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Fertility response of lactating dairy cows subjected to three different breeding programs under subtropical conditions

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Abstract

Background: It is comprehensively recognized that reduced reproductive efficiency represents a great economic loss to dairy producers. Ovarian cysts and anestrus syndromes are considered the greatest significant causes of low reproductive efficiency in dairy herds worldwide as they detrimentally affect the longevity and profitability of dairy herd. Pregnancy rate is the best available single deciding parameter used for assessment of the reproductive efficiency at the herd level which measures the probability that open cows become pregnant per unit of time. So, the current study was planned to evaluate the suitability of using Ovsynch plus CIDR and G6G resynchronization protocols as an efficient treatment regimen for cystic ovarian diseased cows and anestrus cows, respectively, through comparing pregnancy rates of cystic ovarian diseased cows that subjected to Ovsynch supplemented with controlled internal drug release device with the pregnancy rate of healthy cows that subjected to a Presynch-Ovsynch synchronization protocol, as well as through comparing pregnancy rates of anestrus cows that subjected to G6G treatment protocol with the pregnancy rate of healthy cows. Moreover, possible factors such as breed, parity, and season which may affect the treatment success were also evaluated.

Results: The results of the current study revealed an overall mean pregnancy rate of 36.64%. Moreover, Simmental cows recorded a greater ($p < 0.01$) pregnancy rate (45.16%) than that recorded for Holstein cows (34.98%). A highly significant seasonal effect was observed, as a higher ($p < 0.01$) pregnancy rate was recorded for cows inseminated during cold months (39.54%) compared with that recorded for cows inseminated during hot months (29.18%).

Conclusions: No significant differences were detected in the pregnancy rates among the three breeding programs; thence, the application of the G6G synchronization protocol for anestrus cows and Ovsynch-CIDR synchronization protocol for cows with ovarian cysts could be used as effective treatment regimens as they resulted in nearly the same pregnancy rates that recorded for healthy cows. In addition, the treatment response was highly influenced by cow's breed, parity, and season of breeding.

Keywords: Dairy Cow, Breeding, Synchronization, Resynchronization, Ovsynch, Presynch

1 Background

Maximizing the reproductive efficiency of dairy cows is fundamental to dairy producers because it has a major effect on dairy farm profitability [28, 30]. Economically, dairy cows must calve regularly at every 12 to 13 months interval. Prolonged inter-calving interval due to delay in the onset of postpartum ovarian recyclicity is considered responsible for reduced reproductive efficiency and

consequently causes economic loss to the dairy producers [10, 17]. In the last few decades, increased incidence of anovulation and decreased insemination submission rate resulted in lowered reproductive effectiveness of dairy cows and consequently necessitated the application of reproductive programs. Since about 70% of cows may fail to become pregnant after the first insemination; maximizing pregnancy rate [32] and reducing the inter-services interval [28, 29] stay as major objectives of the reproductive regimen preference [28]. A crucial portion of such reproductive management techniques for herds that experience the issues described above is the subjection of

