SOME BIOCHEMICAL ASPECTS OF THE BREASTFEEDING PERIOD

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Abstract. *During lactation, the processes of maturation of many functions of the newborn's body intensively occur. During this period, it is especially important to identify the role of hormonal factors in the milk of a lactating mother in the development of sucklings. Currently, it has been proven that breast milk is the ideal food for a newborn. With mother's milk, it receives*

proteins, fats, carbohydrates, mineral salts, vitamins, immunoglobulins, physiologically important compounds, including growth factors, hormones, enzymes, and other components that are needed for growth and development. Breast milk cannot be replaced by any modern artificial milk formulas. Although additives that bring their chemical composition closer to milk are used during

production, milk formulas cannot perform the subtle regulatory functions that are performed by breast milk components [1–4]. The introduction of thyroid hormones or their deficiency in the body changes the content of many enzymes in both positive and negative directions [1, 2, 3]. We present data indicating the influence of the state of the thyroid gland of a lactating mother on indicators of enzymatic activity in the liver, as well as some development parameters in suckling rat pups. Hormones, enzymes, growth factors, and other components of breast milk ensure the proper development and formation of the child's body. Antibodies and immune complexes protect the baby from pathogens. Moreover, breastfeeding, if carried out over a long period of time, decreases the risk of allergies [5–8]. This review summarizes and systemizes data from literature on lactation and milk components, such as proteins, fats, carbohydrates, mineral salts, vitamins, enzymes, protective factors, and hormones. Human and cow milk composition is compared, as the latter is the main substrate for artificial milk formulas and supplemental feeding. The unique composition of human milk that ensures the proper development of the child is demonstrated.

Keywords: *lactation, α-glycerophosphate oxidase, T4, glucose, glycogen.*

Introduction. Lactation (the period of milk feeding) is a complex hormonally determined physiological process. It involves the entire maternal body and is ensured by the joint interaction of the maternal endocrine system (pituitary gland, thyroid gland, ovaries, pancreas, adrenal glands,

etc.) and the child. The formation of the mammary gland begins during puberty and continues during puberty and throughout woman's life [2]. Lactation is determined by four major proces-

ses (Fig. 1):

1) mammogenesis—development of the mammary gland;

2) lactogenesis—beginning of milk production after childbirth;

3) lactopoesis—maintenance of lactation after its beginning; during this stage, intense secretory reactions in the mammary glands occur;

4) galactokinesis—milk excretion (milk ejection), the main role in which belongs to oxytocin.

