GENETIC AND ENVIRONMENTAL INFLUENCES ON BIRTH WEIGHT, WEANING WEIGHT AND AVERAGE DAILY GAIN OF HOLSTEIN CALVES IN SYRIAN COAST CONDITIONS

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SUMMARY

This study was carried out at Dairy Station which belonging to the General Organization for Cattle in Latakia province, Syria, to investigate the effects of genetic and some environmental factors on birth weight (BW), weaning weight (WW) and average daily gain (ADG) using data of 4055 Holstein calves during the years from 1990 to 2015.

Analysis of variance showed that year of calving had significant effect (P< 0.05) only on average daily gain, and the effect of season of calving had significant effect on birth weight and average daily gain. Whereas, parity, gender and the interaction between parity and gender influenced significantly (P< 0. 01) all the studied traits.

The overall means for BW, WW and ADG were 34.6±0.12 kg, 96.2±0.07 kg and 684±0.002 g/day, respectively. Heritability estimates for these traits were 0.06±0.03, 0.03±0.01 and 0.03±0.02, respectively.

It is concluded that the BW, WW and ADG were adequate under Syrian Coast Conditions. Low heritability estimates indicated that the genetic effect was low.

Keywords: Birth Weight, Weaning Weight, Average Daily Gain, Heritability, Holstein Calves, Syrian Coast

INTRODUCTION

Growth traits are one of the important economic traits of cattle in different production systems and helpful in formulating management and selection decisions. However, weight at birth is one of the first traits that can be easily measured and an important single parameter of subsequent growth performance because the heavier calves can grow faster and healthier compared to the lighter calves (Sofienaz, *et al*. 2014).

The birth weight is commonly used as an early selection criterion in cattle breeding (Kaygisiz *et al*. 2012). In addition, birth weight is one of the main criteria for determination of calving ease. Growth rate of calf is the most important trait for meat productivity in production systems (Correa *et al*. 2006). Weight gains during the preweaning period reflect the capability of calf development (Cucco *et al*. 2009). Weaned calves have a great influence on the economy and profitability of the farm.

Many authors (Abera *et al*. 2013 and Yaylak *et al*. 2011) reported that both birth and weaning weights can be affected by various environmental factors such as farm, year of calving, season of calving, parity, gender, quantity of milk or milk replacer intake and hygiene. Birth and weaning weights are known to be influenced by the direct genetic effect of the calf and the maternal genetic effect (Meyer, 1992).

Average daily gain (ADG) is one of the most important economic indicators for beef, because it is an important trait affecting the profitability of a cow-calf operation. So, it is one of the most developed sectors in European countries (Bruns *et al*., 2005).

Estimates of the heritability for growth traits indicate that the phenotypic value of these traits can be used to demonstrate the direct additive genetic value. Increases body weight gain during animal growth can be used as selection criteria to increase beef cattle efficiency (Boligon *et al*., 2010). Genetic improvement through selection for growth traits are less desirable because the expected rate of genetic gain is very low (Cucco, 2009).

There is no information of these traits for Holsteins calves in Syria. Therefore, the aim of this study was to investigate the effect of genetic (Sire) and some environmental factors such as year of calving, season of calving, parity, gender and the interactions among different factors on birth weight, weaning weight and average daily gain of Holstein calves under intensive production system in Syrian coast.

MATERIALS AND METHODS

Data:

The data of calving date, birth weight (BW), average daily gain (ADG) and weaning weight (WW) were taken from records of 4055 calves born during the period from 1990 to 2015, Fedio Dairy Station

which belongs to the General Organization for Cattle in Latakia province in Syria.

Herd management:

Animals were raised under free housing system in semi-closed sheds with concrete floors. After calving, calves were weighed weekly with a scale (±0.2 kg), and taken into individual pens. Then, colostrum was supplied to calves in the first four days of age. An amount of 400 kg of natural milk were provided for each calf during the suckling period. The age of weaning is 90 days. Beside milk, green fodder, alfalfa hay and concentrates (barley, corn, bran and soya meal) were given at the suckling period. Water was available all the day. Heifers were bred for the first time when reached 13-15 months old using artificial insemination. Cows were machine milked twice a day at 06.00 a.m. and 6.00 p.m.

