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REVIEW ARTICLE

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HORMONAL CHANGES IN DAIRY COWS DURING PERIPARTURIENT PERIOD

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ABSTRACT

In the last month of pregnancy and the first weeks of lactation, intensive adaptations processes, both morphological and functional, take place in the cow's body. An organism adapts through changes in the intensity of metabolic processes and the activity of its regulatory mechanisms. Maintaining the homeostasis of an organism in prepartum and postpartum periods is the key condition in health maintaining of the mother and the foetus/calf. This paper presents studies on changes in the levels of progesterone, estrogens, androgens, placental lactogen, relaxin, pregnancy glycoproteins, prostaglandin F2α, cortisol, oxytocin, prolactin, GnRH, LH, FSH, thyroid hormones, insulin and growth hormone, significantly associated with the growth and development of the foetus, preparation of the mammary glands for lactation, and, after parturition, with reproductive system regeneration and preparation for new fertilization and pregnancy.

Key words: dairy cows, periparturient period, hormonal status

INTRODUCTION

Hormonal changes during periparturient period are abrupt. Optimal concentration of hormones is crucial for maintaining health of mother, fetus and calf, course of parturition without complications, initiation of lactation and preparation of mother's organism for new pregnancy [Kornmatitsuk et al. 2003, Kindahl et al. 2002, 2004; Skrzypczak et al. 2005, Herosimczyk et al. 2013, Kurpińska et al. 2014, 2015, 2016; Wankhade et al. 2017, Mikuła et al. 2018, Kurpińska et al. 2019, Lucy 2019]. The most important hormones involved in the regulation of pregnancy are: progesterone, estrogens, androgens, placental lactogen, relaxin, PAGs (pregnancy-associated glycoproteins). Hormones characterized by dynamic changes connected with parturition are: progesterone, estrogens, prostaglandin F2α, cortisol, oxitocin, prolactin, relaxin. In postpartum period further changes are observed in the concentration of all above-mentioned hormones. During pregnancy and lactation abrupt changes are also noted for GnRH (gonadotropin-releasing hormone), LH (luteinizing hormone), FSH (folicle-stimulating hormone), hormones of the hypothalamic-pituitary axis (prolactin, growth hormone – GH) and the hormones of ovaries, adrenals, thyroid a well as insulin [Convey 1973, Ceriani 1974, Desrivières et al. 2003].

PROGESTERONE

Progesterone is produced in cows by the corpus luteum, adrenal glands and placenta. Its purpose is primarily to maintain pregnancy. Progesterone is involved in the development of the mammary gland and the onset of lactation [Convey 1973, Kindahl et al. 2002, 2004].

According to Lopes et al. [2007] the concentration of progesterone in Holstein cows on the day of insemination was on average 0.225 ng · ml^{-1}. According to Edqvist et al. [1978] high progesterone levels are observed during the entire pregnancy in cows, however a gradual decrease is observed starting from the 60th day before calving. The average concentration of progesterone in the blood plasma of primiparous and multiparous Holstein cows a month before calving was 3.69 ng · ml^{-1} [Ożgo and Skrzypczak 2000]. Abrupt changes were noted 24–48 h before calving [Edqvist et al. 1978].

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The day before parturition concentration of progesterone in cows blood was 0.7 ng · ml^{-1}, and on the day of calving 0.05 ng · ml^{-1} [Henricks et al. 1972, Ożgo and Skrzypczak 2000]. The decrease in the concentration of progesterone before calving is necessary for uterine contractions, contributes to the onset of lactation, allows mammary epithelial to respond to lactogen complex (glucocorticoids and ACTH) [Convey 1973, Bernal 2001, Mastorakos and Ilias 2003, Kindahl et al. 2004]. Decrease in the concentration of progesterone at the end of pregnancy in cows is associated with cortisol-induced fetal enzyme activity – 17α-hydroxylase and C17,20 lyase – which catalyze the conversion of progesterone to androgens, which in turn is converted to estrogen. In addition, 2–3 days before calving luteolysis is also observed [Bernal 2001, Mastorakos and Ilias 2003, Kindahl et al. 2004].

