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Effects of Parity on Postpartum Fertility Parameters in Holstein Dairy Cows

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Abstract: *The aim of this study was to investigate the interactive and main effects of parity numbers, parity seasonand parity month on postpartum fertility parameters [ovarian rebound (OR), days open (DO) and number of services per conception (S/C)] in Holstein dairy cows. Overall, 418 Holstein dairy cows [winter (December: 9, January: 13, and February: 15) spring (March: 14, April: 34, and May: 36), summer (June: 59, July: 76, and August: 50), and fall (September: 44, October: 47, and November: 21)] were used in this study. The main effect of season showed a significant (P<0.0001) decrease of days from parturition until OR in spring (20.69 ± 4.98) than other seasons [winter: 30.97 ± 16.18, summer: 23.71 ± 6.31and fall: 21.93 ± 4.63]. Also, Do was found to be decreased in fall (99.18 ± 42.75, P<0.0001) than other seasons [winter: 189.5 ± 107.75, summer: 156.87 ± 56.05 and spring: 219.20 ± 55.06]. Moreover, the main effect of parturition month was also significant (P<0.0001) on both OR and DO. The days from parturition to OR were decreased in March (20.36 ±8.1) and April (20.52 ± 4.56) than other months of the year. Meanwhile, the DO was decreased in November (86.33 ±41.57, P<0.0001). Further, the parity number affected significantly DO (P<0.0001) but not OR (P=0.804). The days open was longer (177.65 ± 69.22) afterfirst parturitionand shorter (95.66 ± 35.97) after the 6thone than other parity numbers.The interaction effects of parity season, months and number on postpartum fertility parameters were alsosignificant (P < 0.0001).Ovarian reboundwas decreased after1st, 3rd and 4th parturition inspring, fall and summer mainly in March, October and August (16.50±3.21, 16.33±4.04 and 14±1.41, respectively).Whereas, DO was decreased after1st parturition in autumn mainly in November (66.83±26.46). Non significant relation (P=0.6) was estimated between parity number and S/C. However, the season has a significant effect (P<0.02). We concluded that, the parity numbers, season and month have a significant effects on postpartum fertility parameters.*

Keywords: *Dairy cows, reproductive performance, ovarian rebound, days open*

I. Introduction

The reproductive performance of dairy cows is affected by many factors including birth season, mangemental factors as well as the sex of birth calve. The postpartum period is constitute an important period that affects dairy cows fecundity (1). The fore mentioned author have been tried to improve the reproductive indices of dairy cows in Egypt through using of Prostaglandin F2α and GnRH with different regimes during early postpartum period.

It is well known that the birth season have an effect on ovarian resumption (2,3,4), days open (5), milk yield (6) as well as number of services per conception (6).

The onset of normal ovarian cyclic activity is one of the most important events for dairy cow to regain her maximum breeding potential following parturition. To attain a recommended calving interval of 12 months(7), cows should conceive within 85 d after parturition. This requires normal cyclicity within few weeks after calving.

The interval in several herds could be reduced by breeding cows on first heat after 45 days postpartum and/or next to first examining the cows for normal reproductive tracts. El-keraby and Aboul-Ela, 1982(8) reported many factors that caused prolonged days open in dairy cows (i.e. feeding season and milk production, silent estrus, frequency and timing of estrus detection, missed estrus due to weak symptoms).The seasonal effects on the days open interval were marked at this latitude. Parturition during late April, causing convergence of postpartum day 55 with the summer season, was linked to the shortest parturition-to-conception intervals. Further, Ketosis was found to be necessary factor to increase the parturition-to-conception interval, highlighting the effect of negative energy balance on postpartum reinstatement of reproductive purpose(9,10).

Hamdi et al., 2012 (6) reported that the least squares analysis revealed that 305 days milk yield was significantly (P<0.001) affected by calving season. As well, the shorter lactation duration investigated by Hamdi et al., 2012 (6) is 127.56 days and this may be due to incomplete lactations when data were collected. Lactation period reduced with increase the number of lactation. Additionally, he cited that, short lactation duration in the oldest cows (5th lactation number) may be associated with incomplete lactations because of culling.

II. Material and Methods

1. Animals and management

This study was carried out from September 2009 to September 2013. A total of 419 normal parturient Friesian Cows aged 4-9 years old with 1-7lactaion season and 3-4 BCS (scale 1= thin to 5 = fat ; Bhalaru,Tiwana and Singh,1987) (11) , belonging to a private farm at Damietta governorate (Sanad Farm), Egypt, were used in this study.

