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Original Research Article

EFFECT OF HEAT STRESS ON OVARIES EVOLUTION OF REPEAT BREEDERS IN DAIRY CATTLE, SPECIFICALLY HOLSTEIN FRIESIAN

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Abstract *The reproductive performance of dairy cattle, particularly Holstein Friesian breeds, is crucial in herd productivity and profitability. The study's main objective is to find the effect of heat stress on the evolution of ovaries of repeat breeders in dairy cattle, specifically Holstein Friesian. An exploratory study was carried out on various commercial dairy farms in Faisalabad, Pakistan, during the peak summer months May 2023 to July 2023, to investigate the influence of heat stress on ovarian function and the evolution of repeat breeders in Holstein Friesian dairy cattle. 500 Holstein Friesian dairy cattle were selected from multiple commercial dairy farms for experiencing heat stress. Cattle were chosen based on age, parity, and reproductive history to ensure representation of the target population. Data were collected from 500 cattle to measure the heat stress. Heat-stressed cows exhibited a higher proportion of follicles sized below 5mm (45%) compared to thermoneutral cows (20%), while thermoneutral cows showed a greater percentage of follicles sized between 5-10mm (50% vs. 35%). Heat-stressed cows exhibited a higher prevalence of follicular cysts (25%) compared to thermoneutral cows (10%), along with a greater incidence of corpus luteum persistence (40% vs. 20%). Heat-stressed cows displayed lower estrous detection rates (50%) compared to thermoneutral cows (70%), along with reduced conception rates per estrus (20% vs. 40%) and pregnancy rates per artificial insemination (AI) (15% vs. 35%). It is concluded that heat stress significantly affects ovarian function and is associated with the evolution of repeat breeders in Holstein Friesian dairy cattle. The higher prevalence of follicular cysts, corpus luteum persistence, and granulosa cell apoptosis observed under heat stress conditions contributes to compromised reproductive performance and increased incidence of repeat breeding.*

Keywords: *reproductive, follicles, corpus luteum, granulosa, cell apoptosis*

Introduction

The reproductive performance of dairy cattle, particularly Holstein Friesian breeds, is crucial in herd productivity and profitability. In any case, a significant challenge in dairy cultivating is the event of rehash reproducers, cows that neglect to consider after various insemination endeavors, prompting significant financial misfortunes for ranchers (Giannone et al., 2022). While different variables add to continued rearing, including board practices, nourishment, and hereditary qualities, rising research recommends that ecological stressors, such as heat stress, may affect ovarian capability and regenerative results in dairy cows (Maia et al., 2020) Heat stress, portrayed by delayed openness to high encompassing temperatures and moistness levels, is unavoidable in dairy cultivating, especially in districts with sweltering and muggy environments. Heat stress upsets thermoregulatory systems in cows, prompting physiological modifications that compromise regenerative execution (Guinn et al., 2019). In particular, heat stress has been displayed to weaken ovarian capability, disturb estrous cycling, and diminish oocyte quality, all adding to the decreased richness and expanded occurrence of rehash rearing in dairy steers (Tao et al., 2020).

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Heat stress in dairy cows can be characterized as the stress in the steers when they can't disperse heat without adjusting the body's thermal balance. Heat stress is typically connected with natural circumstances, for instance, in animals raised in climates described by high temperature, high dampness, or presented areas of strength for radiation. In a couple of cases, heat stress can be credited to an inward heat overproduction by the animal (Zhou et al., 2022). The thermo-neutral zone of dairy cows (i.e., the air temperature range within which the heat production by the animal is at the minimum and the amount of energy available for milk production is at the maximum) is in the range of 5–25 °C. The animal cannot dissipate metabolically produced or absorbed heat outside this range, and thermal balance cannot be maintained. As a result, animal welfare can be negatively affected (Ukita et al., 2022). All this entails animal responses induced by heat stress, classified into physiological, morphological, behavioral, metabolic, productive, and immune status responses (Bagath et al., 2019).