Kindahl et al. [2004] reported that postpartum increase in the concentration of progesterone in cows is observed after the first ovulation. Cernescu et al. [2010] reported that until day 26 after calving, progesterone levels in the blood of Holstein-Friesian cows gradually increased from 0.48 to 1.61 ng · ml^{-1}, on the day 29 after calving reached similar values as on the day of calving (0.54 ng · ml^{-1}) and subsequently rising again until day 44 postpartum. According to Corah et al. [1974] a significant increase in progesterone levels was observed in postpartum beef cows, 3–5 days before the first heat, as a result of luteinization of maturing follicles, and/or progesterone synthesis in the adrenal glands. According to Stevenson and Britt [1979] lower concentration of progesterone was noted during the first estrous cycle in cows after calving in comparison to later cycles – which in turn may result in a shorter first estrous cycle.

ESTROGENS

The non-bound estrogens present in the blood of cows during pregnancy, parturition and lactation are represented by 17β-estradiol, estrone (in the maternal circulation mainly in the form of estrone sulfate) and estriol. They are synthesized in the placenta, ovaries and fetal membranes. Estrogens contribute to the growth of, *inter alia*, the myometrium, the actomyosin synthesis necessary for uterine contractions during parturition. The local increase in the concentration of estrogens (especially in the amniotic fluid), subsequently shifts the ratio of estrogen to progesterone and contributes to the initiation of the uterus contraction. Estrogens interact with relaxin and prepare the reproductive tissues for calving, additionally they stimulate the release of PGF2α from endometrium [Mastorakos and Ilias 2003, Kindahl et al. 2004].

An increase in the concentration of estrogens during the perinatal period in cattle is associated with the preparation of the mammary gland for lactation and increased enzymatic activity of the mammary gland [Convey 1973].

Takahashi et al. [1997] reported that twin pregnancy in cows result in higher concentration of estrone sulfate compared to singleton pregnancy in cows. This parameter increased rapidly in the third trimester of pregnancy and reached its peak on the day of calving (16.7 ng · ml^{-1}). Singleton pregnancy was characterized by gradual increase in the concentration of estrone sulphate, reaching its maximum 10 days before calving (7.1 ng · ml^{-1}) followed by a period of declining.

Higher concentration of estrone sulfate and other estrogens was noted from mid-pregnancy until the expulsion of placenta [Kindahl et al. 2002]. Convey [1973] stated that the rapid increase was observed in the last 2 weeks of pregnancy. In early lactation a rapid decline was noted.

Between day 14 before calving and the day of calving the estrogens concentration increased from 0.5 to 2.66 ng · ml^{-1}. In the last 5 days of pregnancy estrogens concentration increased gradually at a rate of 0.248 ng per day [Henricks et al. 1972]. The highest estrogen levels were recorded on the day of calving and during postpartum their concentration decreased [Kindahl et al. 2004]. After calving the highest concentrations are observed during the heat as a result of follicular development [Corah et al. 1974, Stevenson and Britt 1979].

ANDROGENS

Androgens are involved, *inter alia*, in the regulation of the ovarian follicle growth, regulation of the hypothalamic-pituitary axis and are precursor of estrogens. The androgens and estrogens are involved in the stimulation of prolactin secretion from the pituitary gland. The concentration of androgens in cows increases in the periparturient period. It is suggested that androgens increase during this period is associated with increased levels of estrogen [Wise et al. 1982].