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cows to synchronization programs that permit application of FTAI. The application of these controlled breeding programs leads to reduced intervals from calving to first postpartum services, reduced days open (DO), and consequently reduced the calving interval [44]. The most widespread FTAI protocol is Ovsynch [61]. Studies on dairy cattle [45] showed that the optimum stage to begin the Ovsynch treatment is from day 5 to day 12 of the estrous cycle. Moreover, it has been proposed that the ideal time to begin Ovsynch is at least 10 and no more than 12 days after Presynch [16]. Based on this concept, it has been stated that Presynch with two PGF2 α injections 14 days apart enhanced pregnancy outcomes in cows when Ovsynch was started 12 days after the second PGF2 α injection [22]. Therefore, presynchronization protocols were performed to augment the proportion of cows in early diestrus stage at the first GnRH dose of the Ovsynch protocol to attain high conception rate (CR) [65]. In this aspect, PO is one of the most widespread protocols used to synchronize ovulation for the first artificial insemination (AI) services postpartum in dairy cows [23]. The main restriction of the PO protocol is the failure to enhance pregnancy in subfertile cows [13] that are predominant in high-yielding dairy cows at the end of the voluntary waiting period [7]. Recently presynchronization protocols including GnRH and PGF2 α were introduced to cope with the restriction of PGF2 α -based protocols in anovular cows [61]. These programs improved pregnancy outcomes in anovular cows and emphasized that a high percentage of cows were at the ideal phase of the estrous cycle when the Ovsynch protocol was commenced. G6G begins with administration of PGF α , which is designed to induce luteolysis of mature corpora lutea. Two days later, a GnRH injection was intended to induce ovulation. Altogether, the two injections of GnRH are aimed to start a new estrous cycle. Ovsynch is planned to begin 6 days later when the cows are at day 6 of the new induced estrous cycle and are very strong to have a mature pre-ovulatory follicle, eligible to ovulate in response to the first Ovsynch GnRH dose [9]. The use of alternative synchronization of ovulation protocols that optimize the physiological ambience before TAI through the reduced duration of the period of ovulatory follicle dominance [55] and exogenous progesterone supplementation [11] may be a viable strategy to improve PR. In this respect, initiating the synchronization protocol either before or after non-pregnancy diagnosis is a prevalent strategy used to resynchronize estrus for FTAI in lactating cows [25]. Inclusion of CIDR in the synchronization protocols [16] prevented the onset of premature estrus through suppressing ovulation [38], and a normal CL was formed following CIDR removal [63], that way permitting 100% submission rate for FTAI [53]. Moreover, it has been stated that vaginal insertion of the CIDR for 7 days with an injection of

PGF2 α either 1 day before [43] or at CIDR removal resulted in an increased percentage of cattle in estrus as well as improved CR following FTAI [22]. An additional advantage of the CIDR is that it can encourage estrus in anestrus cattle in early lactation [14]. Lucy et al. [43] declared that CIDR initiates estrus in about 40% of the anestrus cows and prepubertal heifers. Our hypothesis was that application of the G6G and CIDR synch protocols could improve the PR in acyclic cows which failed to express estrus or failed to conceive after using a PO protocol as well as in cows which suffered from cystic ovarian disease to reach or exceed PR that was recorded for a PO protocol. Thus, the main purpose of the present study was to compare pregnancy outcomes after using three selected breeding programs (PO, G6G, and CIDR-Ovsynch). In addition, the effects of cow's breed and insemination season on the fertility response of the cows to these synchronization protocols were also investigated.

2 Material and methods

2.1 Cows, housing, and feeding

This retrospective study was accomplished at a commercial dairy farm in Northwestern Egypt. Dairy cows ($n = 1520$, 1272 purebred Holstein and 248 purebred Simmental) were included in the current study. Cows were reared up in a free sand-bedded stall equipped with sprinklers and fans for evaporative cooling during summer months. The cows had unrestricted access to freshwater. The animals were fed twice daily a totally mixed ration (TMR) to meet or exceed the minimum nutrient recommendations for lactating dairy cows [49]. Cows were milked thrice daily at 8 h intervals. The cows were under complete veterinary superintendence. Cows diagnosed with pathological reproductive puerperal conditions (adhesions, abscesses, dystocia, retained fetal membranes, endometritis, purulent vaginal discharge, and ketonuria) were precluded from this study. All AI services were done from 1 January 2017 to 30 April 2018.

2.2 Breeding programs

Every week, cohorts of cows that reached 44 ± 3 DIM were automatically enrolled in the study by the on-farm dairy management software (Dairy COMP 305 $^{\circ}$, Valley Ag, Tulare, CA) through a command that randomly assigned a treatment code to every cow. Eligible cows were obligatorily submitted to PO. Cows detected in estrus after an obligatory voluntary waiting period (50 DIM) based on chalk removal and visual observation were inseminated by professional AI technicians according to the a.m/p.m role and did not receive any further treatment. Whereas, cows not detected in estrus within 12 days after the second PGF2 α injection, were assigned for Ovsynch protocol. A total of 1520 cows received TAI and involved in the statistical analysis of the current trial; of them, 481 cows completed the PO breeding

protocol. Cows diagnosed as non-pregnant (35 ± 3 days post-last insemination) either after standing heat or after PO were sectioned into two groups. The first group ($n = 665$) were subjected to G6G breeding program, while the second group ($n = 374$) included cows which experienced cystic ovarian degeneration, and submitted to CIDR-Ovsynch breeding program.