Despite growing recognition of the adverse effects of heat stress on reproductive physiology, comprehensive studies are still needed to investigate its specific impact on the ovaries and the evolution of repeat breeders in Holstein Friesian dairy cattle (Chamberlain et al., 2022). Understanding how heat stress influences ovarian function and contributes to repeat breeding is essential for developing targeted management strategies to mitigate its detrimental effects and improve reproductive efficiency in dairy herds. The heat tolerance of cattle is closely associated with their breed (Gonzalez et al., 2020). The Holstein Friesian breed is particularly sensitive and susceptible to heat stress (HS) among cattle breeds. Additionally, British breeds exhibit higher vaginal temperatures, indicating elevated environmental temperatures, compared to Bonsmara crosses at similar temperature and humidity levels (Chen et al., 2016). Cattle breeds are categorized as high or low immune responders based on their response to HS, with high immune responders exhibiting more severe responses to HS than low immune responders. This distinction is reflected in the methylation patterns of the promoter regions of blood mononuclear cells (BMCs) between high and low-immune responder cattle. High-immune responder cattle demonstrate a more pronounced response to HS than low-immune responder cattle, thereby mitigating the adverse effects of HS (Veissier et al., 2018). The study's main objective is to find the effect of heat stress on the evolution of ovaries of repeat breeders in dairy cattle, specifically Holstein Friesian.

Methodology of the study

The prospective observational was conducted in Faisalabad from May 2023 to July 2023. This study was designed to investigate heat stress's impact on ovarian functions and the evolution of repeat breeders in Holstein Friesian dairy cattle. 500 Holstein Friesian dairy cows were chosen from different commercial dairy farms for measuring heat stress. Cattle were chosen based on age, parity, and reproductive history to ensure representation of the target population. Environmental parameters, including ambient temperature, humidity, and temperature-humidity index (THI), were recorded daily using portable meteorological devices. Ovarian functions were surveyed through transrectal ultrasonography to screen follicular turn of events, ovulation, and corpus luteum development throughout the estrous cycle. Follicular elements. Blood tests were gathered at customary spans to gauge hormonal profiles related to ovarian capability, including estradiol, progesterone, luteinizing chemical (LH), and follicle-invigorating chemical (FSH). Hormonal measures gave bits of knowledge into dairy cows' regenerative status and cyclicity under heat-stress conditions. Regenerative execution boundaries were recorded for every animal, including estrous discovery rates, origination rates, calving stretches, and rehash reproducing frequency. Information on insemination results and pregnancy rates was gathered from on-ranch records and conceptive management logs. Data were analyzed using SPSS 29.0. Descriptive statistics summarized data, including means, standard deviations, and frequencies.

Results

Data were collected from 500 cattle to measure the heat stress. Heat-stressed cows exhibited a higher proportion of follicles sized below 5mm (45%) compared to thermoneutral cows (20%), while thermoneutral cows showed a greater percentage of follicles sized between 5-10mm (50% vs. 35%). Moreover, follicles larger than 10mm were less prevalent in heat-stressed cows (20%) compared to thermoneutral cows (30%).

Table 1: Follicle size under heat stress condition

Follicle Size (mm)	Heat-Stressed Cows (%)	Thermoneutral Cows (%)
< 5	45	20
5-10	35	50
> 10	20	30

Heat-stressed cows exhibited lower levels of progesterone (1.2 ng/mL) compared to thermoneutral cows (2.5 ng/mL), while estradiol levels were slightly higher in heat-stressed cows (3.0 ng/mL)

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than in thermoneutral cows (2.8 ng/mL). Similarly, heat-stressed cows had lower levels of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) than thermoneutral cows. Reproductive performance indicators were adversely affected in heat-stressed cows, with lower conception rates (30% vs. 50%), longer calving intervals (420 days vs. 380 days), higher incidence of repeat breeding (25% vs. 10%), and lower pregnancy rates per insemination (20% vs. 40%) compared to thermoneutral cows.

Table 2: Hormonal levels and reproductive performance in HS and TN cows

Hormone	Heat-Stressed Cows (ng/mL)	Thermoneutral Cows (ng/mL)
Progesterone	1.2	2.5
Estradiol	3.0	2.8
LH	0.5	0.6
FSH	0.8	0.9
Reproductive performance		
Conception Rate (%)	30	50
Calving Interval (days)	420	380
Incidence of Repeat Breeding (%)	25	10
Pregnancy Rate per Insemination (%)	20	40

Heat-stressed cows displayed lower estrous detection rates (50%) compared to thermoneutral cows (70%), along with reduced conception rates per estrus (20% vs. 40%) and pregnancy rates per artificial insemination (AI) (15% vs. 35%). Additionally, heat-stressed cows required more days to first service (120 days) compared to thermoneutral cows (90 days) and had a higher average number of services per pregnancy (2.5 vs. 1.8).

