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Effect of Stress on Ovarian Follicular Activity in Postpartum Sahiwal Cows during Summer Season

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ABSTRACT

Present investigation was carried out to study the effect of heat stress on ovarian follicular activity in postpartum acyclic Sahiwal cows during summer seasonfrom April to June. Postpartum ovarian activity was monitored using trans-rectal ultrasound scanning on alternate days beginning between day 60 and 90 postpartum in Sahiwal cows (n=16) up to next 21 days. Daily maximum temperature and relative humidity was recorded and temperature-humidity index (THI) was calculated during study period. Four animals (25%) showed presence of dominant follicle (≥ 10 mm, cyclic) and remaining 12 animals (75%) were classified as acyclic (ovarian follicle < 10 mm diameter). Present study demonstrated that as the value of THI reduced, the mean follicular diameter proportionately increased and vice versa. Based on the findings of present study, it may be concluded that development of ovarian follicle is highly affected by THI value during summer season in Sahiwal cows and the reproductive performance of animal may be predicted using THI values.
Keywords: Heat Stress, Ovarian activity, Postpartum, Sahiwal cows, THI

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INTRODUCTION

Heat stress is the most traumatic abiotic stress that causes adverse effects on health, welfare and production of farm animals with huge economic losses to the livestock industry to the extent of about 60% of the dairy farms around the world (Behl *et al.*, 2010). In tropical countries like India, summer is the most stressful season for animals because

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of higher ambient temperatures beyond 42°C (Kolli *et al.,* 2014). Heat stress is influenced by air temperature, humidity, air movement, solar radiation, and precipitation. Temperature-humidity index (THI) is a single value depicting the integrated effects of air temperature and relative humidity and is commonly used to quantify the degree of heat stress on dairy cattle. Negative relationships between THI and reproductive performances in dairy cows have been documented (Habeeb *et al*., 2018).

The effect of heat stress on reproductive performance is multi-dimensional through several mechanisms either direct effect on reproductive system or via indirect metabolic and nutritional effects (De Rensis *et al*., 2017). Heat stress damages the developing follicles whenever the core body temperature exceeds 40°C (Roth *et al.,* 2000). Heat stress influences the follicular development by reducing steroid hormone secretion, which disrupts the oocyte growth, reduces the growth of dominant follicles and increases the growth of subordinate follicles compromising oocyte competence, and inhibiting embryonic development. The direct effect of heat stress on the cow with altered endocrine regulation is due to impairment of hypothalamic-pituitary-ovarian axis (Ozawa *et al*., 2005). Heat stress affects reproduction by inhibiting the synthesis of gonadotropin-releasing hormone and luteinizing hormone, which are essential for expression of estrus behaviour and ovulation (Temple *et al*., 2015). Heat stress also increases the production of $PGF_2\alpha$ in the endometrium, leading to the early regression of CL and consequently embryonic death. In the light of above perspective, the present investigation was conducted to study the effect of summer stress on ovarian follicular activity in postpartum Sahiwal cows.

MATERIALS AND METHODS

The present experiment was carried out on acyclic postpartum Sahiwal cows maintained at Bull Mother Experimental Farm, College of Veterinary Science and Animal Husbandry, Anjora, Durg (C.G., India) during April, May and June 2022. Acyclic Sahiwal cows (n=16) between day 60 and 90 postpartum were randomly selected with no any genital abnormality. The postpartum ovarian activity in experimental animals was monitored using trans-rectal ultra sound scanning (Prosound ALOKA, Scanner 7.5 MHz trans-rectal probe). Ultrasound scanning of both ovary were carried out on alternate days starting on any day between 60 and 90 days post-partum up to the next 21 days, i.e., days 0, 2, 4, 6, 8, 10, 12, 14, 16, and 21. Follicles were described as round, non-echogenic entities with a distinct boundary separating the follicular wall from the antrum. Using in-built electronic caliper the maximum diameters of each follicle were measured. Based on their diameter, ovarian follicles were classified as small (3-5 mm), medium (6-9 mm) and large/ ovulatory (≥ 10 mm) follicle. Based on findings of ultrasound scanning of ovaries, experimental animals were divided in to two groups *viz.* cyclic and acyclic. The animals of cyclic group showed presence of dominant and/or ovulatory follicle (≥ 10 mm diameter) on any day of ultrasound scanning whereas; the animals of acyclic group did not reveal presence of dominant and/or ovulatory follicle during entire session of ultrasound scanning.