These animals were kept in an open hygienic yards provided with holding pens for veterinary examination. Animals were offered to have the available daily ration (ration calculated according to Gavish program under National Research Council (NRC) recommendation. Ration consists of corn silage, ground yellow corn, soybean meal, barseem or hay and minerals-vitamins supplement. Analysis of this ration included, dry matter intake (20-22 kg), crude protein (18%), Total Digestible Nutrient (TDN) (76%), Calcium (0.1%), and Phosphorus (0.5%).All animal had free access to water. These cows were milked three times/day " 5.00 AM, 13.00 PM and 21.00 PM" by using a milking machine (with 8 hours intervals) through automatic modern machin connected with computer net via detachment unit under the control of ALBRO system (ALPHA D –Laval Company 2000).

The experimental cows were closely observed through the whole day for estrus detection by skilled person and confirmed by rectal and vaginal examination. Cows and heifers were bred artificially by using imported frozen semen from international company (CRI Company, USA) using recto-vagainal insemination technique. Pregnancy diagnosis was done rectallyat 45 - 60 days post service.

2. Animal grouping and treatment:

The cows under investigation were divided into 4 groups according to season of parturition:

[1-Winter season: Cows delivered in the winter (n = 38); 2- summer season: Cows delivered in the summer (n = 186); 3- autumn season: Cows delivered in the autumn (n = 111) and 4- spring season: Cows delivered in the spring (n = 83)]. Each group is divided into subgroup according to the month of parturition:

1-winter season: [i- Cows give birth in December (n = 9); ii- Cows give birth in January (n = 13) and iii-cows give birth in February (n = 15)].

2- Summer season: [i- Cows delivered in June are count 59 cow; ii – Cows delivered in July are count 76 cow and iii- Cows delivered in August are count 50 cows].

3-Autumn season: [i – Cows delivered in September are count 44 cow; ii- Cows delivered in October are count 47 cow and iii- Cows delivered in November are count 21 cow].

4-Spring season: [i – Cows delivered in Marche are count 14 cow; ii- Cows delivered in April are count 34 cow and iii – Cows delivered in May are count 36 cow].

3. Assessment of the postpartum reproductive performance:

Based on the clinical examination and time of services, the effect of the pervious studied treatments on reproduction performance of cows was evaluated by the following reproductive parameters: Time elapsed from calving to complete uterine involution; Time elapsed from calving to the first estrus (ovarian rebound); Number of services per conception; Days open and Pregnancy diagnoses after two months apart from the last service was checked to determine conception rate.

4. Statistical analyses

Data were collected, organized and then analyzed by usingstatistical package SPSS version 16.Normal probability plots (Q-Q-plots) and the Kolmogorov-Smirnov tests were used to test normal distribution of model-residuals of measured parameters (ovarian rebound, days open, number of service per conception…). To determine the effect of time (season and/or month of parturition) one way anova test was used. Post-hoc multiple pairwise comparisons were done according with a Tukey adjustment of error rate. For all analyses, $P \leq 0.05$ was defined as significant.

III. Results

In this study as described in Fig. (1), the ovarian rebound after parturition was significantly differed ($P < 0.0001$) from season to another. The longest time for postpartum ovarian rebound was recorded in winter (30.97 ± 16.18) in compared to summer (23.71 ± 6.38); autumn (21.93 ± 4.63) and spring (20.7 ± 4.99). Furthermore, the results showed a significant difference between season and each other. In this study as described in Fig 2, the days open after parturition was significantly differed ($P < 0.0001$) from season to another. The longest time of days open was recorded in spring (219.20 ± 55.06) in compared to winter (189.50 ±

107.75); summer (156.87 ± 56.1) and autumn (99.18 ± 42.75). Furthermore, the results showed a significant difference between season and each other.

In this study as described in table 1, the number of artificial insemination after parturition was significantly differed (P < 0.0001) from season to another. The large number of inseminations was recorded in summer (1.84 ± 0.91) in compared to autumn (1.60 ± 0.75); spring (1.48 ± 0.76) and winter (1.29 ± 0.57). Furthermore, the results showed a significant difference between season and each other.

In this study as described in Fig 3, the ovarian rebound after parturition was significantly differed (P < 0.0001) from month to another. The longest time of ovarian rebound was recorded in January (33.39 ± 19.35) in compared to February (32.93 ± 16.24); December (26.00 ± 10.56); July (25.76 ± 6.16); June (23.01 ± 7.16); November (22.86±2.63) ; September (22.16 ± 4.65); august (21.42 ± 4.75); October (21.32 ±5.22); may (20.83 ± 3.88); April (20.53±4.56) and march (20.36 ± 8.10). Furthermore, the results showed a significant difference between months and each other.