Studied traits:

1. Birth weight (BW, kg).
2. Weaning weight (WW, kg).
3. Average daily gain (ADG, g/day) = (Weaning weight - Birth weight) /90.

Statistical analysis:

Data were subjected to statistical analysis of variance, using the General Linear Model of XLSTAT 2020.3.1.27 program.

The statistical model was:

$Y_{ijklm}=\mu+YC_i+SC_j+P_k+G_l+(P\times G)_{kl}+e_{ijklm}$

Where:

Y_{ijklm} = the observations of the studied traits,

μ = the overall mean,

YC_i = the fixed effect of i^{th} year of calving (i= 1, 2, 3, 4, 5), where 1=1990-1994, 2= 1995-1999, 3= 2000-2004, 4= 2005-2009 and 5= 2010-2015,

SC_j = the fixed effect of j^{th} season of calving (j= 1, 2, 3, 4), where 1= winter, 2= spring, 3= summer and 4= autumn,

P_k = the fixed effect of k^{th} parity, where k= 4, (1, 2, 3, ≥4),

G_l = the fixed effect of l^{th} gender (1= male and 2= female),

$(P\times G)_{kl}$ =the effect of the interaction between k^{th} parity and l^{th} gender,

e_{ijklm} = the experimental error.

Estimation of heritability (h^2) for all studied traits, paternal half sibs method was used by adding the sire as the random effect to the model describe above using the Derivative-Free Restricted Maximum likelihood (DF-REML) procedure (Meyer, 1998).

RESULTS AND DISCUSSION

The overall mean of BW was 34.6±0.12 kg. This estimate is lower than estimates reported in other studies on the same breed (Abdel Fattah *et al*. 2019, 35.92 kg; Kaygısız *et al*. 2012, 38.12 kg; Yaylak *et al*. 2015, 39.6 kg). However, BW in this study was close to estimate of Kabuga and Agyemang (1984) in Gana, but higher than reported in Frisian calves in Egypt by Atil *et al*., (2005, 31.84 kg) and by Ali *et al*., (2019, 31.38 kg) in Holstein Friesian calves in Pakistan. Average birth weight of Holstein is commonly reported as 40-45 kg (Wattiaux, 1996b). Since calve weights increase from 4 to 45 kg during the last 1/3 of the gestation period, such a prenatal period is highly critical for birth weights of the calves (Wattiaux, 1996 a). So, further improvements in birth weight can be done by more balanced feeding during the last third of gestation period.

Whereas, the overall mean of WW was 96.2±0.07 kg, it was greater than the values of the same breed reported by Yaylak *et al*. (2015, 79.7 kg), and lower than Atil *et al*. (2005, 97.27 kg). This difference might be due to variations in BW, ADG, weaning age, feeding, hygiene, management and climatic conditions.

Also, the results showed the overall mean of ADG was 684.8±0.002 g/day. This estimate was higher than the value reported by Yaylak *et al*. (2015, 525 g/day).

Effect of year of calving:

The results showed that year of calving had no significant effect on birth weight and weaning weight, but significant effect (P<0. 05) on average daily gain of calves (Table 1). The LSM of daily gain was the highest estimate (692 g/d) among the period (1990-1994) compared with other periods (Table 2). The effect of year of calving on average daily gain reflects the environmental conditions such as temperature and relative humidity, feeding, and management practices conditions from year to year (Manzi *et al*. 2012). The current result disagrees with various studies of the same breed (Kocak *et al*, 2007 and Yaylak *et al*. 2015) that found the effect of year of calving on birth weight and weaning weight was significant.

