EFFECT OF AGE AT FIRST CALVING AND FIRST LACTATION MILK YIELD ON PRODUCTIVE LIFE TRAITS OF SYRIAN SHAMI COWS

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SUMMARY

The objective of this research was to study the effect of age at first calving (AFC) and first lactation milk yield (FMY) on productive life traits of Syrian Shami cows. In this study, the complete records from birth to voluntary culling were collected on 605 cows during the period from 1981 to 2010 at Deir al-Hajar station in Syria. Data were analysed using the General Linear Model (XLSTATE, 2019). The least squares means for AFC and FMY were 30.9±0.16 months and 1203±34 kg, respectively.

The optimum AFC was ≤ 25 months to achieve the maximum lifetime milk yield, productive life and number of calvings. Increasing AFC (especially over 31.8 months) decreased lifetime milk production, lifetime daily milk yield, productive life and the number of lactations. First lactation milk yield reflected the production capacity in subsequent lactations. The first calvers of more than 1900 kg produced high milk yield during their life and had shorten dry periods. While cows that produced less than 600 kg milk in the first lactation had the lowest life time milk production.

Keywords: Age at first calving, First lactation milk yield, Productive life traits, Syrian Shami cows

INTRODUCTION

Rearing replacement heifers need a large cost without profitability till starting their productive life. In general, cows become economically beneficial in the second lactation, because in first lactation their bodies and udder tissues had not reached full development (Sawa, 2011).

Age at first calving (AFC) is influenced by management conditions and cow health. Successful management and adequate nutrition during the rearing period of heifers lead to reaching heifers proper body weight and target AFC. Poor feeding during rearing period delay AFC (Wathes *et al*., 2008). Otherwise, increasing feeding during the rearing period, resulting in heavier heifers and bad body condition score, may be increased infertility and culling rate (Wu *et al*., 2012).

Evans *et al*. (2006) stated that heifers calved at first time between 25 - 26 months had a high fertility and short calving interval in subsequent lactations. However, reducing AFC less than 22 months cause increasing the dystocia and decreasing milk production in subsequence lactations (Hoffman *et al*, 2006). While increasing AFC to 29 months increased replacement costs by 14%, and reduced productive life, lifetime milk yield and number of calvings (Tozer and Heinrichs, 2001).

Janus and Borkowska (2004) showed a negative correlation between first lactation milk yield and productive life traits, so the high first lactation milk yield may affect negatively on the health and growth of cows, and resulted in early culling of cows from the herd.

Productive life is an important trait after milk production that used in selection. This trait is related to productive and reproductive performance and health, and it is affected by management conditions (Krpalkova *et al*., 2017). Increasing productive life reduced costs of replacement, increased lifetime milk production and number of calvings (Caetano *et al*., 2017).

No available papers or researches were found related to productive life traits of native Syrian Shami cows. Therefore, the main objective of this study was to investigate the effect of age at first calving and first lactation milk yield on productive life traits of native Syrian Shami cows.

MATERIALS AND METHODS

Data:

Data used in this study were collected from 605 complete records of 605 Shami cows from birth to voluntary culling dates. These records covered a period of 30 years from 1981 to 2010, belonging to Deir al-Hajar station in Syria. Each record contained the data of age at first lactation, first lactation milk yield, productive life, lifetime milk production and number of lactations for each cow under study.

Herd management:

Animals were raised under free housing system in semi-closed sheds with concrete floors. Cows were fed twice a day on roughages (straw and cotton seed hulls). Commercial concentrates formulated in station, in addition to hay (vetch, barley and alfalfa) and green fodder, if available, were offered to cows. Water was available all days. Heifers were naturally mated for the first time when reached 18 months old taking into account the weight of the animal (270 kg). Cows were machine milked twice a day at 06.00 a.m. and 6.00 p.m. The new born calves suckled their

dams after calving till weaning at 90 days. Milk production was recorded twice a month (Bi-monthly milk recording system) to calculate monthly and total milk yield for each cow.

Studied traits:

1. Productive life (PL, months)= culling date - first calving date.
2. Lifetime milk production (LMP, kg) = cumulated total milk yield produced through productive life of cow.
3. Lifetime daily milk yield (LDMY, kg) = lifetime milk production/ number of days from birth to culling for each cow.
4. Number of lactations = total number of lactations during productive life of cow.