Gaiani et al. [1984] reported that the concentration of androstenedione during the first trimester of pregnancy in Holstein-Friesian cows was approximately 0.1–0.2 ng · ml^{-1} on 200 day of pregnancy reached 1.4 ng · ml^{-1} and on this level was stable until the end of pregnancy. The concentration of testosterone until day 90 of pregnancy was approximately 0.02–0.05 ng · ml^{-1}, then steadily increases reaching the value of 0.22 ng · ml^{-1} on day 270 of gestation. Möstl et al. [1981] reported that in the last week of pregnancy in cows androstendion, epitestosterone and testosterone concentrations were relatively stable (0.92; 0.40; 0.90 ng · ml^{-1}, respectively). After calving their concentration rapidly decreases.

Safonov [2008] stated that the mean concentration of testosterone in Red Pied cows within the first month of lactation was approximately 2.6 ng · ml^{-1} with the highest value one day before estrus. The increase in the concentration of testosterone was also noted in the middle of the reproductive cycle. The increase in the concentration of androgens affects the occurrence of estrous behavior [Nessan and King 1981]. According to Kesler et al. [1979] during the heat testosterone concentration in dairy cows was appriximatelly 0.0463 ng · ml^{-1}, on the day 13 of the cycle, 0.0851 ng · ml^{-1}. On the other hand Kanchev and Dobson [1976] reported that the concentration of androstenedione levels in cows in the reproductive cycle does not increase and ranges from 0.08–0.1 ng · ml^{-1}.

PLACENTAL LACTOGEN

Placental lactogen, a glycoprotein hormone of lactogenic and somatogenic activity, is synthesized by the placenta. The process of transcription of mRNA for placental lactogen occurs in binuclear giant cells from day 30 until the end of pregnancy in cows. Its concentration in blood depends on the stage of pregnancy, placental weight, fetal weight, race, nutritional status. In cows during pregnancy this hormone is involved in the regulation of ovarian steroidogenesis, mammogenesis, lactogenesis, has luteotrophic action and is involved in the supply of the fetus with nutrients. It is believed that its action also increases milk productivity and mass in cows and promotes greater weight of the fetus/calves.

Concentration of placental lactogen increases during pregnancy, peaking during the third trimester, then falls from the day of calving. Placental lactogen can be detected in the blood plasma of the cows from 60 days of pregnancy and its concentration is maintained from 1.3 to 2.0 ng · ml^{-1}. After calving a steep decline in its concentration within 24 hours was noted [Schuler et al. 1988, Byatt et al. 1992, Wallace 1993, Patel et al. 1996, Ollivier-Bousquet and Devinoy 2005, Alvarez-Oxiley et al. 2008].

RELAXIN

The relaxin was isolated from cows corpus luteum in the third trimester of pregnancy, suggesting that the corpus luteum is the main source of relaxin in pregnant cows [Fields et al. 1980]. Relaxin is necessary for expanding the cervix and pelvic canal during calving, also inhibits the uterine contractions. Relaxin is involved in the process of luteolysis, affecting the concentration of progesterone, estrogen, oxytocin, prostaglandins F2α. In beef cows a few days before the calving the relaxin concentration was 0.29 ng · ml^{-1}, on the day of calving was greater than 0.8 ng · ml^{-1} [Anderson et al. 1982, Smith et al. 1997].

PREGNANCY ASSOCIATED GLYCOPROTEINS (PAGs)

PAGs are produced by mono-and-binuclear giant cells of placenta in cows. It was observed that they affect maternal recognition of pregnancy, trophoblast adhesion and implantation. Furthermore, they are a good indicator of embryo viability. It was reported that they may have local immunosuppressive effect, while maintaining a histological heterogeneity of feto-maternal tissues. They are involved in the formation and remodeling of placenta, as well as in the ecpulsion of the placenta after calving. They have an luteotropic, and luteopreventive action.

PAGs may be involved in postnatal growth of ovarian follicles, they induce the release of prostaglandin E2 from the corpus luteum and endometrium and progesterone release from the corpus luteum. Their greater concentrations are recorded in twin pregnancies [Zoli et al. 1992, Kiracofe et al. 1993, Austin et al. 1999].