In this study as described in Fig 4, the days open after parturition was significantly differed (P < 0.0001) from month to another. The longest days open was recorded in February (258.07 ± 85.72) in compared to April (253.82 ± 54.49); March (208.29 ± 83.05); may (203.17 ± 43.84); June (194.03 ± 52.92); January (153.46 ±101.45); July (151.81 ± 46.37); December (142.33 ± 98.37); august (122.78 ± 47.57); October (103.39 ± 46.45); September (100.59 ± 38.41) and November (86.33 ± 41.57). Furthermore, the results showed a significant difference between months and each other.

In this study as described in Fig 5, the AI number after parturition till conception was significantly differed (P < 0.0001) from month to another. The large number of AI was recorded in June (2.07 ± 0.87) in compared to July (1.95 ± 0.98); may (1.69 ± 0.79) ;October (1.64 ± 0.79); September (1.61 ± 0.75); November (1.48 ±0.68) ; August ,December (1.44 ± 0.73); April(1.35 ± 0.77); January (1.31 ± 0.63); March (1.21 ± 0.43) and February (1.20 ± 0.41). Furthermore, the results showed a significant difference between months and each other.

In this study as described in Fig 6, the milk yield per day after parturition was significantly differed (P < 0.0001) from month to another. The longest days open was recorded in March (28.93 ± 4.4) in compared to February (27.93 ± 4.40); January (27.54 ± 3.26); November (26.62 ± 3.29); June (26.10 ± 4.59); August (25.94 ±4.24) ; September (25.75 ± 4.13); December (25.67 ± 4.30); April (24.85 ± 5.78); July (24.78 ± 3.83); may (24.42 ± 5.66) and October (24.04 ± 3.78). Furthermore, the results showed a significant difference between months and each other.

In this study as described in Table 2, the milk yield amount was significantly differed (P <0.1059) from season to another. The amount of milk production per day is increase in winter (27.18 ± 3.97) in compared to summer (25.54 ± 4.23); spring (25.35 ± 5.74) and autumn (25.14 ± 3.92). Furthermore, the results showed a significant difference between season and each other. As well, the numbers of parity were found to cause significant variance in days open but not in ovarian rebound (Table 3)

IV. Discussion

The season effect on this study was significant (P < 0.0001). Also, the same effect was recorded by Montgomery et al., 1985 (12) who concluded that that season of calving influences resumption of ovarian cycles even at a constant high plane of nutrition. Also,Crowe et al., 2014(4)found that, Follicular growth generally resumes within 7-10 days in the majority of cows associated with a transient follicle-stimulating hormone (FSH) rise that occurs within 3-5 days of parturition. Dairy cows that are not nutritionally stressed generally ovulate their first post-partum dominant follicle (approximately 15 days), whereas beef suckler cows in good body condition normally have a mean of 3.2 +/- 0.2 dominant follicles (approximately 30 days) to first ovulation; and beef cows in poor body condition have a mean of 10.6 +/- 1.2 dominant follicles (approximately 70-100 days) to first ovulation. The previous results proof ours which indicate the early resumption of ovarian cyclicity.

In the present study, the ovarian cyclicity was shorter in spring season (20.69 ± 4.99 D). This result is agreed with previous studies which stated that the spring-calving herds grazed on pasture, is correlated to the calving date of individual cows (12, 13).These findings also extend to previous reports on relationships between season and post-partum anoestrus(13, 14).Hansen and Hauser, 1983 (15) reported a tendency for greater seasonal effects on post-partum intervals to first ovulation, first oestrus and conception in cows receiving low energy diets, although the interactions were not significant.

The longest time from parturition to the resumption of postpartum ovarian cyclicity in this study was during winter season (30.97 ± 16.18 D). This may be attributed to low growth rate of pasture in winter environment as described by Round-Turner et al., 1976 (16). As well, this may be also due to the photoperiod influences on the return of ovarian cycles after calving (17). Puberty is delayed in heifers reared in environmental chambers and exposed to the seasonalchanges in photoperiod and temperature characteristic of autumn-winter-spring compared with spring-summer-autumn conditions (18). It appears likely that seasonal effects on post-partum anoestrous interval at constant nutrition (or interacting with nutrition) are related to seasonal changes in photoperiod and/or temperature (12).

