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Review Article

Interference of Climate Change in the Reproduction of Dairy Cows

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Abstract

When exposed to climate changes, dairy cows end up having several physiological changes influenced by environmental factors (radiation, temperature, relative humidity, and wind speed) and by means of thermoregulation (conduction, convection, and evaporation). These changes are visible in various organs and cells, but oocytes and embryos are more vulnerable to thermal stress, in this case, caused by high temperatures and humidity, which may even reduce fertility rates. Changes in climate can also directly affect the duration and regularity of the estrous cycle and the spread of diseases and infections that negatively affect animals, not least directly affecting the availability of forages and grains. Under these conditions, the Zebu breeds are predominant because they have greater resistance to heat. Understanding the problems caused by climate change in the reproduction of dairy cows allows us to develop strategies to reduce the negative effects, maintaining oocyte quality, even with high investments to be made.

Keywords: Heat stress: oocyte: dairy cows

Introduction

It is predicted that by 2040 global warming will increase by up to 1.5°C and that the average surface temperature will increase by between 1.88-4.08°C by the year 2100 [1]. It is known that sudden fluctuations in climate will continue to hinder the development of livestock and agriculture, harming countries that depend on this economy [2]. Since these future scenarios are being considered, heat stress in high-yielding dairy cows becomes a concern for producers [3]. When cows are exposed to high temperatures and humidity, they end up suffering thermal stress, which is responsible for generating problems both in milk production and in animal welfare, in the repetition of heat and in pregnancy, as the cow ends up spending more energy to dissipate heat instead of spending it on its own production [4]. Temperature is one of the environmental factors that most affect animal reproduction [5] and consequently the economy, with an estimated value of approximately US$897 million per year in losses caused by heat stress in the United States of America [6]. Temperature and high rainfall rates play an important role in cattle management, as these factors directly affect the availability of food and the animals' homeostasis [7].

In Brazil, there was a drop in the pregnancy rate from 71.2% in the winter to 45.7% in the summer in Holstein cows confined in a free stall system, since the chances of artificial insemination or another type of reproductive biotechnology that results in a viable embryo, decreases as body temperature increases [8]. As soon as these animals go through unfavorable environmental conditions, there is an increase in body temperature, which ends up reducing dry matter consumption, and as a result, there is a decrease in reproductive and productive performance [9]. One of the most effective alternatives to combat this problem is the use of water sprinklers, which are more used in milking parlors and treatment lanes, and fans. It is relatively effective for improving milk production, however, during the summer its effects on fertility are limited [10]. Therefore, thinking about alternatives that can avoid the negative effects of high temperature and humidity on the reproduction of dairy cows is extremely important. Thus, this review aimed to raise the consequences of climate change on the reproduction of dairy cows and ways to reduce this problem.

Discussion

There is a clear link between increased release of greenhouse gases and extreme climate change, so animals must always be adapting to the environment. Factors that induce these effects are increases in atmospheric levels of carbon dioxide (CO_2), rising temperatures and changes in the amount, seasonality, and variability of rainfall [11]. The aspects to be considered for the relief of these impacts on livestock is complex. The thermal discomfort suffered by the animals compromises the consumption of dry matter, since the quality and quantity of fodder is limited, the production and quality of milk, and reproduction. It is known that for success in reproduction, it is necessary for the oocyte to have the ability to resume meiosis, perform cleavage and maintain initial development until pregnancy, however, immediate results of heat stress consist of changing the regulation hypothalamic-pituitary-ovarian axis, impairing the amounts of progesterone, consequently reducing estrous activity, affecting fertility, increasing the interval between deliveries and decreasing conception rates, since oocytes, spermatozoa and embryos are unable to preserve their vital functions when subjected to high temperatures, because thermal stress due to climate change causes inverse consequences on cell function [12].