2.2.1 Presynch-Ovsynch (PO) breeding program

This group included 481 cows (394 purebred Holstein and 87 purebred Simmental) and were enrolled in this protocol as previously described [46]. Briefly, the cows received two doses of synthetic PGF2 α (500 μ g cloprostenol sodium; 2 ml Estrumate[®]; MSD, USA) with 14 days interval on 44 DIM and 58 DIM. The Ovsynch was initiated 12 days later (at 70 DIM) by injection of 12 μ g GnRH (Buserelin; 3 ml; Receptal[®]; MSD, USA) followed by injection of synthetic PGF2 α (500 μ g cloprostenol sodium; 2 ml Estrumate[®]; MSD, USA) 7 days later (i.e., at 77 DIM). Fifty-six hours later, cows received the second GnRH dose (i.e., at 79 DIM). After that, cows were predetermined FTAI at 16 to 18 h post-second GnRH injection (i.e., at 80 ± 3 DIM) as depicted in Fig. 1.

2.2.2 G6G breeding program

In this treatment, 665 cows (567 purebred Holstein and 98 purebred Simmental) were assigned to the G6G synchronization program according to Bello et al. [9]. Briefly, the G6G synchronization protocol is composed of a series of two hormonal treatments that precede the Ovsynch protocol. It begins with an administration of synthetic PGF2 α (500 μ g cloprostenol sodium; 2 ml Estrumate[®]; MSD, USA) (day 0) pursued by GnRH administration after 2 days (i.e., day 2). Ovsynch is started after 6 days, as cows received 12 μ g GnRH (Buserelin; 3 ml; Receptal[®]; MSD, USA) (i.e., day 8), followed by an injection of PGF2 α (500 μ g cloprostenol sodium; 2 ml Estrumate[®]; MSD, USA) after 7 days (i.e., day 15) and a second injection of GnRH 56 h after PGF α (i.e., day 17). Cows have received FTAI 16–18 h post-second GnRH treatment (i.e., day 18) as presented in Fig. 2.

2.2.3 CIDR-Ovsynch TAI breeding program.

This protocol comprised 374 cows (311 purebred Holstein and 63 purebred Simmental) and were submitted to the CIDR-Ovsynch synchronization program. The cows in this program received a CIDR device including 1.38 g of progesterone (Eazi-Breed[™] CIDR[®] insert, Pfizer Animal Health) received via intravaginal insertion together with an injection of 12 μ g GnRH (Buserelin; 3 ml; Receptal[®]; MSD, USA) (day 0). After 6 days, cows received 500 μ g cloprostenol (2 ml Estrumate; MSD, USA) 1 day (i.e. day 6) before CIDR removal on day 7; after 56 hours, cows received 12 μ g GnRH (Buserelin; 3 ml; Receptal[®]; MSD, USA) (i.e., day 9) and were inseminated (FTAI) after 16–18 h (i.e., day 10) as shown in Fig. 3.

2.3 Insemination and pregnancy diagnosis

Frozen semen straws from sixteen proven AI sires were used randomly during the current study, and the straws were distributed homogenously among the three groups to avoid possible sire effects. All TAI services were performed by five well-trained technicians throughout the trial. Pregnancy determination was accomplished on 35 ± 3 days post-insemination for all cows using ultrasound provided with a 7.5-MHz transrectal transducer (Easi-Scan; BCF Technology, Rochester, MN, USA). Cows diagnosed as pregnant were reexamined after 60 days post-insemination to emphasize pregnancy.

2.4 Statistical analyses

Treatment interactions among season, breed, and breeding protocols and their effects on pregnancy rate were analyzed through general linear model, univariate analysis using SPSS statistical software (IBM, SPSS v25). Significance was considered at p less than 0.05 while a p value more than 0.05 and less than 0.1 was considered a tendency. The data was expressed as mean \pm SEM.