Table 1. Level of significance (p< 0.05) of factors affecting the studied traits of Holstein calves

Affecting factors	df	Birth weight (kg)	Weaning weight (kg)	Average daily gain (g)
Year of calving	4	0.089	0.184	0.043
Season of calving	3	< 0.0001	0.489	< 0.0001
Parity	3	< 0.0001	< 0.0001	< 0.0001
Gender	1	< 0.0001	< 0.0001	< 0.0001
Interaction between (parity and gender)	3	< 0.0001	< 0.0001	< 0.0001
Pr > F	-	< 0.0001	< 0.0001	< 0.0001

Table 2. Least Squares Means (LSM) and standard errors (±SE) of the studied traits according to effect of year of calving of Holstein calves

	Studied traits (LSM±SE)		
	Birth weight (kg)	**Weaning weight (kg)**	**Average daily gain (g)**
Periods	**NS**	**NS**	*
1990-1994	34.1[a]±0.25	96.4[a]±0.15	692[b] ±0.003
1995-1999	34.7[a]±0.25	96.3[a]±0.15	685[ba] ±0.003
2000-2004	35.0[a]±0.24	96.3[a]±0.14	681[a]±0.003
2005-2009	34.7[a]±0.23	96.0[a]±0.14	681[a] ±0.003
2010-2015	34.7[a]±0.23	96.0[a]±0.14	681[a]±0.003

Means followed by different superscripts are significantly different, NS: Non-significant, : P<0. 05,

Effect of season of calving:

Table 3. showed that season of calving had a significant effect of on birth weight trait. The lightest values of BW (33.6 kg) were observed in autumn compared to the other values (Table 3). Which may be due to the dams calved in autumn season would have inadequate feed and pastures during the previous season (summer), therefore results in birth weight decrease and weak body conditions of the pregnant dams during calving. This result in accordance with Kocak *et al*. (2007 and Manzi *et al*. (2018). Thatcher *et al*. (1986) whose indicated that thermal stress lead to reduce feed intake of dams and probably a reduction in the blood flow to the uterus may be the cause of the light birth weight of calves born in the dry season. Collier *et al*. (1982) reported that calves of Holstein cows exposed to heat stress during the last 1/3 of gestation period had three kg less birth weights than the cows stayed at shade. While, Almasri (2010) reported the effect of season of calving was non-significant on birth weight of Holstein Friesian calves in Syria.

Season of calving had no significant influence on WW (Table 3). This result agrees with Obese *et al*. (2013) and Rumph and Van Vleck *et al*. (2004), while disagrees with Yaylak *et al*. (2015) for Holstein calves in Turkish. Yaylak *et al*. (2011) reported that the WW was low in summer and spring and high in winter. Bahashwan (2016) indicated calves weaned at winter season gave highest values with an average of 98.9 ±1.87 kg in Dhofari calves in Sultanate Oman.

Season of calving had significant influence on ADG (Table 1). The highest value was in the autumn (697 g/d) compared to other seasons (Table 3). This result agreed with Bayou *et al*. (2015) in Sheko cattle in Ethiopia. But this result was inverse with Obese *et al*. (2013) and Rumph and Van Vleck *et al*. (2004). Significant seasonal variations may be due mainly to variations in feed and fodder availability as well as disease incidence in different seasons (Bell, 2006).

Table 3. Least Squares Means and standard errors of the studied traits according to effect of season of calving of Holstein calves

	Studied traits		
	Birth weight (kg)	**Weaning weight (kg)**	**Average daily gain (g)**
Season of calving	**	**NS**	**
Winter	34.9[b]±0.20	96.1[a]±0.12	679[a]±0.003
Spring	34.9[b]±0.24	96.1[a]±0.14	681[a]±0.003
Summer	35.1[b]±0.22	96.3[a]±0.13	679[a]±0.003
Autumn	33.6a±0.20	96.3a±0.12	697b±0.003

Means followed by different superscripts are significantly different, **P<0. 01, NS: Non-significant

