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PLASMA CONCENTRATIONS OF INSULIN-LIKE GROWTH FACTOR, TRIIODOTHYRONINE, THYROXINE, AND INSULIN IN COWS DURING DIFFERENT PHYSIOLOGICAL STATES

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Aim. To investigate the plasma concentrations of insulin-like growth factor (IGF, somatomedin C), triiodothyronine, thyroxine and insulin in cows during prepartum and postpartum periods. **Methods.** Enzyme-linked immunosorbent assay, clinical and statistical methods. **Results.** It was demonstrated that the plasma concentration of IGF, triiodothyronine, thyroxine, and insulin is lower in postpartum cows compared to the interlactation ones. Strong positive correlation dependence ($r = 0.7$) between the levels of thyroxine and somatomedin C was found on the 2nd–4th day after calving. The plasma concentration of all the investigated hormones increased in cows on the 10–14th day of postpartum period and remained stable until days 30–40. Strong correlation dependence between the levels of somatomedin C and insulin ($r = 0.7$) was found on the 10–14th day of the postpartum period. **Conclusions.** It was determined that somatomedin C is one of the energetic balance regulators in dairy cows.

Keywords: cows, hormones, insulin-like growth factor, somatomedin C, triiodothyronine, thyroxine, insulin.

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INTRODUCTION

Regardless of considerable impact of the endocrine system on the metabolism of ruminants, there are scarce publications, dedicated to the investigation of hormones. The main attention of authors is paid to the investigation of the sex hormone concentrations for different pathologies and physiological states. The insulin-like growth factor (IGF, somatomedin C) belongs to insufficiently studied hormones, while it is the most important endocrine mediator of the somatotrophic hormone activity, for which it is also called somatomedin [1–3]. It is somatomedin C that provides for practically all the physiological effects of somatotrophic hormone in peripheral tissues. In addition, it conditions the reverse connection of tissues to hypothalamus and hypophysis. This hormone was first described in 1957 [4], but since then it was actively studied only in humane medicine. The mentioned tissue hormone is synthesized by liver hepatocytes in response to the sensation of specific receptors. Practi-

cally all the activity of somatotrophic hormone in tissues is ensured by IGF. Somatomedin C is produced in the liver and penetrates into bloodstream, and therefrom, due to the mediation of proteins-carriers – tissues and organs [5]. However, the investigation of IGF concentration in the plasma of cows is scarce. There are interesting data [6], indicating the connection between the IGF concentration and hormones, responsible for the energetic supply of the organism.

Further study of the nature of high dairy productivity of cows requires the attention to the investigation of hormonal regulation mechanisms for metabolism in conditions of different physiological states of animals. The endocrine system of cows has the highest strain during the transition period from interlactation to lactation.

The aim of this work was to investigate the plasma concentrations of IGF, triiodothyronine, thyroxine and insulin in cows during prepartum and postpartum.

MATERIALS AND METHODS

The objects of the study were black-and-white Ukrainian dairy breed, 2–5th lactation, with the productivity of 5,100–5,700 kg of milk during the previous lactation. Animals were divided into four groups ($n = 5$) for subsequent general clinical investigations and blood sampling during critical physiological periods: 7–10th day prior to calving, 2–4-, 10–14- and 30–40th days after calving.

Blood sampling was conducted in the second decade of March. The blood samples were obtained from the jugular vein into sterile tubes with heparin prior to morning feeding. After obtaining plasma, the blood was centrifuged at 3,000 rpm. The obtained plasma was frozen at -20°C prior to the analyses. The plasma concentration of somatomedin C, triiodothyronine, thyroxine, and insulin was defined by the enzyme-linked immunosorbent assay using the test sets of DRG (Germany) and Orgentec company (Germany).

The samples were obtained with the consideration of “General Ethical Principles for Experiments on Animals” (Ukraine, 2001) and pursuant to the provisions of the European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes (Strasbourg, 1985).

The data obtained were processed in Excel program, defining the mean arithmetic value (M), the statistical error of the mean arithmetic value (m), the probability of the difference between mean arithmetic values of two variational series ($p <$) and the correlation degree between the indices (r).