3 Results

Regardless of the effects of season of insemination, breed of the cow, and breeding program, the overall mean PR obtained in the present investigation was 36.64%. Moreover, the mean PR recorded for Simmental cows

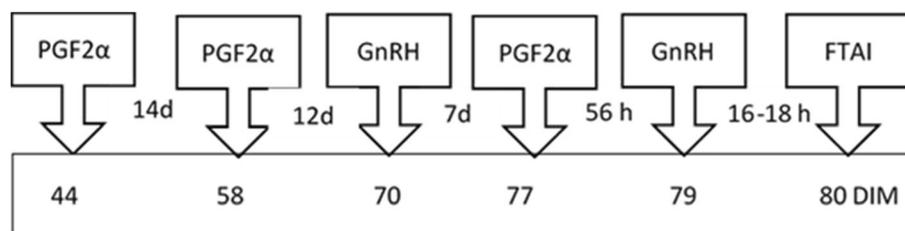


Fig. 1 Schematic representation of the Presynch-Ovsynch breeding program. (PGF2 α , prostaglandin F2 alpha; GnRH, gonadotropin releasing hormone; FTAI, fixed-time artificial insemination; DIM, days in milk)

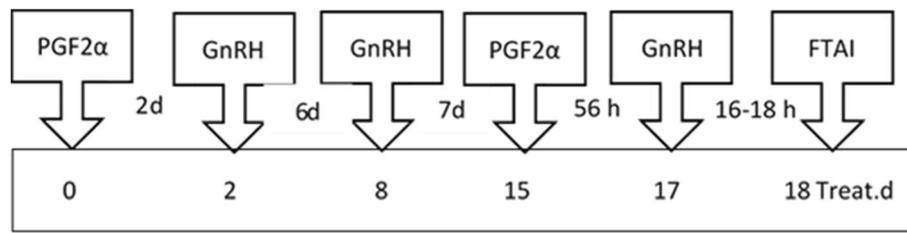


Fig. 2 Schematic representation of the G6G breeding program. (PGF2α, prostaglandin F2 alpha; GnRH, gonadotropin releasing hormone; FTAI, fixed-time artificial insemination; Treat. d, treatment days)

(45.16%) was greater ($p < 0.01$) than that recorded for Holstein cows (34.98%) as shown in Tables 1 and 2. Concerning the seasonal effect on the PR, the current study showed a highly significant seasonal effect ($p = 0.000$) with a higher PR recorded for cows bred during the cold season (39.54%) as compared with that recorded for cows bred during the hot season (29.18%) as depicted in Tables 1 and 2. During the cold season, the response of Simmental cows to PO (56.90%) and G6G (54.41%) was significantly ($p < 0.01$) greater than that of Holstein herdmatres (36.50% and 38.10%, respectively).

This effect has not been observed during the hot season. As presented in Tables 1 and 2, the current study revealed no significant ($p = 0.608$) effects of the breeding programs on the PR, regardless of the effect of both cow's breed and season of insemination. The cow's breed by the breeding program interaction tended ($p = 0.059$) to exert an effect on the PR of lactating dairy cows as displayed in Table 1.

Simmental cows responded better achieving higher ($p < 0.05$) PR (56.9% and 54.41%) than that achieved by Holstein cows (28.33% and 28.57%) submitted either to PO or G6G breeding protocols, respectively, during the cold season. However, there was no significant difference in pregnancy outcomes between Holstein cows (37.45%) and Simmental cows (38.18%) submitted to CIDR-Ovsynch breeding program during the cold season. Meanwhile, no significant influence of cow's breed by breeding programs interaction was observed on pregnancy results following insemination carried out during the hot months. Within each breed and regardless of the

effect of season, similar percentages of pregnancy outcomes after FTAI were obtained for the three breeding programs in both Holstein and Simmental cows (Table 2).

4 Discussion

The main objective of this research was to establish that a combination of more than one synchronization protocol is more effective in the amelioration of fertility in cyclic and acyclic as well as in cystic ovarian diseased cows in modern dairy farming. Furthermore, this study could permit a better understanding of fertility-limiting factors in dairy cows reared in commercial dairy farms under subtropical conditions and may let the development of a suitable breeding program to enhance the reproductive efficiency. Accordingly, this research analyzed the effect of both cow's breed and breeding season on pregnancy outcomes in commercial dairy farms.

The overall mean PR obtained in the current study (36.64%) was on equal terms or superior to that reported earlier (32.2% and 36.1%) by Scheffers et al. [56]. Nearly the same results were obtained by Dirandeh et al. [19] who recorded PR of 32.7% and 31.1% in multiparous lactating Holstein cows reared in Iran and subjected to G7G and double Ovsynch, respectively.