In the present study, the season has a significant effect on days open (P < 0.0001). The longest time of days open was recorded in spring (219.20 ± 55.06) in compared to winter (189.50 ± 107.75); summer (156.87 ± 56.1) and autumn (99.18 ± 42.75). These values were lower than that estimates recorded by Hammoud et al., 2010 (5) although he found a significant effect of the season of calving on parturition to first service (P<0.01), days open and calving interval (P<0.05) in Frisian cows in Egypt. Cows calving in autumn had the shortest calving interval (394.3±4.7 days) comparing with those calved in other seasons (ranged between 404.8±6.5 and 409.4±5.2 days). Cows calving in autumn also had the shortest days open (122.6±4.8 days). The same like in our study the shortest period was showed in autumn in compared to other seasons. This may be due to the mangemental methods as described by Bozworth et al., 1972) and Foote, 1975 (19, 20), with the length of calving interval depending largely on the operator's attitudes and reproductive goals. The interval in many herds could be reduced by breeding cows on first heat after 45 days postpartum, after first examining the cows for normal reproductive tracts. El-keraby and Aboul-Ela, 1982 (8) reported that the longer days open in dairy cows may be caused by several factors (i.e. silent estrus, missed estrus due to weak symptoms, frequency and timing of estrus detection, feeding season and milk production).

In this study the days in milk was significantly differed (P < 0.0001) from season to another. The longest DIM was recorded in spring (492.92 ± 64.04) in compared to winter (468.50 ± 107.7); summer (434.18 ± 58.06) and autumn (377.29 ± 43.59). Similarly, Amimoet al., 2007(21) reported that the least squares analysis revealed that 305 days milk yield was significantly (P<0.001) affected by season of calving. The present results suggested that milk yield was sensitive to seasonal variation. At the same time the calving season has non-significant (P>0.05) effect on dry period. Then, season of calving affected both the lactation length and milk yield. As shown in, least squares mean was higher for automncalvers (307.6±4.57 days) as compared to spring calvers (296.7±3.99 days). Although, summer and winter calvers have similar lactation length (301.4±4.12 and 303.7±4.28 days) but winter calvers have the highest milk yield (5827±63.17 kg). Milk yield on the other hand had the opposite trend. Summer calvers produced 614 kg less milk (5213 vs. 5827 kg) as compared to winter calvers.

Short lactation duration and consequently low milk yield may result from the deficiency of attention and feeding conditions. The significant effect of year of calving productive performance of dairy cows could be attributed to the changes in feeding and managerial systems and environmental conditions which occurred from year to another as well as to differences between years in the quantity and quality of forage available. 305-days milk yield differed significantly (P<0.05) with lactation order. The 305-days milk yield in second lactation was significantly higher than in first lactation. This result is consistent with Munim et al., 2006 (22) who found significant (P<0.05) effect of parity on milk yield. Nevertheless, the results differed from that of Habib et al., 2003 (23) who found non-significant (P>0.05) effect of lactation number on milk yield. The significant effect of parity on productive performance may be due to the changes in managerial systems and environmental conditions among parties.

The average lactation length calculated in this study was 435 days. The average length of lactation in this study (377.29 ± 43.59 and 492.92 ± 64.04) was longer than results reported in previous studies(24, 25) who reported a lactation length of 293 ± 3 and 291.86 ± 6.55 days in Friesian cows in Libya and Pakistan, respectively. Moreover, the days in milk of Holstein cows were between 284.7 and 333.9 days in previous studies (26, 27). The shorter lactation duration recoded by Hamdiet al., 2012 (6) is 127.56 days and this may be due to incomplete lactations when data were collected. Lactation duration decreased with increase of lactation number. Furthermore he mentioned that, short lactation duration in the oldest cows (5th lactation number) may be related to incomplete lactations because of culling.

In this study as described in table (4) and fig. (4), the milk yield amount showed tendency difference (P < 0.10) from season to another. The amount of milk production per day is increase in winter (27.18 ± 3.97) in compared to summer (25.54 ± 4.23); spring (25.35 ± 5.74) and autumn (25.14 ± 3.92). The findings of present study were similar to previous studies (28, 29, 30) which reported a significant increase of milk yield in cows calving in winter. As well, Similar finding have been reported by Javed et al., 2004 and Tekerli et al., 2000 (31, 32) in Holstein Friesian cows. Thorpe et al., 1993 (33) showed the effects of season of calving on production performance of dairy cattle in Kenya. Cows calving in winter have high milk yields, due probably to good feeding levels in the first 3 or 4 months of lactation. On the other hand, cows calving in summer have low milk yields due to their being subject to high environmental temperatures in the first 3 or 4 months of lactation. On the contrary many studies (34, 35, 36) investigated that the season of calving had a non-significant effect on lactation milk yield in Holstein Friesian cows. Furthermore, Catillo et al., 2002 and Kaya et al., 2003 (37, 38) found that 305-days milk yield is significantly (P<0.05) affected by age at calving. The difference in our study than the previous ones may result from the mangemental and environmental factors.

