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COMPARATIVE ANALYSIS OF THE BIOCHEMICAL AND IMMUNOLOGICAL PROPERTIES OF BREAST MILK AND NAN OPTIPRO 1 FORMULA IN FEEDING INFANTS 0–6 MONTHS OF THE YEAR

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Abstract: Breast milk is the biological gold standard in infant nutrition. This article discusses the biochemical and immunological properties of breast milk and its comparative analysis with NAN OPTIPRO 1 infant formula. The study analyzed the quantitative indicators of the main macro- and microelements, bioactive substances, immunoglobulins, fatty acids, vitamins and minerals of breast milk based on scientific sources. It was also shown that, despite the composition of the infant formula close to breast milk, the immunological activity is limited in terms of bioavailability. The article substantiates the importance of exclusive breastfeeding for 0-6 months and the need to use infant formula only on medical indications. The results obtained confirm that supporting breast milk and encouraging breastfeeding have important scientific and practical significance in maintaining the health of infants.

Keywords: Lactoferrin, Whey, casein, Probiotic, nucleotides, fructooligosaccharides, Lysozyme, insulin, palmitic acid, Immunoglobulin A, Leptin, oligosaccharides, Cytokines.

Introduction: Breast milk is recognized as the first and most important nutritional factor in human life. In today's global health trends, breastfeeding is considered the most effective preventive measure for infant health and development. According to the recommendations of the World Health Organization, breastfeeding within the first hour of birth and exclusive breastfeeding for the first 6 months of life significantly reduces the risk of child mortality and morbidity[6]. This practice not only reduces the risk of chronic diseases and gastrointestinal infections, but also plays an important role in strengthening immunity. According to the results of recent national and international studies, only ~48% of infants aged 0–6 months are exclusively breastfed globally, which is very close to the 50% target set by the World Health Organization for 2025, but still falls short[7]. It has also been reported that infants who start breastfeeding within the first hour of pregnancy have a significantly lower risk of death (≈33% lower)[3].

The level of comparative study of prevention methods

Main macrocomponents	**100ml Mature breast milk**	**100ml ready-to-use NAN OPTIPRO 1 nutritional supplement**
Water	87–88 g	87 g
Energy	65–70 kkal	67 kkal

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Proteins (total)	0.9–1.2 g	1.24 g	
Fats (lipids)	3.5–4.5 g	3.58 g	
Carbohydrates (mainly lactose)	6.8–7.4 g	3.58 g	
Dry matter	12–13 g	12.9 g	
PROTEINS (PROTEIN FRACTIONS)			
Protein type	**Quantity**		
Whey proteins	0.6–0.8 g	0.87 g	70 : 30
Casein	0.2–0.4 g	0.37 g	
α-lactalbumin	0.12 g	-	
Lactoferrin	0.1–0.3 g	-	
Immunoglobulin A (IgA)	0.05–0.15 g	-	
Lysozyme	0.03 g	-	
FAT (LIPIDS)			
Components	**Quantity**		
Triglycerides	98% yog‘	98-99%yog’	
Saturated fatty acids	1.5–2.0 g	1.4-1.6 g	
Unsaturated fatty acids	2.0–2.5 g	1.9-2.1 g	
Olein (ω-9)	1.4 g	1.1-1.3 g	
Linoleic (ω-6)	0.4 g	0.58 g	
α-linolenic (ω-3)	0.05 g	0.06 g	
DHA (docosahexaenoic acid)	0.01–0.03 g (10–30 mg)	7.87 mg	
ARA (arachidone)	0.02 g	7.87 mg	
CARBOGADOGS			
Substance	**Quantity**		
Lactose	6.8–7.0 g	7.45 g	

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Oligosaccharides	1.0–1.5 g	0.03 g
Glucose + galactose	oz miqdor	-
VITAMINS		
Fat-soluble Vitamins	**Quantity**	
A (retinol)	50–60 µg	68.4 µg
D (cholecalciferol)	0.03–0.1 µg	0.97 µg
E (tocopherol)	0.2–0.4 mg	1.16 mg
K (phylloquinone)	0.2–0.4 µg	6.45 µg
In water solvents Vitamins	**Quantity**	
C (ascorbic acid)	3–5 mg	9.68 mg
B1 (thiamine)	0.01–0.02 mg	0.07 mg
B2 (riboflavin)	0.03–0.04 mg	0.14 mg
B6 (pyridoxine)	0.01 mg	0.05 mg
B9 (folate)	5–7 µg	9.68 µg
B12 (cobalamin)	0.03–0.05 µg	0.18 µg
Niacin (PP)	0.15 mg	0.58 mg
MINERALS (MICRO AND MACROELEMENTS)		
Element	**Quantity**	
Calcium (Ca)	25–35 mg	42.6 mg
Phosphorus (P)	12–15 mg	25.2 mg
Magnesium (Mg)	3–4 mg	5.68 mg
Sodium (Na)	7–15 mg	16.8 mg
Potassium (K)	50–60 mg	83.9 mg
Iron (Fe)	0.03–0.1 mg	0.63 mg
Zinc (Zn)	0.2–0.4 mg	0.7 mg
Copper (Cu)	0.04 mg	0.05 mg