The PO program used in this study consists of two PGF2α doses given at 14-day interval, with Ovsynch beginning 12 days after the second PGF2α. This program has produced good synchrony of the estrous cycle alongside good fertility at first postpartum inseminations [27, 46]; therefore, it is currently the commercial dairy

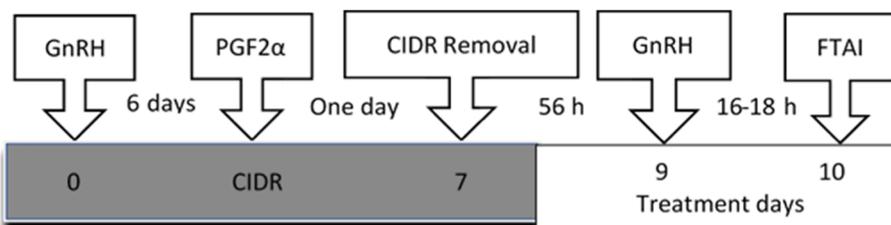


Fig. 3 Schematic representation of the CIDR-Ovsynch breeding program. CIDR, controlled internal drug release; (PGF2α, prostaglandin F2 alpha; GnRH, gonadotropin releasing hormone; FTAI, fixed-time artificial insemination)

Table 1 Interactions between the tested variables and its effects on the pregnancy rate in dairy cows

Analysis of between topic effects (DV: Dependant Variable)					
Source	Sum of squares	df	Mean square	F value	p value
Corrected model	74,447.514a	11	6767.956	2.954	.001
Intercept	2,041,111.842	1	2,041,111.842	891.026	.000
Season of insemination	32,904.704	1	32,904.704	14.364	.000
Breed of the cow	21,005.374	1	21,005.374	9.170	.003
Synchronization protocol	2280.659	2	1140.330	.498	.608
Season × breed	4165.543	1	4165.543	1.818	.178
Season × synch protocol	36.990	2	18.495	.008	.992
Breed × synch protocol	13,019.605	2	6509.803	2.842	.059
Season × breed × synch protocol	1034.638	2	517.319	.226	.798
Error	3,454,440.644	1508	2290.743		
Total	5,570,000.000	1520			
Corrected Total	3,528,888.158	1519			

R squared = .021 (Adjusted R Squared = .014)

industry standard breeding program for first TAI in Egypt. No significant ($p = 0.608$) differences were detected in the fertility response among the cow groups subjected to the three tested synchronization protocols regardless of the influence of cow's breed and season of insemination (Table 2). Moreover, lactating Holstein cows submitted to PO breeding program recorded an overall PR of 34.01% regardless the season of insemination (Table 2), while they achieved a PR of 36.50% when inseminated in cold months (Table 3). These results nearly came in agreement with previous results recorded by Silva et al. [59] and Giordano et al. [31] who recorded a PR of 37% and 36.3%, respectively, for Holstein cows which received PO synchronization protocol. But our findings were lower than that recorded previously for Holstein cows which received PO synchronization programs by many authors [18], and Fricke et al. [25] recorded a PR of 41.0%. Meanwhile, the

results of the last two studies came in agreement with our results observed for lactating Simmental cows which received the PO breeding protocol despite breeding season (48.28%, Table 2) or inseminated in cold months (56.9%, Table 3). Further studies are desired to fully clarify these contradictions and completely illustrate the fertility variations reported in these studies.

The great success of GnRH synchronization programs is quite associated with the estrous day at which the program is initiated [18], ovulatory response to the first and second GnRH treatments [9], progesterone concentration during follicular development before insemination [20], and follicular size at the second GnRH injection [48]. The response of ovulation to the first GnRH dose of Ovsynch is highly associated positively with pregnancy rate [18, 26], as ovulation to the first GnRH leads to the initiation of a new wave of follicles circa 36 h later assuring the synchronous development of a healthy

Table 2 Distribution and descriptive statistics of the cows included in this study