PAGs synthesis begins after the tight connection formation between the trophoblast and the uterus. Their concentration is gradually increasing, with low levels (below 500 ng · ml^{-1}) noted until the second week before parturition in cows. In the last 10 days before calving their concentration triples, reaching the highest values between 1–5 days before calving, During postpartum gradual decrease was noted [Patel et al. 1997, Kindahl et al. 2002, Kornmatitsuk et al. 2003, Kindahl et al. 2004].

80–90 days after calving PAGs are not detectable in maternal blood [Haugejorden et al. 2006]. PAG's changes in concentration may be helpful in monitoring the health of the fetus in animals in which there is a risk that they may give birth to dead calves [Kornmatitsuk et al. 2004]. Kindahl et al. [2004] emphasized that PAG concentration is higher in fetus blood compared to the mother. According to Haugejorden et al. [2006], this compound also enters the bloodstream of neonatal ruminants in the uterus and is provided with colostrum.

PROSTAGLANDIN F2α

PGF2α is unstable prostaglandin and is metabolized to 15-keto- 13,14-dihydro-PGF 2α [Bernal 2001]. Maternal concentration of prostaglandins in cows is regulated by changes in the concentration of cortisol. The increasing estrogen to progestins ratio also stimulates the production of prostaglandins in the uterine tissues, and as a result, sensitizes the myometrium to the action of oxytocin.

The release of prostaglandins is necessary for luteolysis and onset of parturition. 10 days before calving average concentration of PGF2α metabolites in cows was 500 ng · ml^{-1} and subsequently increased contributing to prepartum luteolysis. The highest value is observed on the day of birth [Edqvist et al. 1978].

After calving, the release of PGF2α is higher for a period of about 2–3 weeks, but their concentration gradually decreases. The presence of PGF2α is essential for the involution of the uterus. Until it is released in large quantities, the cow is not ovulating [Kornmatitsuk et al. 2003, 2004; Kindahl et al. 2004].

PROLACTIN, SOMATOTROPIN AND OXITOCIN

Prolactin is necessary for the secretion of milk during lactation, is involved in the development, differentiation and function of mammary tissue, supports the function of the corpus luteum. It is related to the supply of nutrients and their disposal in the fetus [Knight 2001, Soares 2004, Ollivier-Bousquet and Devinoy 2005]. It was reported that prolactin is not involved in the regulation of the reproduction cycle in cattle [Bevers et al. 1988].

Higher concentration of prolactin during pregnancy were observed in cows with male fetus [Oxender et al. 1972]. The concentration of prolactin 2–4 weeks before calving was 50 ng · ml^{-1}, in the last 5 days of pregnancy an increase was noted. On the day of calving prolactin concentration was 234 ng · ml^{-1}. During the first 6 weeks of lactation decreased to 69 ng · ml^{-1}. [Edgerton and Hafs 1973]. Convey [1973] reported that in the first 90 days of lactation the prolactin concentration was 9 ng · ml^{-1}.

Somatotropin (GH) in cows affects laktopoesis and contributes, among other things, to increased hepatic gluconeogenesis, increased amino acid uptake and release of urea from liver, it also increases the deposition of proteins in the liver. The concentration of somatotropin increases before calving, reaching its peak on the day of calving, and then steadily decreases [Bell 1995, Grummer 1995, Etherton and Bauman 1998]. The concentration of growth hormone one month prior to calving was 3.5 ng · ml^{-1} [Leury et al. 2003]. Between 9 and 5 days before parturition an increase was observed with a significant increase during and immediately after calving, then a gradual decrease was noted [Convey 1973]. Leury et al. [2003] reported that GH concentration in cows on day 7 after calving was 4.6 ng · ml^{-1}. According to Bell et al. [2000] an increase in the concentration of growth hormone was observed in the early stages of lactation. According to Gabai et al. [2004] the concentration of GH in primiparous cows on the day 37 of lactation was 7.5 ng · ml^{-1}, on the day 50 of lactation 11 ng · ml^{-1}, on day 60 of lactation 7.8 ng · ml^{-1}.

