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Side effects of high environmental temperature on reproductive efficiency of ruminants

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A B S T R A C T
The thermal comfort region for the greatest animals is between 4° C and 25° C. When the temperature surpasses 25° C, animals suffer heat stress. In severe heat stress, the profound body temperature increases, animal cells are affected and reproduction performance is reduced. Most physiological and biochemical variations could occur to protect essential cell functions in contradiction of heat stress and to permit a fast recovery from moderate hypothermic destruction. In hot countries, the climatic characteristic is the major constraint on reproductive efficiency of ruminants. Reproduction is reduced as a result of the extreme changes in biological functions affected by heat stress.

Keywords*: Heat stress, ruminants, reproduction, alleviation techniques*

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INTRODUCTION
The best climatic conditions for animals would be something like an air temperature of 13 to 20 ºC, wind velocity of 5 to 18 km/ hour, relative humidity of 55 to 65%, and a moderate level of sunshine, and these factors are interrelated. Ambient temperature is related to other climatic factors but the relationship with the relative humidity seems to be the most important, since the feeling of warmth under high ambient temperature increases with high relative humidity percentage. Such a relationship induced to propose a measurement of the level of severity of heat stress using the two factors and was termed the temperature-humidity index. The effect of heat stress is enlarged when the relative humidity is larger than 50% [1]. In tropical and subtropical countries, the climatic characteristic is the major constraint on animal productivity. Production and reproduction are impaired as a result of the drastic changes in biological functions caused by heat stress [2]. According to the World Health Organization, World Meteorological Organization, and the United Nations Environmental Program, global warming would be a greater frequency and greater duration of exposure to hotter temperatures, especially, during the summer months. Typical hyperthermia sometimes occurs during severe heat in summer and as a result of hard expose to the sun throughout the world [3].

Side effects of heat stress on reproductive efficiency
Negative relationships between the temperature-humidity index and reproductive performances in animals were documented by many authors [4, 5, 6 & 7]. Heat stress define as a daily maximum THI of 72 or more from day 35 before to the day 6 after the day of breeding decreases the conception rate of lactating dairy cows by around 30% relative to days of breeding and when maximum THI during three to one-day pre–artificial insemination values were greater than 80, conceptionratedecreasedfrom30.6%to23.0% [8]. Heat stress causes reproductive problems such as reduced semen quality, lower birth weights, decrease the immune system, and harmed the developing embryo lead to lower conception rates and fertility [9]. Fertility in farm animals is well-defined as the ability of the animal to conceive and maintain pregnancy if inseminated at the appropriate time relative to ovulation [10]. Poor estrous detection and embryonic or fetal losses are among the leading causes of poor reproductive performance. During the postpartum period, about 50% of standing periods of estrus are undetected and this failure in estrous detection can increase the average interval between successive inseminations to about 40-50 days and reduces both reproductive efficiency and profitability [11]. The interval from parturition to conception during summer was 24-67 days longer than during the winter even though barns during summer were supplied with evaporative coolers [12]. Heat stress severely reduces pregnancy rates in farm animals and the conception rates of lactating animals decreased sharply when maximum air temperature on the day after insemination exceeded 30ºC [11]. In contrast, conception rates for heifers did not decline until 35 ºC. Virgin heifers had higher conception rates for all services (50%) than lactating cows (34%) and suffered only slight depression of fertility during the summer months. Heifers required 1.5 services per conception compared with 2.3 for lactating cows.

Conception rates decreased from 40 to 50% during months when ambient temperatures are greater and to be less than 10% during the months of the year when ambient temperatures are lesser [13].

High temperature lowered conception rates in cows more than in heifers since lactating cows were usually unable to maintain normal body temperature under heat stress conditions because of the high rates of lactation associated with internal heat production [14]. Higher environmental temperature is one of the major factors responsible for reduced fertility in farm animals. Heat stress harmed reproductive events by decreasing the expression of estrous behavior, altering ovarian follicular development, compromising oocyte competence, and inhibiting embryonic development [15]. Heat stress after insemination reduced the weight of corpora lutea and impaired concept growth [16]. Heat stress also increases the production of prostaglandin secretion (GF2α) in the endometrium, leading to the early regression of corpus leuteam or the death of embryos. The heat stress from 8 to 16 days after insemination modulated the uterine environment reduced the weight of corpora lutea and impaired concept growth [16]. Heat stress decreases the intensity and duration of behavioral estrus so that a smaller proportion of cows are detected in estrus under heat stress conditions and increases embryonic mortality [17]. In heat-stressed cows, the intrauterine environment is compromised which results in reduced blood flow to the uterus and elevated uterine temperature and these changes suppress embryonic development and increase early embryonic loss and minimize the proportion of successful inseminations [18]. High ambient temperature will also affect pre-attachment stage embryos but the magnitude of the effect has been reduced as embryos develop [19]. Holstein heifers subjected to heat stress from the onset of estrus had an increased proportion of abnormal and developmentally disturbed embryos as compared with heifers preserved at thermo-neutrality and the production of embryos by super ovulation is often reduced and embryonic development compromised in seasons when ambient temperatures are greater [20]. Heat stress can affect endometrial prostaglandin secretion, leading to premature luteolysis and embryo loss. However, the majority of embryo loss occurs before day 42 in heat-stressed cows [21]. Heat stress in the period around the day of breeding was consistently associated with a reduced conception rate [22]. Abortions represent a loss of reproductive efficiency in normal bovine populations, and spontaneous abortion of dairy cows is an increasingly important problem that contributes substantially to low herd viability and production inefficiency by decreasing the number of potential female herd replacements and lifetime milk production by increasing costs associated with breeding and premature culling [23].

