, TMY and 305MY of 0.29; 0.31 and 0.32, respectively. These were lower than 0.60 with 305MY by Wang (2014), but that of Cue and Hayes (1985) was negative at -0.82. Also, Adkinson *et al*. (1977) revealed that sire of fetus effects on TMY were highly correlated (0.96) and affected milk yield, accounting for 8.2 to 14.3% of the total variability. Skjervold and Fimland (1975) reported an r_g estimate of 0.04 between breeding value and sire of fetus effects on lactation yield. On the other side, our corresponding r_p estimates were positive and moderate for female birth with LP; TMY and 305MY being 0.26; 0.33 and 0.36, respectively.

For female calves, the r_g estimate is 0.14 with GL, but there are low estimates of 0.004 to 0.014 with AFC; DO and CL. The r_g estimate between female births and DO was almost zero, similar to that obtained by Khan *et al*. (2012) who mentioned that a cow with a male birth had a longer service period than a female. Adkinson *et al*. (1977) observed that the sire of embryo effects on DO amounted to 1.9 and 3.2% of the whole variance for Holsteins plus Jerseys and the correlations were -0.02 and -0.12, respectively. While, the r_p estimates for female births were low to moderate , around 0.11 and 0.19 with AFC and GL, respectively, and 0.007 with DO and CI.

Conclusion

The present study highlights that the female gender of the first calf had an effect on the next lactation's milk yield. Dams giving female births tended to produce high TMY during their immediate and subsequent lactations relative to those giving male births. Calve gender affects all milk production and most reproductive traits. Female births showed shorter GL and CI than male births, which reduces the generation interval and increases the amount of genetic gain. Using female sexed semen is recommended to increase milk production profitability under better environmental and management conditions on our dairy farms.

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Conflict of interest

The authors declare that they have no conflict of interest.

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