Meteorological data were obtained from Automatic Weather Station of Indian Meteorology Department installed at Krishi Vigyan Kendra, Anjora, Durg (CG). Information, consisting of daily maximum temperatures and relative humidity was used to calculate the temperature-humidity index (THI) for each day using following equation (National Research Council, 1971). Where,

$$THI = 0.72 (Cdb + Cwb) + 40.6$$

Cdb = Dry bulb temperature (°C)

Cwb = Wet bulb temperature (°C)

The association between follicular diameter and THI values was determined ina linear regression model using SPSS computer programme.

RESULTS AND DISCUSSION

The ultrasound scanning of ovaries in postpartum Sahiwal cows revealed ovarian activity with respect to follicular growth right from the first day of examination. The ovaries were characterized by growth and regression of several small, medium and large follicles until the detection of first postpartum dominant follicle (≥ 10 mm) during the study period.

Among the experimental animals, 4 animals (25 %) showed presence of dominant follicle (≥ 10 mm) between days 18 and 21 of the ultrasound scanning and these animals (n = 4) were classified as cyclic animals (Group-I). Among these cyclic animals, 2 cows expressed overt signs of estrus during experimental period. Remaining 12 animals (75%) were classified as acyclic animals (Group-II) and they showed presence of medium to large follicles (5-9 mm) but did not show presence of dominant follicle during the study period. Mean diameter (mm) of the largest ovarian follicles of cyclic and acyclic animals were recorded which are presented in Table 1. Highly significant difference ($P < 0.01$) was recorded in mean follicular diameter on day 14 and very high significant differences in mean follicular diameter ($P < 0.0001$) were recorded on days 16, 18 and 21 between animals of cyclic and acyclic groups.

Table 1: Mean follicular diameter (mm) in animals of cyclic and acyclic group of post-partum Sahiwal cows

Days of ultrasound examination	Mean Follicular diameter (mm)		P value
	Cyclic (n=4)	Acyclic (n=12)	
0	4.4±0.61	5.51±0.69	0.19
2	4.42±0.65	4.13±0.29	0.32
4	5.17±0.54	4.65±0.31	0.20
6	6.25±0.44	5.27±0.42	0.11
8	6.37±0.44	5.50±0.33	0.09
10	6.57±0.51	6.04±0.30	0.19
12	7.05±0.46	6.46±0.28	0.15
14	10.18±0.21	6.78±0.48	0.0007**
16	10.53±0.13	7.08±0.33	2.1E-05*
18	10.79±0.11	7.47±0.30	1.6E-05*
21	11.53±0.18	8.09±0.30	1.2E-05*

(** = P < 0.01, E-05* = P < 0.0001)

The effect of THI on ovarian follicular development during summer season is presented in Table 2. The mean ovarian follicular diameter and THI values on various days in April, May, and June were subjected to regression analysis, which demonstrated an inversely proportional association between these two characteristics. Higher THI levels were associated with smaller mean follicular diameters;however, as the THI value decreased, the mean follicular diameter grew correspondingly.

The regression analysis for association revealed that the effect of THI was significant on ovarian activity of postpartum Sahiwal cows during months of April, May and June. The mean follicular diameter was found to be the highest as 11.87 mm in the month of June and the lowest follicular diameter was recorded as 3.22 mm during the month of May. The mean follicular size was continued to be larger on days with lower THI values and vice-versa.

In the present study, the cyclic status of animals was identified based on size of ovarian follicle. Interestingly, all cyclic animal were detected in the later part of June with lower THI values, while acyclic animals were detected during the month of April and May with comparatively higher THI values. These results suggested that heat stress affects ovarian cyclicity in Sahiwal cows. Similar findings have been reported by Diaz *et al.* (2020) who concluded that reproductive behavior and ovarian activity of *Bos indicus* cows suffered as a result of the high level of THI.