A positive relationship between heat stress during the pre-implantation period and early fetal loss in dairy cattle was found by Lopez-Gatius et al. [24]. Conception and pregnancy rates in purebred Holstein cows under subtropical Egyptian conditions were significantly decreased from 31.6% and 26.3% at the lesser THI to 11.5% and 9.9%, respectively, than at the greater THI. At the same time, conception and pregnancy rates were significantly reduced at either the lesser or greater THI while the embryonic loss rate was significantly increased from11.5% at the lesser THI to 22.2% at the greater THI [7]. The relationship between THI and the conception rate of lactating dairy cows to identify periods of exposure to heat stress relative to breeding in an area of moderate climate was studied by Schuller et al. [25]. The authors compared three different heat load indices related to conception rate: mean THI, maximum THI, and the number of hours above the mean THI threshold. The THI threshold for the influence of heat stress on the conception rate was 73. It was statistically chosen based on the observed relationship between the mean THI at the day of breeding and the resulting conception rate. Negative effects of heat stress were already apparent at lower levels of THI, and 1 hour of mean THI of 73 or more decreased the conception rate significantly. The conception rate of lactating dairy cows was negatively affected by heat stress both before and after the day of breeding. The greatest negative impact of heat stress on the conception rate was observed 21 to 1 day before breeding. When then mean THI was 73 or more in this period, the conception rate decreased from 31% to 12%. Compared with the average maximum THI and the total number of hours above a threshold of more than or 9 hours, the mean THI was the most sensitive heat load index relating to conception rate. The conception rate of dairy cows rose in moderate climates and was highly negatively affected by heat stress. The relationship between temperature and breeding efficiency indicates that high environmental temperatures were associated with low breeding efficiency [26].

Increased maximum temperature from 29.7 º C to 33.9 ºC was associated with a decrease in conception rate on the first service from 25 to 7% and fetal loss rate of Holstein was significantly increased from 17.1% at low THI to 24.9% at greater THI and abortion and stillbirth rates were significantly increased from 3.6% and 3.8% at low THI to 7.2% and 5.9% at greater THI, respectively[7].The same authors concluded that animals had a significantly longer calving interval and days open at high THI compared with low THI. Holstein cows had a significantly longer calving interval and days open at high THI (449 and 173 days, respectively), compared with low THI (146 days)[27].Heat stress affects reproduction by inhibiting the synthesis of gonadotropin-releasing hormone and luteinizing hormone which is essential for oestrus behavior expression and ovulation [28].Heat stress affects reproduction by inhibiting the synthesis of gonadotropin-releasing hormone and luteinizing hormone which is essential for oestrus behavior expression and ovulation[29].Body temperature greater than 39°C may harm the developing embryo from day 1-6 and lead to loss of pregnancy. Heat stress during late gestation may also lead to cows calving 10-14 days before their due date [30].

Heat stress affects reproduction by inhibiting the synthesis of gonadotropin-releasing hormone and luteinizing hormone which is essential for estrus behavior expression and ovulation [28]. It can be concluded that heat stress is one of the major concerns which affect the reproduction potential of farm animals almost in every part of the world. Elevated temperature and humidity as presented in THI negatively affect feed intake and altered hormonal concentrations leading to negatively affecting the reproductive efficiency of dairy cattle[31].

CONCLUSION

Animals raised under the hot summer season of tropical and subtropical countries are suffering from severe climatic stress for almost 6 months of the year and become uncomfortable suffering extremely in reproduction. Exposure of animals to heat stress evokes a series of drastic changes in the biological functions ending in impairment the reproductive efficiency.

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