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Iodine (I)	5–10 µg	14.2 µg
Selenium (Se)	1–2 µg	1.68 µg
BIOACTIVE SUBSTANCES		
Substance	**Function**	
Immunoglobulin A	Protection of the intestine from infection	-
Lactoferrin	Antibacterial	-
Lysozyme	Antibacterial	-
Cytokines	Immune regulation	-
Growth factors (EGF)	Intestinal maturation	-
Hormones (leptin, insulin)	Metabolic programming	-

Analysis and results; Breast milk and industrially produced infant formulas may look similar in appearance, but their biological essence is fundamentally different. Breast milk is a living biological fluid, the composition of which changes dynamically depending on the age of the baby, the duration of breastfeeding, and even the health of the child. NAN OPTIPRO 1 formula is a technological product, which has a strictly defined chemical composition and cannot interact biologically with the body. It is this difference that sharply distinguishes their physiological effects. In the case of proteins, the main difference is not in quantity, but in functional quality. Despite the relatively low total protein content in breast milk, these proteins have high biological activity. Lactoferrin binds iron, leaving pathogenic bacteria without iron, thereby reducing the infectious pressure in the intestine[1]. Secretory immunoglobulin A covers the intestinal mucosa with a thin protective layer and blocks the adhesion of viruses and bacteria to epithelial cells. Lysozyme directly breaks down the bacterial cell wall. These proteins are not only digestible, but also actively "train" the baby's immune system. The proteins in the NAN OPTIPRO 1 formula are mainly derived from cow's milk, which has lost its immunological activity during technological processing. Although the ratio of whey and casein is brought closer to that of breast milk, these proteins perform only structural and energetic functions, and are not able to transmit immune signals. Therefore, the intestinal immunity of a formula-fed baby remains passive and susceptibility to external infections is higher. In the case of fats, the difference is even deeper and manifests itself at the molecular level. The fatty acids in breast milk have a specific location in the triglyceride molecule, with palmitic acid located mainly in the sn-2 position[5]. This structure is ideal for intestinal lipases, ensuring complete breakdown of fat and preventing the formation of soaps that are insoluble with calcium. As a result, constipation is less common and calcium absorption is higher. In the NAN OPTIPRO 1 formula, fats are mainly derived from vegetable oils, and palmitic acid is located in the sn-1 and sn-3 positions[8]. This can lead to the formation of calcium soaps in the intestine, which can lead to stool hardening and reduced mineral absorption. Although long-chain polyunsaturated fatty acids

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such as docosahexaenoic acid and arachidonic acid are present in both sources, in breast milk they are in the form of phospholipids and are ready to be directly integrated into cell membranes. In formula, their amount is lower and their biochemical activity is lower. The most important difference from the point of view of carbohydrates is the oligosaccharide system in breast milk. Oligosaccharides are not energy substrates, but complex biological signals that "trick" pathogenic microorganisms, keeping them away from the intestinal epithelium, selectively growing beneficial bifidobacteria and suppressing the formation of allergic responses. Prebiotics, such as fructooligosaccharides in NAN OPTIPRO 1, act only as fermentable fibers, but cannot directly interact with immune receptors. Therefore, the intestinal microbiota in formula is more mixed and less stable. When it comes to vitamins and minerals, there is often a misconception. The amount of vitamins and minerals in formula is higher than in breast milk, but this is not an advantage. The trace elements in breast milk are bound to special carrier proteins and have a high bioavailability. For example, although iron is very low in breast milk, 50–70% of it is absorbed, while formula is rich in iron, but the absorption rate does not exceed 10–15% [2]. Excess unabsorbed iron can increase oxidative stress in the intestine and stimulate the growth of pathogenic bacteria. The most profound and irreversible difference is manifested in bioactive substances. Breast milk contains cytokines, growth factors, and hormones that provide long-term metabolic and immune programming to the infant. Hormones such as leptin and insulin modulate the appetite-satisfaction mechanisms and reduce the risk of future obesity[4]. Epidermal growth factor accelerates the maturation of the intestinal mucosa. These molecules are not present in the NAN OPTIPRO 1 formula because they are unstable under industrial storage and sterilization conditions. Probiotics and nucleotides can only partially fill this gap, but cannot fully replicate the biological signal.

Recommendations: Breast milk provides the baby with food, water, medicine, and protection all at once. Even in hot weather, the baby does not need additional water - breast milk is enough. Breastfeeding should not be stopped even during illness, because even if the baby has diarrhea or a cold, breast milk is the best medicine. Nutritional supplements should be used only when necessary, because they are not equal to breast milk, do not provide immunity, and if breast milk is not available, they should be used only if recommended by a doctor.

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