Oxytocin is synthesized by the hypothalamus and released from the posterior pituitary. It is also synthesizeded by the large cells of the corpus luteum and luteal cells of uterus placnetoma. Oxytocin is, *inter alia*, necessary for the secretion of milk during lactation, stimulates the production of lipids, involved in osmoregulation, stimulates the synthesis of prostaglandins in uterus tissues. It is involved in the control of ovarian cycle – contributes to the regression of the corpus luteum. During sexual cycle in cows changes in the concentration of oxytocin are similar to progesterone. During pregnancy oxytocin is released intermittently and in small quantities [Flint et al. 1986, Fuchs et al. 2001, Ollivier-Bousquet and Devinoy 2005].

Before calving the frequency and the amount of oxytocin increases. A gradual increase in the concentration of oxytocin (The highest concentration was noted 5 minutes before calving), followed by the decrease in the concentration after the expulsion of placenta [Williams et al. 2001, Perumamthadathil et al. 2014].

GONADOTROPIN-RELEASING HORMONE (GnRH)

GnRH is a hormone produced in the hypothalamus. It stimulates the synthesis and release of LH and FSH, thus indirectly is involved in steroidogenesis and gametogenesis. GnRH is produced in response to increased concentrations of estrogen in the blood, in turn, increase the concentration of progesterone inhibits its secretion [Jadav et al. 2010]. Macmillan et al. [1986] reported that GnRH has the luteotropic effect.

GnRH concentration before calving is very low which and associated with the negative feedback between gonadotropins and high concentration of estrogen and progesterone [Rhodes et al. 2003]. After calving at first GnRH is secreted rarely and in small quantities [Peters and Lamming 1990]. According to Jadav et al. [2010] cows pituitary is able to respond to GnRH from day 20 after calving.

LUTEINIZING HORMONE (LH)

LH is primarily luteotropic hormone which stimulates the ovulation. The concentration of LH in late pregnant cows is subject to dynamic changes under the influence of GnRH [Little et al. 1982]. Very high levels of estrogen during pregnancy in cows suppresses the LH release. Before calving LH concentration is high, during postpartum LH concentration changes are characteristic for the sexual cycle in cows [Cernescu et al. 2010].

During the estrous cycle in cows LH release is associated with a reduction in the concentration of progesterone. The decrease in progesterone concentration is also observed before calving, which stimulates the secretion of LH [Edgerton and Hafs 1973]. It is worth noting that negative energy balance in cows contribute to the inhibition of LH secretion [Roche et al. 2000].

LH concentration during pregnancy in cows ranges between 0.7–1 ng · ml^{-1} and statistically significant changes were observed between the different trimesters of pregnancy [Oxender et al. 1972]. Edgerton and Hafs [1973] reported that LH concentration in the last month of pregnancy in cows was maintained at 0.5 ng · ml^{-1}, after calving increased up to 5–6 weeks to 1.5 ng · ml^{-1}. On the other hand Cernescu al. [2010] reported that the concentration of LH in Holstein-Friesian cows eight days before calving was 7.75 ng · ml^{-1}, at the day of calving 0.41 ng · ml^{-1}, on day 7 of lactation 0.84 ng · ml^{-1}, on day 14 of lactation 0.82 ng · ml^{-1}, on day 32 of lactation 0.86 ng · ml^{-1}.

During estrus in cows (about a day before ovulation) a high concentration of luteinizing hormone (42 ng · ml^{-1}) was noted, with subsequent decrease to a value of 0.5–1.7 ng · ml^{-1} at the peak of estrus [Arije et al. 1974]. Stevenson and Britt [1979] reported that there is a positive correlation between the increase in the concentration of estrogens in postpartum and stimulation of the production and secretion of LH, however GnRH-dependent release of LH is partially inhibited to about 10 days postpartum. The reduced secretion of LH during this period may be associated with a high milk production. According to Rhodes et al. [2003] The increase in the concentration of LH in postpartum cows was observed between 10 and 20 days after calving.