Statistical analysis:

In order to determine the effect of age at first calving on the productive life traits, heifers were classified into five groups according to their average of AFC depending on the standard deviation distribution of AFC as indicated in table (1):

Concerning the effect of first lactation milk yield on the same traits, cows were classified according to their average first lactation milk yield (FMY) into five groups depending on the standard deviation distribution of FMY as presented in table (2):

Table 1. Distribution of heifers according to their average age at first calving

Groups	Avg. AFC (mo.)	Min. (mo.)	Max. (mo.)
1	23.4	20	25.4
2	27.4	25.5	28.6
3	30	28.7	31.7
4	33.1	31.8	34.7
5	37.2	34.8	39.9

No. of heifers= 605

Table 2. Distribution of cows according to their first lactation milk yield

Groups	Avg. FMY (kg)	Min. (kg)	Max. (kg)
1	507	450	559
2	832	560	1119
3	1361	1120	1679
4	2011	1680	2400
5	2977	2420	3925

No. of cows = 605

Data were subjected to statistical analysis of variance, using the General Linear Model of XLSTAT 2019.1.2.56963program.

The statistical model was:

$Y_{ijklm} = \mu + A_i + T_j + Y_k + S_l + (A \times T)_{ij} + e_{ijklm}$

Where:

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

μ = the overall mean,

A_i = the fixed effect of i^{th} age at first calving (i=1, 2, 3, 4, 5),

Where: 1=≤ 25.4, 2= 25.5–28.6, 3= 28.7–31.7, 4= 31.8–34.7 and 5= ≥ 34.8 months,

T_j= the fixed effect of j^{th} first lactation milk yield (j=1, 2, 3, 4,5), Where: 1 =<560 kg, 2= 560-1119, 3= 1120-1679, 4= 1680-2400 and 5=>2400 kg,

Y_k= the fixed effect of k^{th} year of calving for first lactation (k= 1, 2, 3, 4, 5, 6), Where: 1=1981-1985, 2= 1986-1990, 3= 1991-1995, 4= 1996-2000, 5= 2001-2005 and 6= 2006-2010,

S_l= the fixed effect of l^{th} season of calving for first lactation (l= 1, 2, 3, 4), where 1= winter, 2= spring, 3= summer and 4= autumn,

$(A \times T)_{ij}$ =the effect of the interaction between i^{th} age at first calving and j^{th} first lactation milk yield, and

e_{ijklm} = the experimental error.

The simple correlation coefficients between each of age at first calving and first lactation milk yield and the studied traits were estimated using the XLSTAT 2019.1.2.56963.

RESULTS AND DISCUSSION

Productive life (PL):

The least squares means (LSM) and standard errors of productive life (PL) are presented in table (3). The overall mean of the productive life was 67±1.35 months, which was longer than that found by Abou-Bakr (2009, 47.5 mo.), Sawa and Bogucki

(2017, 37.4 mo.) and Kučević *et al*., (2019, 40.2 mo.) on Holstein cows.

Table 3. Least squares means and standard error (LSM±SE) of productive life (PL) in months

Classification[1]	productive life (PL, months) (LSM±SE)
Overall mean	**67±1.35**
Age at first calving (month)	**
≤25.4	76.3^{b}±5.54
25.5-28.6	69.3^{b}±3.05
28.7-31.7	68^{b}±2.44
31.8-34.7	64.9^{ab}±3.12
≥ 34.8	56.3^{a}±3.33
First lactation milk yield (kg)	**NS**
<560	65.8^{a}±2.89
560-1119	67.4^{a}±2.70
1120-1679	71.1^{a}±3.20
1680-2400	63.4^{a}±3.36
> 2400	67.1^{a}±4.62
Year of calving (periods)	**
1981-1985	77.3^{c}±3.74
1986-1990	77.1^{c}±3.88
1991-1995	67.1^{b}±3.62
1996-2000	63.7^{b}±3.73
2001-2005	67.4^{b}±3.12
2006-2010	49.2^{a}±3.28
Season of calving	**NS**
Winter	64.8^{a}±3.23
Spring	66.6^{a}±2.70
Summer	67.3^{a}±2.84
Autumn	69.2^{a}±3.04

1=within each classification, means not followed by the same letter differ significantly at 5 % level;
Number of records = 605; * * ($p<0.01$); NS = not significant.