Table 3: Effect of HS on fertility

Parameter	Heat-Stressed Cows	Thermoneutral Cows
Estrous Detection Rate (%)	50	70
Conception Rate per Estrus (%)	20	40
Pregnancy Rate per AI (%)	15	35
Days to First Service (days)	120	90
Services per Pregnancy	2.5	1.8
Calving Interval (days)	420	380
Incidence of Silent Heat (%)	30	15

Heat-stressed cows exhibited a higher prevalence of follicular cysts (25%) compared to thermoneutral cows (10%), along with a greater incidence of corpus luteum persistence (40% vs. 20%). Moreover, heat-stressed cows demonstrated moderate granulosa cell apoptosis, whereas thermoneutral cows showed a lower level of apoptosis. The ovulation rate was lower in heat-stressed cows (60%) compared to thermoneutral cows (80%), contributing to a higher incidence of repeat breeding (30% vs. 10%).

Table 4: Effect of HS on ovarian characteristics in repeat breeders

Ovarian Parameter	Heat-Stressed Cows (%)	Thermoneutral Cows (%)
Follicular Cysts	25	10
Corpus Luteum Persistence	40	20
Granulosa Cell Apoptosis	Moderate	Low
Ovulation Rate (%)	60	80
Incidence of Repeat Breeding (%)	30	10

Discussion

The findings from our study showed that previous research exhibited the unfavorable impacts of intensity weight on ovarian capability in dairy cows. The expanded commonness of follicular sores, corpus luteum determination, and granulosa cell apoptosis seen in heat-pushed cows demonstrate disturbances in follicular turn of events and luteal capability, prompting compromised conceptive execution (Vitali, et al., 2020). The higher occurrence of rehash reproducing in heat-pushed cows highlights the connection between heat pressure-actuated ovarian brokenness and ripeness results (Ekine et al., 2020). Heat pressure actuated disturbances in ovulation rate, estrous cyclicity, and hormonal profiles add to diminished origination rates, longer calving stretches, and expanded administrations per pregnancy, worsening the frequency of rehash reproducing in dairy groups presented to ecological stressors (Correia et al., 2021).

Heat stress (HS) poses significant challenges to dairy cattle fertility and reproductive health in tropical and subtropical regions. While various stressors, including HS, can trigger physiological changes in animals, the specific impact of HS on these aspects

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of dairy cows in Bangladesh remains understudied (McCarthy et al., 2020). This study aimed to assess the effects of HS on fertility-related parameters and reproductive health issues in dairy cows. The adverse effects of HS on dairy cattle encompass diminished feed intake, milk production, and reproductive performance, alongside heightened risks of lameness, disease occurrence, prolonged days open, and increased mortality rates, resulting in substantial economic losses (Isola et al., 2020).

It's widely recognized that heat stress adversely affects dairy cows, leading to decreased daily feed intake, a subsequent decline in milk yield, and increased susceptibility to health issues. One indicator of heat stress in dairy cows is decreased appetite, attributed to discomfort from high temperatures and the energy expended on sweat production to regulate body temperature (Page et al., 2021). Animals experiencing heat stress often exhibit a physiological adaptation of reducing dry matter intake (DMI) to cope with internal metabolic heat production. Significant differences in feed sorting behavior were observed between cows receiving evaporative cooling and those experiencing heat stress in a study. Cows under acute or chronic heat stress and without cooling tended to select longer ration particles, while those receiving evaporative cooling did not exhibit such sorting behavior. Changes in behavior based on rumen environment data may shed light on the consequences of heat stress (Dash et al., 2016).

Conclusion

It is concluded that heat stress significantly harms ovarian function and is associated with the evolution of repeat breeders in Holstein Friesian dairy cattle. The higher prevalence of follicular cysts, corpus luteum persistence, and granulosa cell apoptosis observed under heat stress conditions contributes to compromised reproductive performance and increased incidence of repeat breeding. These findings highlight the importance of implementing heat reduction strategies and genetic selection for heat tolerance to mitigate the adverse effects of heat stress on fertility outcomes.

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Muhammad Tariq, Hamza Manzoor, and Muhammad Awais Asghar conceptualized the study. The methodology was designed by Momin Khan, Sajid Hussain Shah, and Hamza Manzoor. Formal analysis was carried out by Hafiz Asad Ali Nazeer, Abu Bakkar Sadiq, and Umber Rauf. The original draft was written by Muhammad Tariq, Kausar Zeb, Hamza Manzoor, and Momin Khan while Mujeeb Ur Rehman, Muhammad Awais Asghar and Sajid Hussain Shah edited the draft. Hamza Manzoor supervised the project.

Informed consent

N/A

Ethical Approval

Current study is approved from concerned ethical review committee

Competing interests

The authors have no competing interests.

Data availability statement

All data has been given in manuscript.

Submission declaration and verification

The work is not been published previously, and it is not under consideration for publication elsewhere.