Item	Breed	Breed						Total		
		Holstein			Simmental					
		AI (n)	Preg. (n)	PR (%)	AI (n)	Preg. (n)	PR (%)	AI (n)	Preg. (n)	PR (%)
Season	Cold	914	342	37.42 ± 1.60	181	91	50.28 ± 3.73	1095	433	39.54 ± 1.48
	Hot	358	103	28.77 ± 2.39	67	21	31.34 ± 5.71	425	124	29.18 ± 2.20
	Total	1272	445	34.98 ± 1.38	248	112	45.16 ± 3.17	1520	557	36.64 ± 1.24
Breeding protocol	PO	394	134	34.01 ± 2.39	87	42	48.28 ± 5.39	481	176	36.59 ± 2.20
	G6G	567	196	34.57 ± 1.20	98	48	48.98 ± 5.07	665	244	36.69 ± 1.87
	CIDR	311	115	36.98 ± 2.74	63	22	34.92 ± 6.05	374	137	36.63 ± 2.49
	Total	1272	445	34.98 ± 1.38	248	112	45.16 ± 3.17	1520	557	36.64 ± 1.24

AI artificial insemination, Preg. pregnant, PR pregnancy rate, PO Presynch-Ovsynch protocol, CIDR controlled internal drug release, G6G gonadotropin of Presynch, 6 days later gonadotropin of Ovsynch

Table 3 Effect of interactions among season, breed, and breeding program on pregnancy rate in lactating dairy cows

Season × breed × synch protocol						
Dependent variable: pregnancy rate						
Season	Breed	Breeding protocol	Mean	SE	95% confidence interval	
					Lower value	Upper value
Cold	Holstein	PO	36.50 ^b	2.90	30.82	42.17
		G6G	38.10 ^b	2.53	33.13	43.06
		CIDR	37.45 ^b	2.84	31.87	43.04
	Simmental	PO	56.90 ^a	6.28	44.57	69.22
		G6G	54.41 ^a	5.80	43.03	65.80
		CIDR	38.18 ^b	6.45	25.52	50.84
Hot	Holstein	PO	28.33 ^b	4.37	19.76	36.90
		G6G	28.57 ^b	3.30	22.09	35.05
		CIDR	32.14 ^b	9.04	14.40	49.88
	Simmental	PO	31.03 ^b	8.89	13.60	48.47
		G6G	36.67 ^b	8.74	19.53	53.81
		CIDR	27.50 ^b	7.92	12.31	42.69

PO Presynch-Ovsynch protocol, CIDR controlled internal drug release, G6G gonadotropin of Presynch, 6 days later Gonadotropin of Ovsynch. Values with different superscript letters are significantly different ($p < 0.05$)

preovulatory follicle [9, 35]. Another contribution to an elevated PR is the result of a more functional healthy uterus. The first two doses of PGF2 α have a recovery effect, on the uterus.

Progesterone is considered a master hormone of reproduction, and inadequate progesterone is a principle cause of lowered fertility in high yielder cows. CIDR intravaginal inserts have been used to improve both synchronization and pregnancy rates in FTAI protocols [42]. We ascertained if the integration of a CIDR into the first 7 days of the Ovsynch protocol is effective in treating cystic ovarian disease (COD) cows and achieving a normal or exceed the pregnancy rate recorded for normal healthy cows. Holstein cows which experienced COD responded better to CIDR-Ovsynch protocol (32.14%) compared with Simmental cows diagnosed with COD and received the same protocol (27.50%) during the hot season. Meanwhile, during the cold season, the Simmental (38.18%) and Holstein (37.45%) cows which experienced COD had shown the same fertility response level when subjected to CIDR-Ovsynch protocol (Table 3). It is interesting to note that the PR obtained for cows which received the CIDR-Ovsynch was the same (36.6%) as achieved by healthy cows in the PO groups (Table 2). In our study, the cows in the CIDR-Ovsynch group were diagnosed as non-pregnant after previous insemination (i.e., resynchronized). Consequently, our findings confirmed that supplementing cows with exogenous progesterone during resynchronization starting on day 32 after the previous insemination will

ameliorate the subsequent PR. In the same manner, Kawate et al. [37] stated that the CR of the cystic ovarian diseased cows subjected to CIDR-Ovsynch treatment regimen was 43.5%. Nearly the same results were recorded previously by Bisinotto et al. [12] and Ahmed et al. [2] who reported that the CR following CIDR-Ovsynch protocol was 42.86% in postpartum anestrous crossbred cows. On the contrary, Ari et al. [6] reported that PR after CIDR-Ovsynch was 53% in Brown-Swiss, Simmental, and crossbred cows which is higher than that observed in the current study for Simmental cows (34.92%) subjected to the same protocol. Under the same Egyptian subtropical conditions, El-Zarkouny et al. [22] obtained higher PR at 29 days and 57 days (59.3% and 45.1%, respectively) in cows treated with CIDR-Ovsynch compared with that recorded in the current study. The simplest explanation for this discrepancy might be due to the different breed, season of insemination, nutritional status of the cows, and dose of used drugs as well as the product of GnRH (Receptal vs Cystorelin) and statistical calculation methods of the reproductive parameters.