The effect of age at first calving (AFC) was highly significant ($p<0.01$) on PL, the longest PL (76±5.54 months) was that of heifers calved at ≤ 25.4 months, then it decreased gradually with increasing AFC till it reached 56±3.33 months for cows that had AFC more than or equal 34.8 mo. This could be due to those cows calved early started productive life early, so they had longer PL compared to those calved late, in addition, there is a negative correlation between age at first calving and productive life. Sawa *et al*. (2019) and Curran *et al*., (2013) arrived at the same conclusion on Holstein cows in Poland and USA, respectively. Sawa and Bogucki (2010) indicated cows had AFC ⩽22 months had the longest productive life.

Coffey *et al*. (2006) explained that a share of Holstein genes in the population of Polish dairy cows increased growth rate of heifers and probably they reached the body weight and body condition score desired for breeding at a younger age. Zavadilová and Štípková (2013) concluded that Holstein cows in Czech had AFC greater than 33 months had a lower probability to show oestrus or conceive, so those

cows were culled early and had a shorter productive life.

While, Ojango *et al*. (2005) reported a nonsignificant effect of AFC on productive life on Holstein cattle in Kenya.

The effect of first lactation milk yield (FMY) on PL was nonsignificant (table 3), which may be due to that native Syrian Shami cows are normally low milk producers and short lactating animals. This result is in agreement with Brzozowski *et al*., (2003) on Polish Black and White cows. Januś and Borkowska (2012) on Holstein-Friesian cows in Poland and Herlihy *et al*. (2013) on dairy cows in Ireland, who found a negative correlation between productive and reproductive traits, and added that cows of high FMY had low fertility and short productive life.

The year of calving had a highly significant effect on PL (table 3). Cows calved during the years between 2006 and 2010 had the minimum value of PL, this could be due to differences in managerial systems from year to another. It is in agreement with Singh *et al*., (2018), Almasri (2010), and Hammoud *et al*., (2010) on crossbred Frieswal cows (Friesian × Sahiwal) in India, Holstein-Friesian cows in Syria and Friesian cows in Egypt, respectively.

The effect of season of calving was nonsignificant on PL, which may be due to the lack of variation in the quality of feed stuffs among seasons, which is in agreement with Almasri (2010).

Number of lactations (NL), Lifetime milk production (LMP) and Lifetime daily milk yield (LDMY) :

The least squares means of number of lactations (NL), lifetime milk production (LMP) and lifetime daily milk yield (LDMY) are presented in table 4.

The overall mean of NL was 4.4±0.08 (table 4), which was higher than the estimates reported by Kučević (2019, 2.45) and Sawa and Bogucki (2017, 3.11). However, higher estimates were found by Atil and Khattab (1999, 5.26) and Alhammad (2008, 5.5) on Holstein-Friesian in Egypt.

The lifetime milk production was 6974±174.47 kg. This estimate was lower than the estimates reported by Sawa *et al*. (2019, 22977 kg) on Holstein cows in Poland, Cielava *et al*., (2017, 37916 kg) on Latvian dairy cows and Kučević*et al*. (2019, 18798 kg) on Holstein cows in Serbia. Differences among estimates may be due to breed differences, climate and management practices.

The lifetime daily milk yield was 2.3±0.04 kg. This value was lower than those reported by Sawa *et al*., (11.3 kg, 2019) on Holstein cows in Poland and found by Cielava *et al*. (13.2 kg, 2017) on Latvian dairy cows.

Age at first calving (AFC) affected significantly number of lactations (NL), lifetime milk production (LMP) ($p<0.05$) and lifetime daily milk yield (LDMY) ($p<0.01$). The highest values of NL (4.9), LMP (7610 kg) and LDMY (2.5 kg) were found for cows of AFCless than or equal 25.4 months, and the lowest values of NL (3.8), LMP (5761 kg) and LDMY (1.9 kg) were for cows of AFC more than or equalto 34.8 months (table 4). This could be due to the fact that cows calved early had longer PL and more NL, LMP and LDMY compared to those calved late, in addition, there is a negative correlation between age at first calving and number of lactations and lifetime milk production. Similar results were found by Sawa *et al*., (2019) on Polish Holstein-Friesian and Sawa and Bogucki (2010) on Australian Holstein cows.