RESULTS AND DISCUSSION

The results demonstrated that the concentration of IGF in blood plasma of postpartum cows decreased compared to the interlactation ones (Fig. 1). For instance, compared to the 7–10th day of prepartum period, the IGF concentration on the 2nd–4th day of lactation decreased by 29.3 % ($p < 0.05$). The secretion of somatotropin-releasing of the hormone and somatotropin increases with the low level of somatomedin C in blood, and decreases, when the latter is high [7, 8]. At the same time IGF regulates the secretion of somatostatin. A high level of IGF triggers the increase in the somatostatin secretion, and a low level – the decrease of the latter. However, its activity may be inhibited by insufficient consumption of the feed, insensitivity of the growth hormone, the absence of any

response of the receptors or the activity of the signaling pathway, which is below the required minimum. In addition, it was established that if there is shortage of IGF in blood, it may be produced in the very muscles [9].

It should be noted that after calving the concentration of triiodothyronine, thyroxine, and insulin decreases as well (by 54.2, 35.2 and 52.9 %, respectively; $p < 0.01$ – 0.001 ; Fig. 2–4). A low level of thyroid hormone allows decreasing the activity of using the energetic compounds in tissues and increasing their availability for the mammary gland. This is one of the mechanisms of energy re-distribution for the sake of milk formation [10, 11]. In addition, there is solid evidence [12–15] to the fact that a considerable amount of triiodothyronine and thyroxine is released with colostrum to stimulate the metabolism in calves.

The main reason of low concentration of insulin is considered to be a high level of non-esterified fatty acids [16, 17]. In addition, the decrease in the content of insulin in blood plasma of cows at the beginning of the lactation period is related to glucose deficiency, which quickly transforms into lactose in the mammary gland [18]. A considerable number of researchers [19–22] pay attention to the relation between the level of insulin synthesis and negative energetic balance, especially after calving. The matter lies in the registration of physiological insulin-resistance in ruminants in the postpartum period [20, 21, 23]. Therefore, the highest level of insulin (Fig. 4) was registered in cows during the prepartum period, which may be explained by the need of intensive accumulation of nutrient compounds in the depot.

It is noteworthy that on the 2nd–4th day after calving, the strong positive correlation dependence was found between the level of thyroxine and IGF ($r = 0.7$), and the average positive one – between the concentration of triiodothyronine and IGF ($r = 0.4$). The authors of works [6, 24] related the metabolism intensity to the activity of the thyroid gland via the mediator – IGF.

As seen from the presented results (Fig. 1–4), on the 10–14th day after calving, the concentration of the investigated indices in the blood plasma of cows increased. Namely, the IGF concentration increased by 64.2 % compared to the 2nd–4th day after calving ($p <$

< 0.01; Fig. 1), the concentration of triiodothyronine – 2.1-fold ($p < 0.001$; Fig. 2), and that of thyroxine – by 53.1 % ($p < 0.01$; Fig. 3). During this period of studies the concentration of insulin was found to be 37.3 % lower ($p < 0.05$) compared to the cows in the interlactation period (Fig. 4). At the same time the somatomedin C concentration was the highest for the whole experiment. It should be noted that on the 10–14th day after calving, the correlation dependence between the level of somatomedin C and thyroid hormone was weak ($r = 0.2–0.3$), whereas it was stronger regarding the level of insulin ($r = 0.7$). This fact may provide the conclusion about the close correlation between the energetic supply of the organism and the somatomedin C level. There are data [25] proving that the IGF level in blood depends on the impact of not only somatotropin hormone, but also sex steroid, thyroid hormones, glucocorticoids, and insulin on the liver. Insulin, androgens, estrogens increase the IGF secretion by the liver, while glucocorticoids decrease it. This is one of the reasons of the synergy of the impact of insulin, somatotropin, sex and thyroid hormones in terms of the processes of growth and development of the organism and the differentiation of tissues and one of the reasons of remarkable inhibiting impact of glucocorticoids on the growth processes [26, 27].