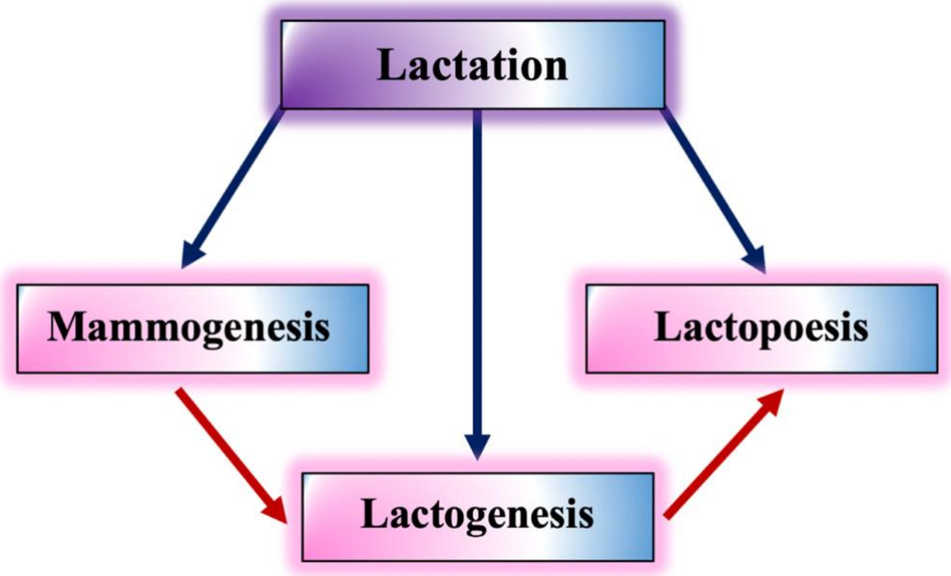

Fig. 1 Lactation is determined by four major processes

Humoral Regulation Milk synthesis is ensured by a number of hormones.In this process, an important role is played by progesterone, prolactin, chorionic somatomammotropin, hyroliberins, thyroxine, insulin, etc. Prolactin is needed for normal development of the mammary glands, milk synthesis, and lactation. It also controls the secretion of progesterone and inhibits the secretion of follicle stimulating hormone, ensuring a normal menstrual cycle [1,2]. Milk excretion is omoted by oxytocin that stimulates the contraction of myoepithelial cells surrounding the areola and ducts of the mammary glands. Because of this, milk, produced under the influence of prolactin, is released from the breast. During lactation, the synthesis of gonadotropic hormones is suppressed, which is linked to a blockade of the gonadoliberins release from hypothalamus. At the same time, blood levels of estrogens, especially progesterone, decrease, and changes in the production of other hormones are observed. Neuronal Regulation Neuronal regulation of lactation is exercised through the “sucking” reflex (Fig. 2), which is based on the reflex arc: irritation of the nerve endings of the nipple → afferent neuron of the spinal ganglion → associative efferent neurons of the lateral and intermediate nuclei of the spinal cord → efferent neurons of the sympathetic ganglia → postganglionic adrenergic fibers → myoepithelial cells of the mammary glands. Factors that Influence Lactation. Lactation is influenced by many factors: woman’s health, her nutrition during pregnancy and breastfeeding, daily work and rest schedules. During this period, mother’s nutrition should contain proteins, carbohydrates, fats, vitamins, and mineral salts. Sufficient amount of protein is of particular importance, as proteins are used for, among other things, the synthesis of enzymes, hormones, immunoglobulins, etc. [1, 2].

Materials and methods. The experiments were carried out on Wistar rats weighing 200-250 g. Thyroidectomy was performed on days 3-5 of lactation. Hyperthyroidism of a lactating female was caused by daily administration from days 1 to 21 of lactation of a solution of L-T1 in 0.05 N NaOH at a dose of 50 μg/100 g. Body weight. The control group was injected with an equivalent volume of solvent. The suckling rats were sacrificed on days 1, 5, 10, 15, 17, and 21 of the postnatal periods. To determine the activity of α-glycerophosphate oxidase, mitochondrial fractions were isolated from the liver using the generally accepted method [4] The level of T4 in the blood serum was determined by the radioimmunological method using Rio - T4 - PG sets, the glycogen content - by the anthrone method, the glucose level - by the glucose oxidase method using Glu enz Lachem (Czechoslovakia). Statistical processing of experiments was carried out using the method of Student.

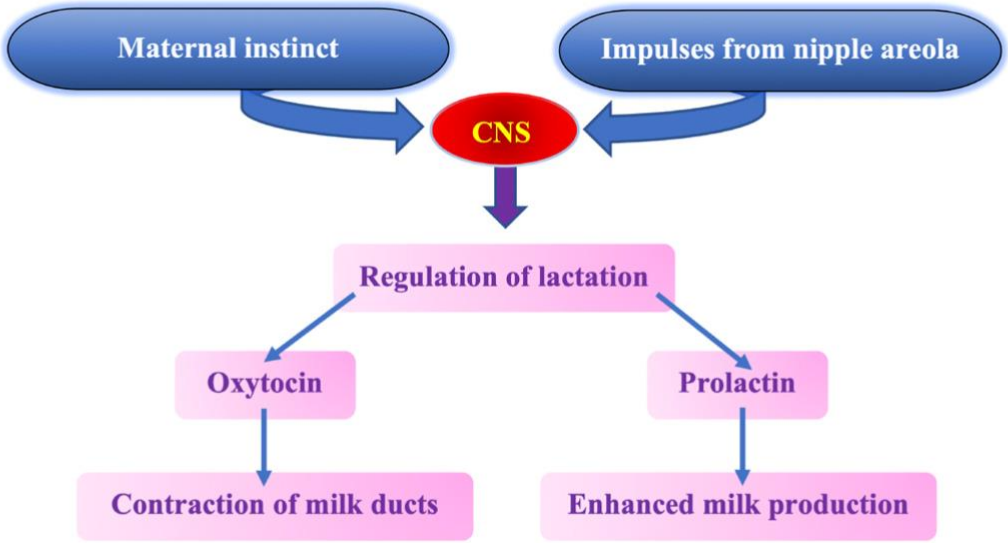

Fig. 2 Neuronal Regulation of lactation.