In this study the number of artificial insemination after parturition was significantly differed ($P < 0.0001$) from season to another. The large number of inseminations was recorded in summer (1.84 ± 0.91) in compared to autumn (1.60 ± 0.75); spring (1.48 ± 0.76) and winter (1.29 ± 0.57). In previous studies by Elmetwally (2004)and Zaabel et al., 2004 (1, 39) the number of service per conception was 1.75 ± 0.13 and 1.79 ± 0.14 in dairy cows. These results are similar to our results at autumn and summer but not at spring and winter which showed decreased number of service per conception (Spring: 1.48 ± 0.75; Winter: 1.29 ± 0.59). The source of difference may be either season due to change in photoperiod and/or mangemental methods. Furthermore, our results investigated a significant effect ($P < 0.0001$) of season on the number of service per conception here in Egypt. These results were disagreed than that reported by **Mureda** and Zeleke, 2007 in Ethiopia and Amasaib et al. 2011 (40, 41) in Sudan. The previous two authors did not found a significant effect for the season on number of service per conception. These results may support the actual effects of geographical and atmospheric conditions on reproductive performance in dairy cows. The variability of results of number of service of conception may also attribute to Genetic merit (42). He investigated that the genetic merit but not diet affected the number of services required per conception and the conception rate. Other studies (2, 6, 43, 44) measuring directly the physiological parameters have produced similar data to show that reproductive function during the early postpartum period and subsequent fertility are reduced in animals with a higher genetic merit or a higher milk yield.

The difference may further related to the milk yield characteristics of the cows used in this study. It has also been suggested that reproductive performance of high yielding cows is compromised as a result of increased negative energy balance during early lactation (3, 45). Owing to the difference between dietary energy intake and requirements for milk production, high yielding dairy cows typically experience a period of negative energy balance during early lactation which results in mobilization of body fat reserves (45). The extent of negative energy balance is normally related to milk yield (3, 46).

In our study, the number of service per conception was higher in summer (1.84 ± 0.91) which is constituted the dry season in compared to winter which constitute the green season (1.29 ± 0.57). The difference between the dry and green season was significant ($P < 0.002$). Similar results were published by Denbargaet al., 2012 (47) who found a significant ($P < 0.003$) increase of number per conception in dry season (1.9 ± 0.14) than green one (1.5 ± 0.1). The significant effect ($P < 0.0001$) of season on number of service per conception observed in this study is in agreement with Tessema et al.,2003 (48). The number of service per conception was higher in dry season.