Effect of parity:

Table 4 presents the effect of parity on the studied traits, and indicated that calves born in the first parity had heavier birth weight than the other parities. This result in accordance with Aksakal and Bayram (2009). This result may be because the pregnant cows during dry off period in the most years were fed green fodder, hay and small amounts of concentrates which cannot provide the nutrition needs completely in this period. Contrary to our finding, Johanson and Berger (2003) explained that earlier-parity cows continue to grow until reaching adult size and compete with the fetus for available nutrients during pregnancy. Also, Almasri (2010) found the birth weight was lightest in the calves born in the first parity of Holstein Friesian in Syria.

Calves born in early parities were heavier in WW than those born to later parity (Table 4), because they were higher in BW. The effect of parity on WW was significant effect. This finding conflicts with Wasike *et al*. (2006) who found that the calves from multiparous cows had the highest weaning weight, might be due to well- developed mammary tissue of their mature status has contributed to reveal better maternal environment in terms of milk for the suckling calf.

Also, the effect of parity was significant on ADG. The ADG increased with increasing parity till the third parity (Table 4). This finding agreed with Goyache *et al*. (2003) who reported that ADG increases with calving number till fourth calving as a consequence of the differences in nursing ability between developing and adult dams. While, Addisu *et al* (2010) didn't find any significant of the parity on ADG.

Table 4. Least Squares Means and standard errors of the studied traits according to effect of parity of Holstein calves

	Studied traits		
	Birth weight (kg)	**Weaning weight (kg)**	**Average daily gain (g)**
Parity	**	**	**
1	37.7^{c}±0.17	100^{c}±0.10	693^{b} ±0.002
2	32.8^{a}±0.21	99.8^{c}±0.12	745^{c} ±0.003
3	32.6^{a}±0.26	99^{b}±0.15	737^{c} ±0.003
≥4	35.4^{b}±0.25	86^{a}±0.15	562^{a} ±0.003

Means followed by different superscripts are significantly different, **P<0. 01,

Effect of Gender:

The BW mean of male and female calves were 36.0±0.17 kg and 33.3±0.17 kg, respectively (Table 5). The effect of gender on BW was highly significant (p<0. 01). Previous studies also reported higher birth weights of male calves than female (Hoka *et al*. 2019; Almasri, 2010; and Yaylak *et al*. 2015). This result might be due to longer gestation periods and higher androgen hormone intensity of fetus serum (Uzmay *et al*. 2010). Where, a day prolongation in gestation period result in 0.5 kg increase in birth weights (Wattiaux, 1996a).

Table 5 shows the mean of WW and ADG of male calves 94.7 kg and 653 g/d, respectively, and significantly different (p<0.001) than female calves were 97.6 kg and 715 g/d, respectively. This result agreed with Obese *et al* (2013). In contrary, this result disagrees with a previous study (Vendruscolo *et al*., 2020; Abera *et al*., 2013; and Goyache *et al*. 2003), they found males grow faster and have higher growth ability. In Contrary, Bayou *et al* (2015) didn't found any significant differences in weaning weights for both genders.

Table 5. Least Squares Means and their standard errors of the studied traits according to effect of gender of Holstein calves

	Studied traits		
	Birth weight (kg)	**Weaning weight (kg)**	**Average daily gain (g)**
Gender	**	**	**
Male	36.0^{b}±0.16	94.7^{a}±0.91	653^{a} ±0.002
Female	33.3^{a}±0.16	97.6^{b}±0.96	715^{b} ±0.002

Means followed by different superscripts are significantly different, **P<0. 01

Heritability estimates of the studied traits:

The heritability estimate of BW was low 0.06 ± 0.03 (Table 6), but it was higher than what was reported in Holstein calves by Kaygisiz *et al*. (2012, 0.04), and lower than the estimates reported in the same breed by Kocak *et al*. (2007, 0.115). However, it was lower than value reported by Wasike *et al*. (2006) for Born breed cattle (0.36). Low heritability indicates that BW is not significantly controlled by additive gene effects. It also indicates that selection in this trait may be not fruitful and cannot cause genetic improvement.