The data in the Fig. 1–4 allow for the conclusion that on the 30–40th day after calving, compared to days 10–14, the concentration of hormones changed insignificantly, except for thyroxine. For instance, the level of thyroxine ($p < 0.01$) increased by 38.3 % reliably (Fig. 3), reaching the highest index for the whole study period.

CONCLUSIONS

The plasma concentration of IGF, triiodothyronine, thyroxine, and insulin decreased in postpartum cows. Strong positive correlation ($r = 0.7$) dependence between the levels of thyroxine and somatomedin C was found on the 2nd–4th day after calving. The plasma concentration of all the investigated hormones increased in cows on the 10–14th day of postpartum period and remained stable until days 30–40. Strong correlation dependence between the levels of somatomedin C and insulin ($r = 0.7$) was found on the 10–14th day of the postpartum period. Thus, these facts allow for the conclusion that somatomedin C is one of the energetic balance regulators in dairy cows.

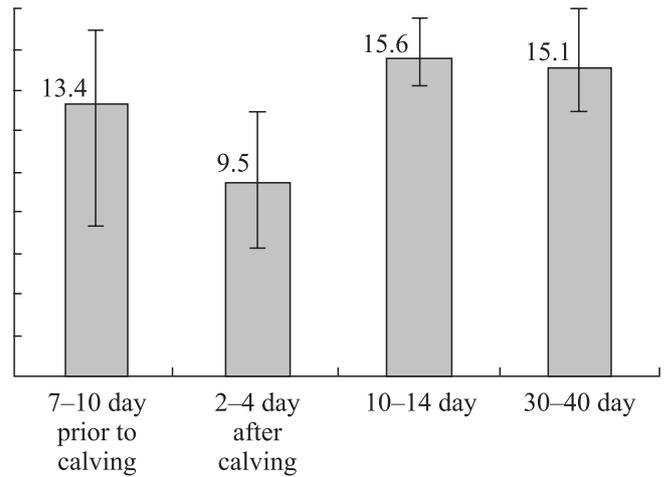


Fig. 1. The concentration of insulin-like growth factor in blood plasma of cows, nmol/l