Results and its discussion. Thyroid hormones play a leading role in metabolism. Data on the levels of T3 and T4 content in human, rat, and cow milk vary greatly [34, 35, 38–40]. T4 and T3 concentrations in human and primate milk is 1.3 µg% and 301 ng%, while in blood serum they are 3 µg% and 204 ng%, respectively. Moreover, it has been shown that levels of these hormones in human milk significantly increase with the duration of lactation, as colostrum transitions to mature milk. Along with human and rat milk, cow milk and baby food products made on its bases were analyzed. It has been proven that T4 content in cow milk and baby food products is extremely low. This fact led to a number of studies on the level of thyroid hormones in milk and their role in the development of newborns with different thyroid status. T4 that enters the gastrointestinal tract of newborns with mother's milk overcomes the gastrointestinal barrier, enters the child's bloodstream, and is included in the thyroid balance and metabolic processes of the developing organism. T4 plays an important role in the formation of enzyme systems of the digestive tract [1-2].

Tab. 1

α - glycerophosphate oxidase activity (µA O2 in 1 min/mg protein) of liver mitochondria of suckling rat pups from sham-operated (control) and thyroidectomized (experimental) females

Lactation day	Control	Experiment	% to control
8	0,105 ± 0,0052	0,079 ± 0,0048	75
10	0,160 ± 0,01	0,096 ± 0,007	60
15	0,170 ± 0,01	0,119 ± 0,01	70
17	0,253 ± 0,02	0,30 ± 0,02	90
21	0,288 ± 0,019	0,286 ± 0,018	99

Note. The number of repetitions in all series is 5, * - the differences are significant.

The administration of high doses of T1 to a lactating rat, as well as its thyroidectomy, were reflected in the level of thyroxine in the blood serum of suckling rats. The content of the hubbub varied correlatively depending on the thyroid status of the lactating mother (Tab. 1). We present the results of measuring α - glycerophosphate oxidase activity (μA O2 in 1 min/mg protein) of liver mitochondria of suckling rats from sham-operated (control) and thyroidectomized (experimental) females.

As the duration of lactation increased, enzyme activity increased from 0.105 to 0.288 μA O2 per 1 min/mg protein. Thyroidectomy of a lactating rat led to a pronounced decrease in the activity of α-glycerophosphate oxidase in rat pups in experiments on days 8 and 10 of lactation. From the 15th day of lactation, the enzyme activity in the experimental group began to be restored to the control level and by the 21st day it no longer differed from the level in the group of rat pups born from a sham-operated female. In rat pups, the critical period of ontogenesis during which hormones are necessary for normal development, especially the central nervous system, occupies days of the week of life [5]. The main energy substrate for the central nervous system during this period is glucose [6]; therefore, changes in the state of carbohydrate metabolism in newborn rat pups can have certain consequences during further development. Our research data indicate a decrease in the concentration of serum glucose and glycogen in the liver of rat pups in response to maternal thyroidectomy. When T4 was administered at a dose of 12.5 γ to lactating rats, we observed a significant increase in the content of both glycogen in the liver and the level of glucose in the serum of suckling rats. Administration of T4 at a dose of 100 γ to lactating rats leads to an even greater decrease in glycogen content in the liver and glucose in the blood of rat pups than after thyroidectomy. These changes indicate that T4 has different effects on liver glycogen and blood glucose depending on the dose, as is the case with other effects of T4 [7].

Conclusions. Thus, the research results make it possible to expand the understanding of the mechanisms of disruption of the connection between the functional system “mother-fetus-newborn”, to highlight the most aggravated risk factors affecting the newborn’s body, to supplement existing ideas about the role of biologically active substances of milk in the early postnatal period and to prove the physiological necessity, at least for certain species of mammals, the intake of thyroid hormones with milk. Summarizing the reviewed data, the following points can be highlighted: After birth, the newborn has not yet completed the process of full development of individual organs, systems, and the entire organism as a whole. Maturation of the immune system, differentiation of the gastrointestinal tract, kidneys, and other organs continues in the postnatal period. Therefore, mother’s milk is most valuable for the nutrition of the child, especially during the first year of life. In the early postnatal period, the connection between the mother and metabolic processes of the child is maintained through milk.Mother’s milk cannot be replaced by any of the most modern artificial milk formulas. Despite the fact that additives that bring the chemical composition of formulas closer to breast milk are used during their production, these additives cannot perform those subtle regulatory functions that are performed by the components of human milk.

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