Eastham *et al*., (2018) found that reducing age at first calving was associated with improving reproductive performance and increasing of number of lactations on Holstein and Holstein-Friesian cows in the UK.

Zavadilová and Štípková (2013) concluded that Holstein cows had early age at first calving had a good fertility trait, so those cows produced a greater number of lactations during their productive life. The authors found that late age at first calving (33 to 46 months) had worse fertility traits, so those cows produced a smaller number of lactations.

On the contrary, Krpalkova *et al*. (2017) found that age at first calving had no significant effect on the number of lactations on Holstein and Czech Fleckvieh breed.

The effect of first lactation milk yield on the NL was nonsignificant, while, it affected significantly ($p<0.01$) LMP and LDMY (table 4). This result was in agreement with Sawa and Krezel-Czopek (2009). While Sawa and Bogucki (2017) concluded that cows produced in the first lactation more than 11000 kg milk had a smaller number of lactations (2.3).

The lifetime milk production and lifetime daily milk yieldwere increased by increasing first lactation milk yield (table 4), where cows produced greater than 2400 kg milk yield in first lactation had lifetime milk production equals 10251 kg and LDMY equals 3.4 kg. Cows produced less than 560 kg milk yield in the first lactation had the lowest values of LMP (4471 kg) and LDMY (1.4 kg). This result indicated that first lactation milk yield could be used for prediction of the lifetime milk production of a cow. Tekerli and Kocak (2009) and Sawa and Krezel-Czopek (2009) arrived at the same conclusion.

Year of calving had a highly significant effect on the number of lactations, lifetime milk production and lifetime daily milk yield ($p<0.01$) (table 4). This could be due to differences in managerial systems from year to another. While the effect of season of calving on the same traits was nonsignificant (table 4). Hammoud *et al*. (2010) on Friesian cows in Egypt,Almasri (2010) on Holstein-Friesian cows in Syria and Singh *et al*., (2018) on Frieswal cows (Friesian × Sahiwal) in India obtained the same conclusion.

Table 4. Least squares means and standard error (LSM±SE) of number of lactations, lifetime milk production (LMP) and lifetime daily milk yield (LDMY)

Classification[1]	Number of lactations (No)	Lifetime milk production (kg) (LSM±SE)	Lifetime daily milk yield (kg) (LSM±SE)
Overall mean	4.4±0.08	6974±174.47	2.3±0.04
Age at first calving (month)	*	*	**
≤25.4	4.9^{b}±0.35	7610^{b}±715	2.5^{b}±0.16
25.5-28.6	4.5^{b}±0.19	7247^{b}±394	2.4^{b}±0.09
28.7-31.7	4.5^{b}±0.15	7459^{b}±315	2.3^{b}±0.07
31.8-34.7	4.4^{b}±0.20	6791^{ab}±403	2.2^{ab}±0.09
≥ 34.8	3.8^{a}±0.21	5761^{a}±430	1.9^{a}±0.09
First lactation milk yield (kg)	NS	**	**
<560	4.3^{a}±0.18	4471^{a}±373	1.4^{a}±0.08
560-1119	4.5^{a}±0.17	5772^{b}±348	1.8^{b}±0.08
1120-1679	4.7^{a}±0.20	6955^{c}±412	2.2^{c}±0.09
1680-2400	4.3^{a}±0.21	7420^{c}±433	2.5^{d}±0.10
> 2400	4.3^{a}±0.29	10251^{d}±596	3.4^{e}±0.13
Year of calving (periods)	**	**	**
1981-1985	4.5^{b}±0.23	6798^{ab}±482	2.1^{a}±0.11
1986-1990	5.3^{c}±0.24	7877^{a}±501	2.3^{ab}±0.11
1991-1995	4.6^{b}±0.23	6570^{ab}±467	2.1^{a}±0.10
1996-2000	4.6^{b}±0.23	7734^{b}±482	2.6^{b}±0.11
2001-2005	4.4^{b}±0.20	7174^{b}±403	2.3^{ab}±0.09
2006-2010	3.3^{a}±0.21	5690^{a}±423	2.2^{a}±0.09
Season of calving	NS	NS	NS
Winter	4.4^{a}±0.20	7294^{a}±416	2.4^{a}±0.09
Spring	4.3^{a}±0.17	6749^{a}±348	2.2^{a}±0.08
Summer	4.4^{a}±0.18	6648^{a}±366	2.2^{a}±0.08
Autumn	4.6^{a}±0.19	7204^{a}±392	2.3^{a}±0.09