Folliculogenesis is also impaired by heat stress, as it ends up reducing steroidogenic rates and ovarian follicular dynamics, causing cells to stop producing hormones in the necessary amounts, influencing the development of follicles, which end up becoming smaller in diameter and hindering recruitment of the same. Such hormonal changes lead to reproductive problems, such as delayed puberty, irregular estrous cycle, ovarian cysts, anestrus and embryonic death, due to impaired oocyte qualifications and blockage of embryonic development. Elevated temperatures affect the evolution of young embryos by decreasing the flow of blood in the uterus and increasing its temperature, since embryos are very vulnerable in their first days of life, radically reducing survival rates [13]. There may be a change in the development of gametes, zygotes and embryos according to the progress of pregnancy, being minimal from the third day on in cattle. Embryos from heat resistant breeds develop better to the blastocyst stage after thermal heat stress compared to embryos from heat sensitive breeds [14]. In this way, embryonic losses occur since the embryo has difficulty in generating biochemical signals to signal gestation, with an increase in the secretion of prostaglandin by the endometrium and triggering premature luteolysis [15].

Post-transfer embryonic survival, especially during the period of maternal recognition of pregnancy, requires a minimum number of viable blastomeres, on the other hand, the greater the impairment of cell mass due to morphological defects, the lower the chance of pregnancy formation. In this case, the thermal stress that causes damage and even death of embryonic cells, embryos of common or poor morphological classification are less likely to develop [16]. Heifers exposed to the heat stress of estrus until their insemination or mating end up directly affecting their embryos in the pre-implantation stage, as the pre-ovulatory follicle ends up producing low values of androstenedione, estradiol and inhibin, implying in the expression of estrus, which normally lasts for 14-18 hours, but in hot environments lasts for 8-10 hours, decreasing the efficiency of artificial insemination during the summer, reducing the preovulatory LH surge, disrupting ovulation, maturation and luteinization, reducing follicle dominance, as well as embryonic development which is also intertwined with the environment of that uterus or oviduct.

Holstein cows that suffered heat stress may compromise the redistribution of blood flow from the viscera to the periphery, consequently reducing the vascular perfusion of the placenta, and its growth and development must follow the fetal growth, and with that there may be delay in the development of the fetus. Their daughters may have low reproductive efficiency, with increased age at first birth and predisposition to culling, so the consequences of heat stress can last for up to two generations [17-19]. Furthermore, cows covered in the winter period are five times more likely to conceive postpartum than cows covered in the summer period [20-24]. With the creation of protocols for fixed-time artificial insemination, it became possible to avoid the need for heat detection. The use of such protocols in stressed cows has been shown to be effective in increasing the postpartum pregnancy rate. Thus, FTAI manages to increase the number of cows inseminated, however it does not decrease the effects of heat stress on fertility [25-28].

Studies on in vitro Bos indicus embryos subjected to heat stress in the early stages of development have a greater capacity to develop than Bos taurus embryos, this is because Zebu animals have a smaller reduction in embryonic function when they suffer from climate change than do zebu animals. bulls. Furthermore, oocytes from Holstein cows fertilized with Nellore bull semen are more heat resistant than when fertilized with Angus semen. Therefore, it is in the interest of producers to think about the genetic selection of thermotolerant breeds, such as Bos indicus, as such a strategy can provide a productive environment even with unfavorable weather [29-31]. Not least, provide drinking water if the animals are raised on pasture and worry about leaving several points for water intake so that they do not need to travel long distances and make changes in the environment so that the animal can dissipate the heat that receives, also provide shady environment, fans, and water sprinklers in case of confined animals. Increasing crude protein and digestible energy values in the diet may also help to compensate for low feed intake during heat stress.

Conclusion

Climate change unfortunately represents an unpredictable problem for livestock, causing various losses and damages to it, with the studies of recent years we have been able to see what the biggest challenges and consequences are, and one of them is undoubtedly in reproduction, causing embryonic losses and problems in future generations. However, the heat stress that is the result of such climate change has ways of contouring to generate improvements in animal welfare and properties.

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