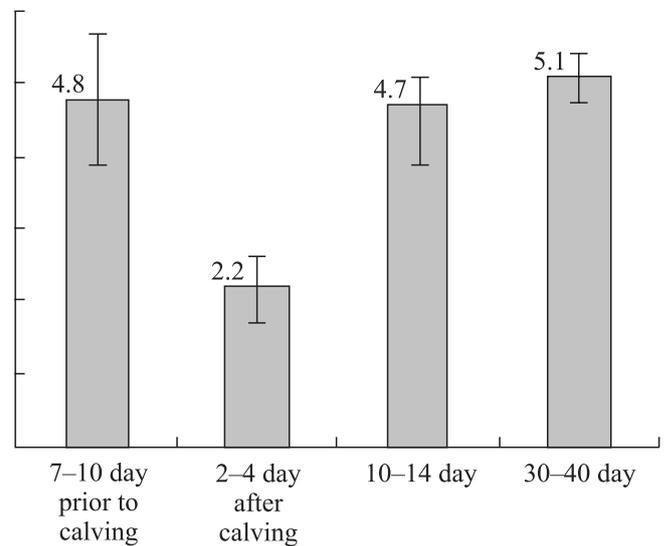


Fig. 2. The concentration of triiodothyronine in blood plasma of cows, nmol/l

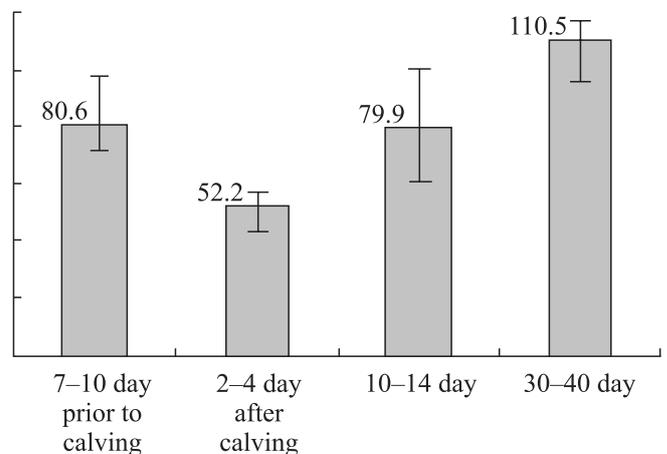


Fig. 3. The concentration of thyroxine in blood plasma of cows, nmol/l

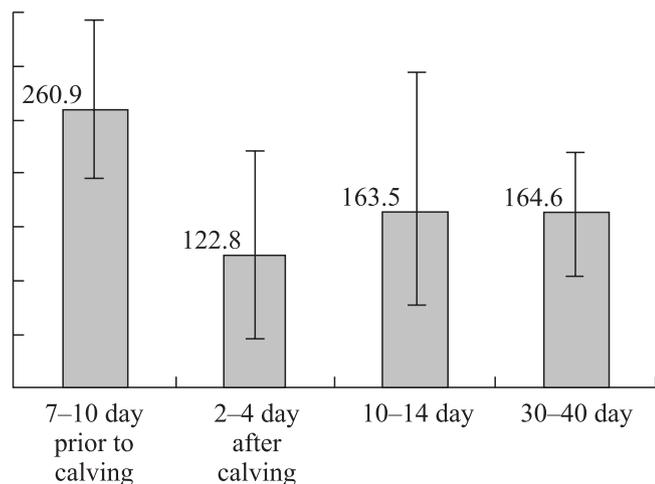


Fig. 4. The concentration of insulin in blood plasma of cows, pmol/l

Концентрація інсуліноподібного фактора росту, трийодтироніну, тироксину та інсуліну в плазмі крові корів за різних фізіологічних станів

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Мета. З'ясувати концентрацію інсуліноподібного фактора росту (ІФР, соматомедина), трийодтироніну, тироксину та інсуліну в плазмі крові корів у до- та післяродового періоду. **Методи.** Імуноферментний аналіз, клінічні та статистичні методи. **Результати.** Показано, що в плазмі крові корів після отелення порівняно із сухостійними знижується концентрація ІФР, трийодтироніну, тироксину та інсуліну. При цьому на 2–4-ту добу після отелення між рівнем тироксину та соматомедина знайдено сильну позитивну ($r = 0,7$) кореляційну залежність. На 10–14-ту добу після пологів концентрація всіх досліджуваних гормонів у плазмі крові корів зростала і була стабільною протягом 30–40 діб. На 10–14-ту добу після отелення виявлено сильну кореляційну залежність між рівнем соматомедина та інсуліну ($r = 0,7$). **Висновки.** Встановлено, що соматомедина є одним з регуляторів енергетичного балансу у молочних корів.

Ключові слова: корови, гормони, інсуліноподібний фактор росту, соматомедина С, трийодтиронін, тироксин, інсулін.

Концентрация инсулиноподобного фактора роста, трийодтиронина, тироксина и инсулина в плазме крови коров при различных физиологических состояниях

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Цель. Выяснить концентрацию инсулиноподобного фактора роста (соматомедина), трийодтиронина, тироксина

и инсулина в плазме крови коров в до- и послеродового периода. **Методы.** Иммуноферментный анализ, клинические и статистические методы. **Результаты.** Проведенные исследования показали, что в плазме крови коров после отела, по сравнению с сухостийными, снижается концентрация инсулиноподобного фактора роста, трийодтиронина, тироксина и инсулина. При этом, на 2–4 сут после отела между уровнем тироксина и соматомедина было установлено сильную положительную ($r = 0,7$) корреляционную зависимость. На 10–14 сут после родов концентрация всех исследуемых гормонов в плазме крови коров выросла и была стабильной до 30–40 сут. На 10–14 сут после отела было установлено сильную корреляционную зависимость между уровнем соматомедина и инсулина ($r = 0,7$). **Выводы.** Таким образом, можно констатировать, что соматомедина является одним из регуляторов энергетического баланса в молочных коров.

Ключевые слова: коровы, гормоны, инсулиноподобный фактор роста, соматомедина С, трийодтиронин, тироксин, инсулин.

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