Effects of heat stress on milk production, fertility and health of dairy cows in Tehran province, IRAN

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Cow comfort is one of the most important aspects in herd management economy as it raises animal life span and feed conversion rate and also lower the risk of health problems.

Heat stress is a very big issue which disturbs cow comfort as in many countries like Iran, there are more than 5-7 months per year in which heat stress is a critical issue.

The objective of this paper has been analyzing heat stress impact on health, production and reproduction status of Iranian farms. The negative effects of heat stress were calculated in 21 Farms and 41291 cows in different parities, in Tehran province.

We compared service rate, conception rate, pregnancy rate, average days in milk, culling rate, production level in different parity and different days in milk, dry matter intake and still birth rate in winter and summer.

The obtained results showed the significant difference in conception rate, pregnancy rate, and average days in milk and milk production in different days in milk in first parity except in cows less than 40 days in milk. In second and third parity, there was a significant difference in production level in less than 200 days in milk

Heat stress is characterized by elevated respiration rates and rectal temperatures, and has been implicontents in impaired metabolism (Bandaranayaka and Ban- Holmes, 1976),

Temperature-humidity index (THI), which uses dry bulb temperature (Tdb) and wet bulb temperature, was initially developed by Thom (1959) as a heat index for human comfort but it remained the most common heat stress indicator used until now for different animal species.

Lactating dairy cows prefer ambient temperatures of between 5 and 25 8C, the ‘thermoneutral’ zone THI 50-72 (Roenfeldt, 1998).

Lactating dairy cows create a large quantity of metabolic heat and accumulate additional heat from radiant energy. Heat production and accumulation, coupled with compromised cooling capability because of environmental conditions, causes heat load in the cow to increase to the point that body temperature rises, intake declines and ultimately the cow’s productivity declines.

Environmental factors such as temperature, relative humidity, solar radiation, and air movement and their interactions often limit the performance of dairy cows (West, 2003)

Heat stress has a variety of negative effects on physiology and health status of animal's life stages.

Many studies show that heat stress decreases uterine blood flow (Oakes et al., 1976), placental weight (Alexander and Williams, 1971), and birth weight of the offspring (Collier et al., 1982; Tao et al., 2012a), which suggests compromised fetal growth.

Heat stress during the last 6 wk. of gestation negatively affects the ability of the calf to acquire passive immunity, regardless of colostrum source. No differences were observed in the amount of colostrum produced ($P = 0.52$), mean IgG concentration in colostrum ($P = 0.46$), or total IgG produced ($P = 0.54$) by cows from each treatment group at the first milking (Monteiro)

Heat stress during the dry period impairs cows' immune function (do Amaral et al., 2011) and leads to a greater disease incidence in the postpartum period (Thompson and Dahl, 2012). Heat stress during gestation also has adverse effects on the offspring.

Summer heat stress is a major contributing factor in low fertility among lactating dairy cows. It is a worldwide problem, which inflicts heavy economic losses and affects about 60% of the world cattle population. Conception rates drop from about 40–60% in cooler months to 10–20% or lower in summer, depending on the severity of the thermal stress (Cavestany et al., 1985).

HS-induced alterations in follicular dynamics (_Wolfenson et al., 1995) the lack of a decline in the number of medium-size follicles during the period of dominance of the first-wave (Badinga et al., 1993).or preovulatory follicle (Wolfenson et al., 1995)

Exposure of cattle to thermal stress does not suppress the overall pattern of follicular wave dynamics in cattle. However, HS does suppress follicular dominance, resulting in a number of changes in follicular growth. Among them, at least two responses standout in their physiological importance: 1. development of a larger number of large follicles probably increases the rate of double ovulation and hence of twin calving; and 2. early emergence of the preovulatory follicle lengthens the dominance period, and this has been shown to be associated with lower fertility in spontaneously cyclic dairy cows (Bleach et al., 1998).

Studies indicated that plasma estradiol concentration was lowered during HS. Lactating cows and dairy heifers that were heat-stressed during the second half of the cycle (Wilson et al., 1998) or during the entire cycle(Roth, 1998) had a reduced preovulatory surge in plasma estradiol concentration.