Whereas the heritability estimate of WW in this study was 0.03 ± 0.01 (Table 6) and in good agreement with Kocak *et al*. (2007, 0.02), but lower than other studies like Khan and Khan (1999, 0.08) in Nar master calves. Low heritability indicates that the WW improvement cannot be achieved by selection and genetic improvement, but by good management.

Also, the estimate of heritability of ADG 0.03±0.02 (Table 6) was in good agreement with (Krejčova *et al*. 2008) in Czech Fleckvieh calves (0.014 to 0.043), but lower than what was reported by (El-Saied *et al*., 2006) in Charolais calves (0.22). Low heritability indicates that the environment plays the major role in improving ADG.

Table 6. Heritability (h^2±SE) estimates of the studied traits

Studied traits	**h^2±SE**
Birth weight (BW)	0.06±0.03
Weaning weight (WW)	0.03±0.01
Average daily gain (ADG)	0.03±0.02

CONCLUSION

Holstein calves are raised successfully under intensive production system in Syrian coast. Some environmental factors such as year of calving, season of calving, parity, gender, and interactions between studied factors should be considered when calves are evaluated. The birth weight in the same breed is lower than what is found in the most other studies. However, the weaning weight and average daily weight seem to be adequate. Therefore, improvements in birth weight trait could be achieved through better feeding, housing system and management practices of pregnant cows during dry off period. The low estimates of heritability in these three traits indicate that the major part of the

variation was environmental and selection may not be effective in genetic improvement. Therefore, better environmental and management conditions can play the major role in improvement these traits.

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العوامل البيئية والوراثية المؤثرة على وزن الميلاد, وزن الفطام ومتوسط الزيادة اليومية في عجول الهولشتاين تحت ظروف الساحل السوري

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أجريت هذه الدراسة في محطة فديو التابعة للمؤسسة العامة للمباقر في محافظة اللاذقية في سورية، لدراسة تأثير بعض العوامل البيئية على وزن الميلاد، وزن الفطام ومعدل الزيادة اليومية بإستخدام ٤٠٥٥ سجلاً لعجول الهولشتاين خلال الفترة من عام ١٩٩٠ إلى ٢٠١٥. أظهرت نتائج التحليل الإحصائي وجود تأثير معنوي ($P < 0.05$) لسنة الولادة فقط على معدل الزيادة اليومية، وتأثير معنوي ($P < 0.01$) لفصل الولادة على كلٍ من وزن الميلاد ومعدل الزيادة اليومية، بينما كان تأثير كلاً من ترتيب الموسم وجنس المولود والتداخل بين ترتيب الموسم وجنس المولود تأثيرا معنوياً ($P < 0.01$) على جميع الصفات المدروسة. بلغ المتوسط العام لوزن الميلاد، وزن الفطام ومعدل الزيادة اليومية ٣٤,٦ ±٠,١٢ كجم، ٩٦,٢±٠,٠٧ كجم، و٦٨٤±٠,٠٠٢ جرام/يوم، على الترتيب، بينما بلغ تقدير العمق الوراثي لهذه الصفات ٠,٠٦±٠,٠٣، ٠,٠٣±٠,٠١، ٠,٠٣± ٠,٠٢ على الترتيب. نستنتج من الدراسة بأن كلاً من وزن الميلاد، وزن الفطام ومعدل الزيادة اليومية مناسب، كما تبين أن تقدير العمق الوراثي للصفات المدروسة كان منخفضاً، وهذا يدل على أن التأثير الوراثي كان منخفضاً، وبالتالي بالإمكان الحصول على وزن ميلاد أعلى من خلال تحسين الأساليب الإدارية والتغذوية وخاصةً خلال الأشهر الأخيرة من الحمل.