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List of Figures and tables

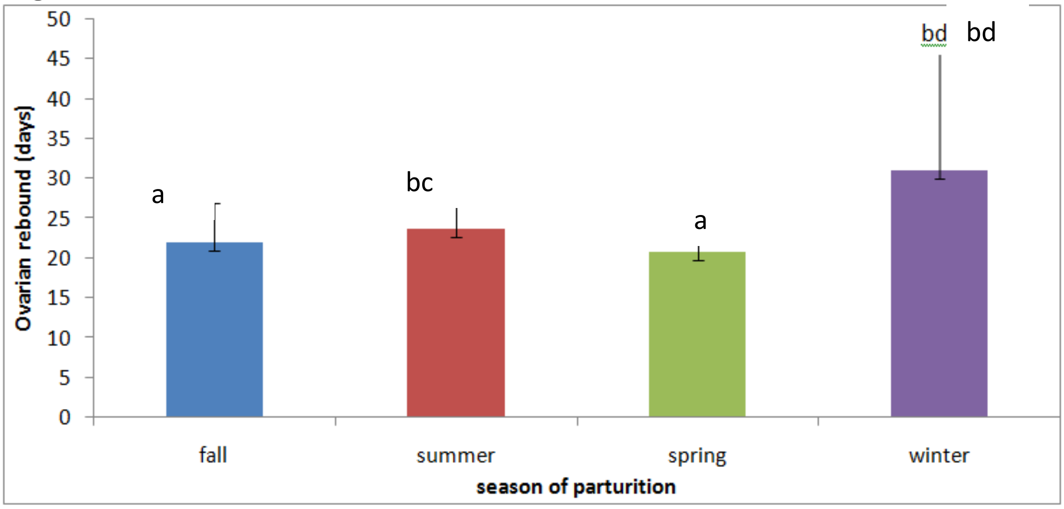

Fig 1: Effect of parturient season on postpartum ovarian rebound in dairy cows

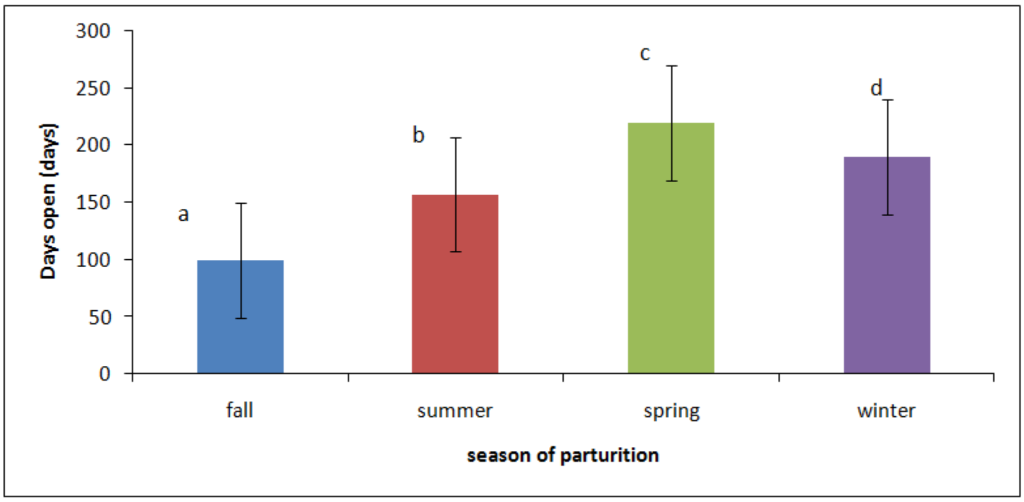

Fig 2: Effect of parturient season on postpartum days open in dairy cows (P<0.05)

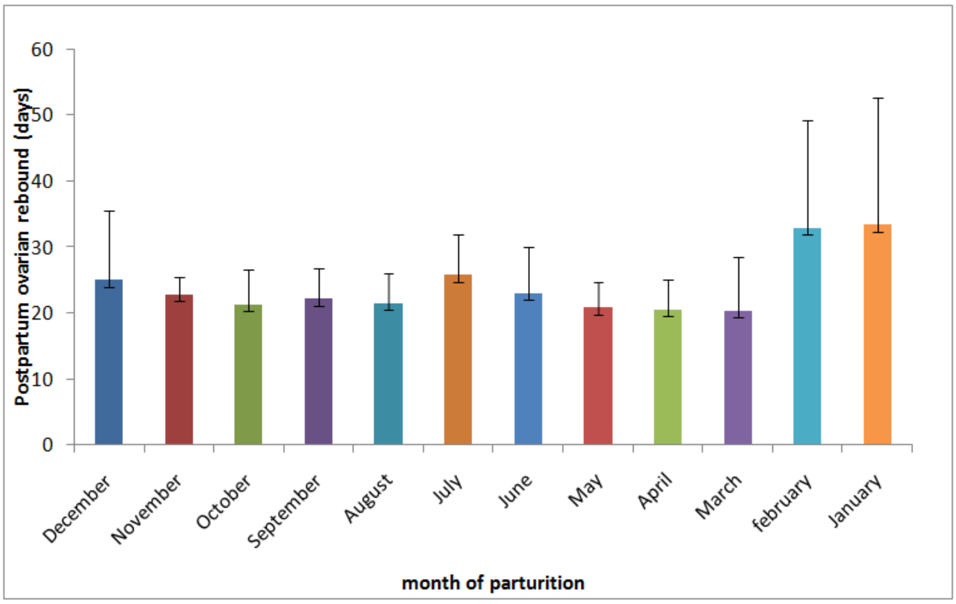

Fig 3: values of postpartum ovarian rebound in dairy cows (mean ±Sd) in relation to the month of parturition(P<0.05)