The ameliorative effect of CIDR-Ovsynch on the pregnancy outcomes in COD and anestrous diagnosed cows that treated with CIDR vaginal insert might be attributed to proper endocrine balance, progesterone priming, good body condition score (BCS) of the cows, and good managemental conditions [36]. Over and above, Rastegarnia and Anvari Savojbolghi [52] proposed that higher concentration of peripheral blood progesterone before insemination inhibits the secretion of PGF2 α from the uterus. In addition, it is well recognized that the priming of reproductive system with appropriate amount of circulating progesterone during the preconception period is favorable for the better development of preovulatory follicle that will yield a well-developed CL and consequently successful conception occurs. Our results proposed that using CIDR-Ovsynch protocol is useful in initiating cyclicity in subfertile cows, and it can be used as an efficient treatment tools for COD in dairy cows.

G6G presynchronization protocol depends on the idea that the first PGF2 α injection will make luteolysis of all mature corpora lutea. Then, a GnRH injection 2 days late will encourage ovulation of mature follicles. So, the traditional Ovsynch protocol will be initiated at the sixth day of the cycle which is the ideal time as indicated by the augmented proportion of ovulated cows and the improved rate of synchronization [9]. In the current study, Simmental cows responded better to G6G protocol (48.98%) than Holstein cows (34.57%) with an overall PR of 36.69% (Table 2) which appeared lower than 50% recorded by Bello et al. [9] and also lower than CR (71.43%) obtained by Ahmed et al. [2] following G6G treatments in postpartum anestrous crossbred cows. Meanwhile, it was greater than (32.9%) that recorded by Heidari et al. [35] at 32 days post-insemination in

submitted lactating Holstein cows reared in Iran. These conflict results might be attributed to the day of the estrous at which the treatment is initiated. Apart from variations might be attributed to different environmental, management, and genetic factors like nutritional status, parity, stage of lactation, suckling stimulus, season/climate, drug source, age, breed, and species of animal.

Concerning the seasonal effect on the PR, the present investigation revealed high significant ($p < 0.0001$) seasonal effect with the higher PR obtained for cows bred during winter (39.54%) as compared with that recorded for cows bred during summer (29.18%) as depicted in Tables 1 and table 2. During the cold season, the response of Simmental cows to PO (56.90%) and G6G (54.41%) was significantly ($p < 0.01$) higher than that recorded for Holstein herd mates (36.50% and 38.10%, respectively). This effect has not been observed during the hot season. The obtained PR during hot months in the current study is comparable to that recorded by Ahmadi and Ghaisari [1] for dairy cows in Iran (27.70 %) and more than that obtained by Ahuja et al. [3] in lactating anestrous crossbred cows (20.83 %), but less than that recorded by Alnimer et al. [5] in Friesian (56.30%). Moreover, it has been stated that cows exposed to heat stress (HS) before breeding recorded significantly ($p < 0.001$) lower CR (23%) compared to 31.3% that recorded for cows not exposed to HS [15]. The decreased PR observed for lactating cows inseminated during hot months may be ascribed to inadequate dry matter consumption resulting in poor BCS and consequently negative energy balance (NEB) that may lead to disturbances in secretion of hormones needed for reproduction [64], decreased fertilization rate, and a lowered proportion of zygotes reaching the blastocyst stage [33].

The harmful effect of HS before insemination is concomitant with a small diameter preovulatory follicles and inconstant biochemistry of the follicular fluid [57], which may lead to ovulation of poor-quality oocytes [24]. Hyperthermia of fertilized oocytes may inhibit embryonic growth [21]. Moreover, HS before breeding may result in delayed ovulation, anovulation, and ovulation of a poor-quality oocyte, leading to diminished fertilization rate and high embryonic loss [4]. Furthermore, hyperthermia after breeding increased uterine temperature and diminished the uterine blood flow which may lead to failure of implantation and consequently increased early embryonic death [47]. All these detrimental effects are believed to be linked with reduced interferon-tau (signal to block CL regression) production by the conceptus [58]. Moreover, HS may disturb the secretions of prostaglandins and reduce the motility of the smooth muscle of the oviduct, which in turn disturbs the transport of oocytes, spermatozoa, and zygote [40] which resulted in premature luteolysis of the corpus luteum graviditatis and consequently early death of

the embryos [54]. Exposure of the uterus to high temperature may obstruct the endometrial factors essential for preservation of pregnancy.