Chronic exposure to summer HS suppressed progesterone production, Various aspects of the effects of HS on oocyte quality and embryonic development include the following: 1. the deleterious effects of heat exposure during different stages of oocyte maturation and early embryo

development, on the impaired function of oocytes and embryos, in both in vitro and in vivo systems; 2. the increase in the heat tolerance of the embryo with age; _3. The production of heat-shock proteins by the embryo, and their potential function in protecting the embryo during HS; and _4. The possible use of antioxidants to increase embryo resistance to thermal stress (Wolfenson et al., 2000)

A milk yield decline between 0.08 and 0.26 kg for each unit increase in THI unit was found (Brügemann et al. 2012).

A decrease in milk yield of 21% when the THI increased from 68 to 78 is reported. For THI values above 69, the milk yield decreased by 0.41 kg/d per cow and THI unit increase. This decrease in milk yield of heat-stressed cows may be explained mainly by a lower DMI and a lower conversion efficiency of feed into milk (kg of FCM/kg of DMI)(Bouraoui et al. 2002) .

In a study conducted in the United States, the milk yield decreased by 0.23 to 0.59 kg per THI unit per day (Bohmanova et al., 2007).

Another important factor influencing the effects of heat stress on milk production is the stage of lactation. a greater decrease in early lactation than in mid or in late lactation is reported (Novak et al. 2009) . They mentioned that cows in early lactation are more sensitive to the effect of heat than cows in late lactation.

References:

1. Badinga, L., Thatcher, W.W., Wilcox, C.J., Morris, G., Entwistle, K., Wolfenson, D., 1994. Effect of season on follicular dynamics and plasma concentrations of oestradiol-17b, progesterone and luteinizing hormone in lactating Holstein cows. Theriogenology 42, 1263–1274
2. Bleach, E.C.L., Glencross, R.G., Knight, P.G., 1998. Association between ovulatory follicle development and pregnancy rates in spontaneously cycling dairy cows. Winter Meeting. Soc. for the Study of Fertility, Aachen, Abstract 30.
3. Bohmanova, J., I. Misztal, and J. B. Cole. 2007. Temperature-humidity indices as indicators of milk production losses due to heat stress. J. Dairy Sci. 90:1947–1956.
4. Bouraoui, R., M. Lahmar, A. Majdoub, M. Djemali, and R. Belyea. 2002. The relationship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate. Anim. Res. 51:479–491.
5. Brügemann, K., E. Gernand, U. König von Borstel, and S. König. 2012. Defining and evaluating heat stress thresholds in different dairy cow production systems. Arch. Tierzucht 55:13–24.

6. Cavestany, D., El-Whishy, A.B., Foot, R.H., 1985. Effect of season and high environmental temperature on fertility of Holstein cattle. J. Dairy Sci. 68, 1471–1478.
7. Do Amaral, B. C., E. E. Connor, S. Tao, M. J. Hayen, J. W. Bubolz, and G. E. Dahl. 2011. Heat stress abatement during the dry period influences metabolic gene expression and improves immune status in the transition period of dairy cows. J. Dairy Sci. 94:86–9
8. Novak, P., J. Vokralova, and J. Broucek. 2009. Effects of the stage and number of lactation on milk yield of dairy cows kept in open barn during high temperatures in summer months. Arch. Tierzucht 52:574–586.
9. Thompson, I. M., S. Tao, J. Branen, A. D. Ealy, and G. E. Dahl. 2013. Environmental regulation of pregnancy-specific protein B concentrations during late pregnancy in dairy cattle. J. Anim.Sci. 91:168–173
10. West, J. W. 2003. Effects of heat-stress on production in dairy cattle. J. Dairy Sci. 86:2131–2144
11. Wilson, S.J., Marion, R.S., Spain, J.N., Spiers, D.E., Keisler, D.H., Lucy, M.C., 1998a. Effects of controlled heat stress on ovarian function of dairy cattle: 1. Lactating cows. J. Dairy Sci. 81, 2124–2131
12. Wolfenson D. , Roth Z., Medina R. , 2000 impaired reproduction in heat-stressed cattle:
13. Basic and applied aspects Animal Reproduction Science 60–61_.535–547
14. Wolfenson, D., Flamenbaum, I., Berman, A., 1988. Hyperthermia and body energy store effects on estrous behavior, conception rate, and corpus luteum function in dairy cows. J. Dairy Sci. 71, 3497–3504.
15. Wolfenson, D., Thatcher, W.W., Badinga, L., Savio, J.D., Meidan, R., Lew, B.J., Braw-Tal, R., Berman, A., 1995. Effect of heat stress on follicular development during the estrous cycle in lactating dairy cattle. Biol. Reprod. 52, 1106–1113