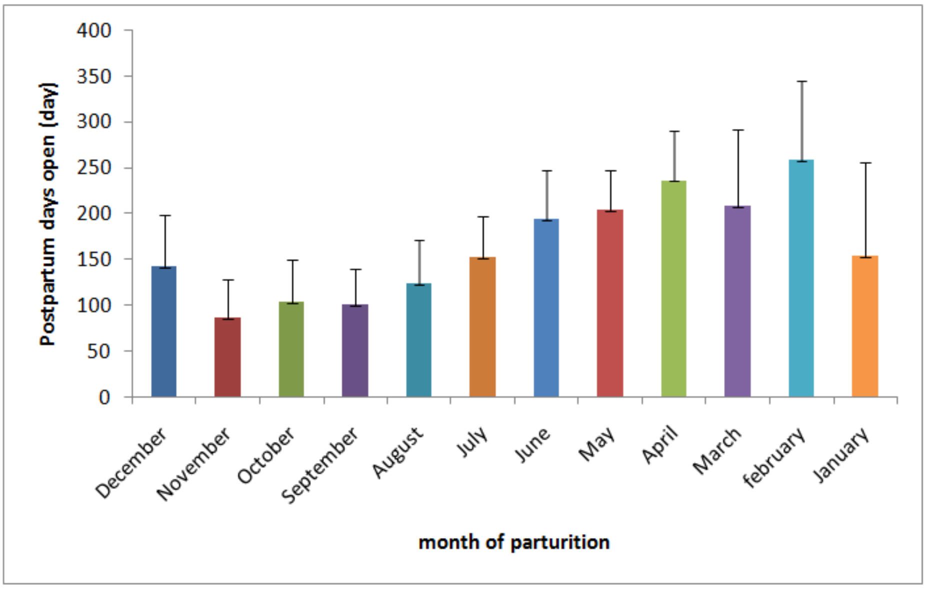

Fig 4: values of postpartum days open in dairy cows (mean ±Sd) in relation to the month of parturition(P<0.05)

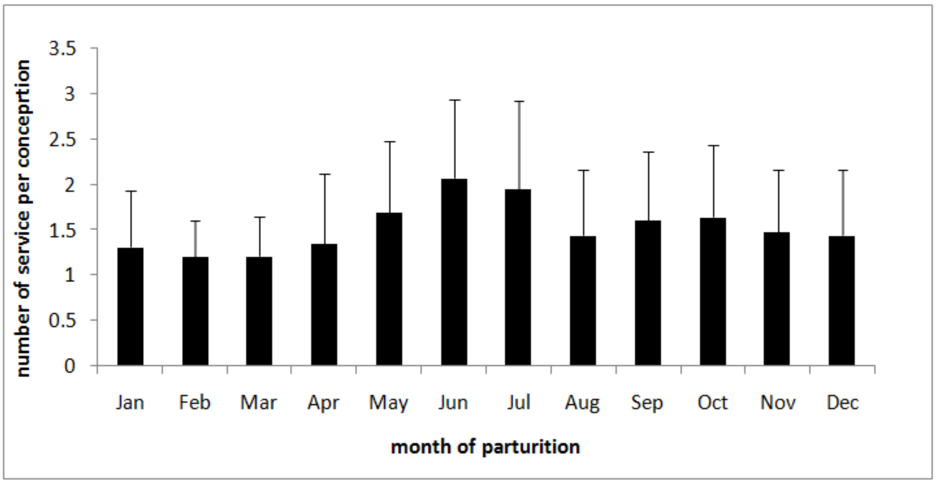

Fig 5: Effect of breeding month on number of services per conception in dairy cows (P<0.05)

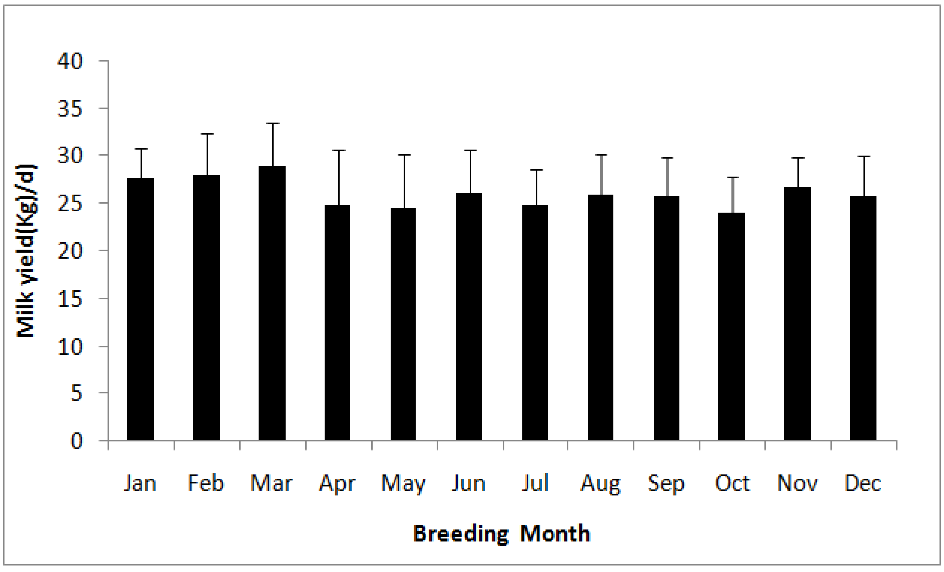

Fig 6: Effect of breeding month on milk yield (kg/day)in dairy cows (P<0.05)