Cattle experience the negative impacts of heat stress, including decreased milk output, altered milk composition, and poor reproductive performance, when the ambient temperature rises above the upper critical temperature. Armstrong (1994) categorized THI values into five different classes as no stress with THI value < 72, mild stress (72-78), moderate stress (79-88), severe stress (89-98) and dead cows with THI > 98. On the other hand, McDowell *et al.* (1976) developed three different classes of THI as comfortable (≤ 70), stressful (71-78) and extreme stress (> 78). However, no such classification of THI has been reported in tropical area of India. THI values were consistently recorded above 90 during April and May and dominant follicle was not detected when THI values were > 90. However, dominant follicle was detected along with overt signs of estrus when THI value fell below 90 during later part of June suggesting that Sahiwal cows might be under comfort zone with THI value < 90. The acute exposure to extreme heat load is associated with disturbance to a physiological mechanism of

Table 2: Mean ovarian follicular diameter (mm) in relation to THI during summer season in postpartum Sahiwal cows

Days of observation	April			May			June		
	THI	Follicle Diameter(mm)	Regression P Value	THI	Follicle Diameter(mm)	Regression P Value	THI	Follicle Diameter (mm)	Regression P Value
0	90.28	5.45		93.16	3.22		91.72	4.63	
2	88.84	4.24		91.72	4.55		91.0	4.88	
4	92.44	4.93		91.72	4.88		91.72	5.3	
6	90.28	6.03		92.44	6.08		93.16	6.45	
8	93.16	6.18		91.0	7.17		91.72	7.52	
10	92.44	6.46	0.140379	91.72	6.88	0.570962	92.44	7.04	0.014433*
12	91.72	6.95		93.88	7.85		90.28	8.23	
14	91.72	8.36		94.60	9.02		89.56	9.12	
16	92.44	8.43		91.16	9.11		90.28	9.54	
18	92.44	8.76		91.72	8.89		88.84	8.91	
21	91.72	9.75		92.44	9.03		88.84	11.87	

* Significant (P<0.01)

body like rapid respiration and excessive saliva production along with significant depression in reproductive performances in animals (Kadzere *et al*., 2002).

One of the primary elements influencing the reproductive performances of dairy cattle is heat stress. Cow reproduction is negatively influenced by high summer-time temperatures and high relative humidity levels. The location of the current experiment Durg typically experiences moderate, dry tropical weather that gets warmer during the summer. Although the cows of the Sahiwal breed are well acclimatized to this climate, the results of the current study show that they also appear to be affected by rising THI levels. All the animals exhibited presence of small and medium sized ovarian follicles unless THI values fell below 90 when they started to show presence of dominant follicle and two animals expressed overt signs of estrus. Similar to the findings of present study, exposure of Gir cows to heat stress exerted a delayed deleterious effect on ovarian follicular dynamics and heat-stressed animals showed presence of small and medium sized ovarian follicles with absence of signs of estrus (Torres-Junior *et al*., 2008).

Heat stress can negatively influence follicle growth in dairy cows, which could therefore hinder subsequent follicular development and the function of the dominant follicle (Wolfenson *et al.*, 1997). Heat stress seems to have a negative impact on the effectiveness of follicular selection and dominance as well as the quality of ovarian follicles. (Badinga *et al*., 1993 and Alves *et al*., 2014). A greater number ($P < 0.01$) of ovulation was reported in the cows during cool season compared to the hot season and luteal phase was prolonged and ovulation were either delayed in cows during hot season or they failed to ovulate (Kornmatitsuk *et al*., 2008). Decreased feed intake during heat stress caused less pulse frequency of luteinizing hormone resulting in development of ovarian follicles of small diameter in size (Ronchi *et al.,* 2001).

Masoumi and De Rensis (2013) documented that compared to non-stressed cows, heat stressed nursing cows have reduced follicular diameters. Interestingly, these investigators also noted that during the months of April and May, the majority of the animals usually displayed smaller-sized follicles; however, during the month of June, the follicular size grew as the THI decreased. Similar pattern of follicular development was recorded in present study with the onset of monsoon around mid-June.

CONCLUSIONS

The results of the present study led to the conclusion that growth and development of ovarian follicle is affected by THI during summer season in Sahiwal cows and we may predict reproductive performance of animal using THI values.

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CONFLICT OF INTEREST

None.

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