1=within each classification, means not followed by the same letter differ significantly at 5 % level;
Number of records = 605; * ($p<0.05$); * * ($p<0.01$); NS = not significant

Correlation Coefficients :

The correlation coefficients between each of AFC and FMY with PL, LMP and LDMY are presented in table 5. The correlation coefficients between AFC and each of PL and NL were negative and highly significant ($p<0.01$). Sawa *et al*. (2019) found that the correlation coefficients between AFC and each of PL, LMP and NL were -0.08, -0.11 and -0.099, respectively.

The correlation coefficients between FMY and each of LMP and LDMY were positive and highly significant ($p<0.01$). Sadek *et al*. (2009) found that the correlation coefficient between FMY and PL was 0.2 on Holstein cattle in Egypt. Teke and Murat

(2013) found that the correlation coefficient between FMY and LMP was positive and significant (0.12).

While, Sawa and Krezel-Czopek (2009) found that the correlation coefficient between FMY and NLwas positive and significant (0.10).

Table 5. Correlation Coefficients between each of age at first calving and first lactation milk yield with productive life traits

Productive life traits	Coefficient of correlation	
	Age at first calving (month)	First lactation milk yield (kg)
Productive life (month)	**-0.180****	0.030
Lifetime milk production (kg)	-0.067	**0.373****
Lifetime daily milk yield (kg)	-0.051	**0.542****
Number of lactations	**-0.126****	0.009

Number of records = 605; * * ($p<0.01$).

CONCLUSION

It could be concluded that the optimum age at first calving of Syrian shami heifers was less than, or equal to, 25 months to achieve the maximum lifetime milk production, the maximum LDMY and the number of lactations. First lactation milk yield reflected the production capacity of Shami cows in subsequent lactations.

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تأثير العمر عند أول ولادة وإنتاج لبن الموسم الأول على صفات الحياة الإنتاجية للأبقار الشامية السورية

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هدف هذا البحث هو دراسة تأثير العمر عند أول ولادة وإنتاج لبن الموسم الأول على صفات الحياة الإنتاجية للأبقار الشامية السورية. استخدمت في هذه الدراسة سجلات ٦٠٥ بقرة من الميلاد وحتى الاستبعاد الطبيعي لها خلال الفترة من عام ١٩٨١ إلى عام ٢٠١٠ في محطة دير الحجر في سورية.

حللت البيانات وفق النموذج الخطي العام باستخدام برنامج XLSTATE. 2019. بلغ المتوسط العام لكلٍ من العمر عند أول ولادة وإنتاج لبن الموسم الأول ٣٠.٩±٠.١٦ شهراً و١٢٠٣±٣٤ كجم، على الترتيب.

أظهرت النتائج أن العمر الأمثل للولادة الأولى يكون أقل من أو يساوي ٢٥.٤ شهراً لتحقيق أعلى إنتاج من اللبن الكلي خلال حياتها الإنتاجية، وزيادة عمرها الإنتاجي وعدد المواسم الإنتاجية. أما تأخر العمر عند أول ولادة وخاصة إلى ٣١.٨ شهراً أدى إلى انخفاض إنتاج الأبقار من لبنها الكلي وإنتاج اللبن اليومي خلال حياتها الإنتاجية، كما أدى إلى قصر طول حياتها الإنتاجية ونقصان عدد مواسمها. كما عكس إنتاج لبن الأبقار في موسمها الأول القدرة الإنتاجية للأبقار الشامية في إنتاج اللبن في المواسم اللاحقة، حيث تبين أن إنتاج الأبقار الشامية في الموسم الأول من اللبن إذا كان أكثر من ١٩٠٠ كجم أدى إلى زيادة إنتاج اللبن الكلي خلال حياتها الإنتاجية، في حين أن الأبقار التي أنتجت أقل من ٦٠٠ كجم من اللبن في الموسم الأول أنتجت أقل كمية من اللبن خلال حياتها الإنتاجية.