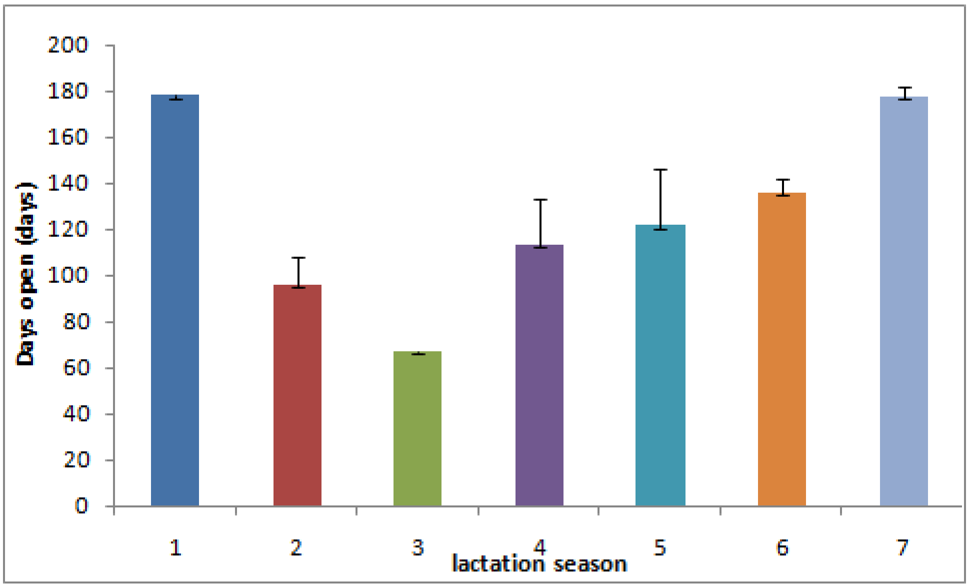

Fig 5: values of postpartum days open in dairy cows (mean ±Sd) in relation to the season of parturition(P<0.05)

Table 1: Effect of breeding season on AI_no in dairy cows

Breeding season	Total animal number(n)	Mean ± SD
Summer	186	1.84 ± 0.91[d]
Winter	38	1.29 ± 0.57[a]
Autumn	111	1.60 ± 0.75[c]
Spring	83	1.48 ± 0.76[b]

Values with different leteers were significantly different (P<0.05)

Table 2: Effect of season on Milk yield in dairy cows

Breeding Season	Total animal number(n)	Mean ± SD
Summer	186	25.54 ± 4.23[b]
Winter	38	27.18 ± 3.97[a]
Autumn	111	25.14 ± 3.92[b]
Spring	83	25.35 ± 5.74[b]

Values with different letters were significantly different (P<0.05)

Table 3: Effect of parity number on the postpartum ovarian rebound (OR) and daysopen (DO)

		N	**Mean**	**Std. Deviation**	**Std. Error**
OR	1	212	22.9698[a]	6.32209	.41507
	2	143	23.9021[a]	9.35852	.78260
	3	23	24.2609[a]	10.51500	2.19253
	4	9	22.8889[a]	5.90433	1.96811
	5	11	23.0000[a]	.	.
	6	9	20.3333[a]	3.39116	1.13039
	7	21	22.0000[a]	.	.
	Total	418	23.2990	7.68904	.37608
DO	1	198	177.65[a]	69.22561	4.58458
	2	142	135.92[b]	70.93040	5.95235
	3	23	121.43[bc]	61.33427	12.78908
	4	7	113.00[bc]	60.61147	20.20382
	5	13	76.000[d]	.	.
	6	20	95.667[cd]	35.96874	11.98958
	7	15	178.00[a]	.	.
	Total	418	156.73	72.52989	3.56896

Values with different letters (a, b, c, d) are significantly different and P<0.05
Numbers (1, 2, 3, 4, 5, 6, and 7) indicates the month of parturition