FOLLICLE STIMULATING HORMONE (FSH)

FSH is a hormone that stimulates follicular maturation. The concentration of FSH in the blood of cows during pregnancy s cycling subsidiary the follicle maturation cycles (0.1–1.2 ng · ml^{-1}) [Ginther et al. 1996]. Cernescu et al. [2010] reported that the concentration of FSH in Holstein-Friesian cows 8 days before calving was 2.41 ng · ml^{-1}, on the day of calving 2.21 ng · ml^{-1}, on day 7 of lactation 3.12 ng · ml^{-1}, day 14 of lactation 2.26 ng · ml^{-1}, day 32 of lactation 0.86 ng · ml^{-1}, day 44 of lactation 0.78 ng · ml^{-1}. The authors reported that the concentration changes are related to the maturation of ovarian follicles (characteristic for ovarian activity in estrous cycle).

THYROID HORMONES

Thyroid hormones are essential for the differentiation, growth and proper metabolism of the cells. Among other things, they have a significant impact on the regulation of the mammary gland, lactopoesis. They are involved in the initiation and stimulation of ovarian activity – in steroidogenesis in the follicles. Their high concentration is observed in late pregnancy. In cows exhibiting postpartum negative energy balance, lower concentrations of T3 and T4 hormones was noted. Low levels of these hormones were observed during the first three months of lactation, due to the fact that the concentration of T3 and T4 is negatively correlated with milk productivity [Capuco et al. 2001, Huszenicza et al. 2002, Jorritsma et al. 2003, Klimienė et al. 2008, Djoković et al. 2010, 2014, 2015]. According to Meikle et al. [2004] in the period from 30 days before to 60 days after calving a higher concentration of T3 in multiparous Holstein cows (0.89 ng · ml^{-1}) compared to primiparous (0.8 ng · ml^{-1}) was noted. T4 concentration also remained at a higher level in multiparous cows (33.41 ng · ml^{-1}) compared to primiparous cows (30.61 ng · ml^{-1}). The authors bind the fact with the observed metabolic problems in multiparous cows.

About a month before calving triiodothyronine concentration in cows was 2.42 nM · L-1 [Safonov 2008]. The concentration of T3 in Holstein-Friesian cows eight days before calving was 0.75 ng · ml^{-1}, on the day of calving 0.98 ng · ml^{-1}, on day 7 of lactation 1.05 ng · ml^{-1}, on day 14 of lactation 1.04 ng · ml^{-1}, on day 32 of lactation 0.96 ng · ml^{-1}, on day 44 of lactation 1. ng · ml^{-1} [Cernescu et al. 2010].

The concentration of thyroxine in Holstein-Friesian cows eight days before calving was 21.75 ng · ml^{-1}, on the day of calving 25.75 ng · ml^{-1}, on day 7 of lactation 24.56 ng · ml^{-1}, on day 14 of lactation 21.08 ng · ml^{-1}, on day 32 of lactation 24.58 ng · ml^{-1}, on day 44 of lactation 21.10 ng · ml^{-1} [Cernescu et al. 2010] .

CORTISOL

The cortisol concentration reflects the stress during calving [Kindahl et al. 2002]. Cortisol is, *inter alia*, an endogenous inhibitor of the effects of progesterone, it contributes to the conversion of progesterone to estrogens, affects progesterone-inactivating enzymes, which contributes to increase in the number of receptors for oxytocin and release of prostaglandins, which affects the date of parturition. The average concentration of cortisol during pregnancy in Holstein cows was maintained at 2–4 ng · ml^{-1}, the increase in the concentration was observed in the last days of pregnancy [Patel et al. 1996]. Two days before parturition cortisol level in cattle was 6.2 ng · ml^{-1}. The concentration of cortisol during calving was 19.2 ng · ml^{-1}, one hour after calving 11.2 ng · ml^{-1}. Three days postpartum cortisol returned to levels observed before pregnancy [Hudson et al. 1976, Mastorakos and Ilias 2003, Kindahl et al. 2004, Djoković et al. 2014].