Concerning the impact of cow's breed on the fertility results, assumptions are often made that some cattle breeds are significantly more fertile than others. Particular cattle breeds will entirely acclimate better to certain types of environmental conditions and have a higher fertility rate under those types of conditions. It has been reported that the heritability of reproductive measures in dairy cows is inferior when compared to other economically essential merits and the effects of environmental and managemental conditions are superior to the genetic merit [50]. The results of the current investigation revealed high significant ($p = 0.003$) effect of cow's breed on the PR (Table 1) as manifested by a higher PR recorded for Simmental cows (45.16%) than that recorded for Holstein cows (34.98%) as shown in Table 2. Furthermore, during the cold season, the responses of Simmental cows to PO (56.90%) and G6G (54.41%) were significantly ($p < 0.01$) greater than that of Holstein herd mates (36.50% and 38.10%, respectively). The results of the current study were concurred well with Piccand et al. [51] who found that Simmental cows recorded a high submission rate (86%) and a high CR (89%) and attributed these good results to the good BCS of this breed peripartum. Moreover, Toledo-Alvarado et al. [62] concluded that, the Simmental cows have a greater reproductive potential than Holstein cows. In addition, the crossbreed between Simmental and Holstein cows has been found to improve CR [34]. Equally, Knob et al. [39] informed that crossbred Simmental \times Holstein cows had good reproductive efficacy compared with Holstein cows, characterized by higher CR (37.3 vs. 33.6 %). It has been well documented that there is a close relationship among BCS, NEB, and fertility [8]. NEB is recognized by the destruction of body fat reserve and ketone bodies and non-esterified fatty acids that exert a deleterious effect on both oocytes and corpus luteum functions. This results in low uterine progesterone concentration and hostile uterine conditions unsuitable for the embryonic development, leading to embryonic death [41]. Furthermore, it has been mentioned that, lactating cows which suffered from great BW loss in early lactation, entering in a state of greater NEB, had more reproductive problems than cows that lost less BW [60]. The lower PR of Holstein cows relative to that recorded previously for other breeds might be attributed to genetic improvement programs that have prioritized milking performance over other genetic predispositions. Interestingly, reproductive performance was closely associated with BCS; Simmental

cows were the fattest and had the best results. Overall, a higher BCS post-calving was linked with increased reproductive performance, irrespective of breed.

5 Conclusions

Application of CIDR-Ovsynch breeding program could be used as an effective treatment regime for cystic ovarian disease in lactating dairy cows; likewise, G6G program could be used as a substitutional treatment regime for acyclic lactating cows. Furthermore, the present study would permit development of applicable breeding regimen to improve the fertility outcomes in intensive breeding commercial dairy farms.

Abbreviations

BCS: Body Condition Score; CIDR: Controlled internal drug release device; COD: Cystic ovarian disease; CR: Conception rate; DIM: Days in milk; FTAI: Fixed-time artificial insemination; G6G: Gonadotropin releasing hormone of Presynch-6 days-gonadotropin releasing hormone of Ovsynch; GnRH: Gonadotropin releasing hormone; HS: Heat stress; NEB: Negative energy balance; Ovsynch: synchronization of ovulation; PGF2 α : Prostaglandin F2 alpha; PO: Presynch-Ovsynch; PR: Pregnancy rater; Presynch: Presynchronization of ovulation

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Author's contribution

The author designed the study, performed the statistical analysis, and drafted the manuscript. The author read and approved the final manuscript.

Funding

This study was achieved in a large private commercial dairy farm.

Availability of data and materials

The raw as well as the SPSS data are available.

Ethics approval and consent to participate

As this is a retrospective study depended mainly on data analysis, so we did not handle any cows at all.

Consent for publication

Not applicable.

Competing interests

The author declares that he has no competing interests.

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