Tauck et al. [2010] reported that on the second day after calving, the concentration of cortisol in the blood of primiparous beef cows was about 2 ng · ml^{-1}. In cows in lactation average cortisol concentration was 5.67 ng · ml^{-1} [Roussel et al. 1983].

INSULIN

Insulin is a hormone associated with the metabolism of nutrients. It is *inter alia* necessary for the production of milk proteins. The concentration of insulin before calving is higher than in the lactation and is negatively correlated with the milk productivity [Sano et al. 1991, Menzies et al. 2009]. Insulin, together with FSH and LH, stimulates steroidogenesis and proliferation of granulosa cells and thecal cells [Rhodes et al. 2003].

After calving the concentration of insulin is essential for the occurrence of estrus and ovulation in cows. The reduced concentration of insulin after calving is caused by the following factors: reduced energy consumption, low energy reserves, increased energy expenditure to produce milk, and diseases of the perinatal period [Rhodes et al. 2003]. Bell et al. [2000] reported that perinatal decrease in insulin concentration helps to enhance mobilization of amino acids from peripheral tissues.

Starting from 3 weeks before calving insulin concentration in cows gradually decreased from 0.3 to 0.05 ng · ml^{-1}. The concentration of insulin one month before calving was 1.8 ng · ml^{-1} [Leury et al. 2003]. Two weeks before the parturition its concentration in primiparous cows was 0.45 ng · ml^{-1}, postpartum decrease in the concentration was observed until the fourth week postpartum (approximately 0.32 ng · ml^{-1}), then a gradual increase was noted [Taylor et al. 2003]. According to Meikle et al. [2004] and Djoković et al. [2014] there were no differences in the profiles of changes in the concentrations of insulin in primiparous and multiparous cows.

CONCLUSION

In conclusion, morphological and functional changes that occur in a cows body during the last period of pregnancy and the first weeks of lactation require constant adjustments of several mechanisms that regulate their metabolism. This article addresses one of the above- mentioned alterations i.e. hormonal changes attempted at maintaining the homeostasis of pregnant cows. The efficiency of these processes depend on further health, and therefore the milk yield of cows and the regeneration of the reproductive system as well as preparation for new fertilization and pregnancy. Maintaining the cow homeostasis is also critical for proper fetal growth and development. The efficiency of neonatal adaptation, and in the longer term its productivity depends on the health of the newborn. Comprehensive knowledge of these issues is important not only for researchers, but also for breeding and veterinary practice.

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ZMIANY HORMONALNE U KRÓW MLECZNYCH W OKRESIE OKOŁOPORODOWYM

STRESZCZENIE

W ostatnim miesiącu ciąży i pierwszych tygodniach laktacji w ciele krowy zachodzą intensywne procesy adaptacyjne, zarówno morfologiczne, jak i czynnościowe. Organizm dostosowuje się poprzez zmiany intensywności procesów metabolicznych i aktywności mechanizmów regulacyjnych. Utrzymanie homeostazy organizmu w okresie przedporodowym i poporodowym jest kluczowym warunkiem utrzymania zdrowia matki i płodu/cielęcia. W pracy przedstawiono badania zmian poziomu progesteronu, estrogenów, androgenów, laktogenu łożyskowego, relaksyny, glikoprotein ciążowych, prostaglandyny F2α, kortyzolu, oksytocyny, prolaktyny, GnRH, LH, FSH, hormonów tarczycy, insuliny i hormonu wzrostu, istotnie związanych ze wzrostem i rozwojem płodu, przygotowaniem gruczołu mlekowego do przyszłej laktacji, a po porodzie z regeneracją układu rozrodczego i przygotowaniem do nowego zapłodnienia i ciąży.

Słowa kluczowe: krowy mleczne, okres okołoporodowy, status hormonalny

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