BREAST MILK - FACTORS THAT INFLUENCE ITS COMPOSITION

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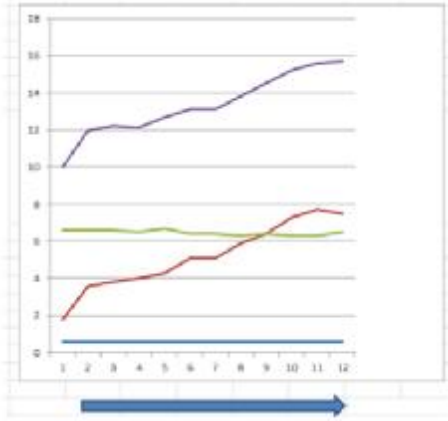
Abstract: *The breast milk has a composition which varies depending on a multitude of factors; these variations adapt perfectly to the infant's needs. Among the main nutrients, lipid concentration suffers most of the changes, especially 30 minutes after breastfeeding. The theory of fat globule adsorption to the mammary alveolar membrane is more considered a biological response than a physical one and reflects the physiological changes associated to milk secretion. The breast milk is a dynamic product, with macronutrients, micronutrients, bioactive factors, absolutely indispensable for the newborn and infant growth.*

INTRODUCTION

The breast milk has a composition that varies in terms of nutrition, during lactation, from mother-to-mother, between population, diurnal variation that perfectly adapts to the infant's needs.(1) For example, the milk that is expressed at the beginning is thinner, with a high lactose content, suitable for the need to hydrate the infant and during breast-feeding, it is creamier, with a higher fat content.(2)

A study of 12 breast milk samples at the beginning and at the end of the breast-feeding showed the following: the protein and carbohydrate concentration remains unchanged during breast-feeding; In contrast, the lipid concentration is significantly higher at the end of the breast-feeding.(3,4)

Figure no. 1. Nutrient concentration in breast milk at the beginning and at the end of breast-feeding



Legend: blue - protein; red - lipids; green - carbohydrate; purple - solid content (grams / 100 ml breast milk); the arrow indicates the beginning and the end of the breast-feeding.

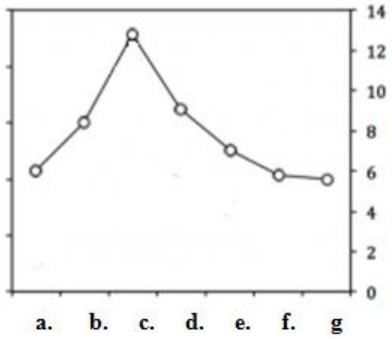
The breast milk at the end of breast-feeding is richer in beta casein, osteopontin, as1-casein and MUC1 proteins. Also, the time since the last breast-feeding, as well as the amount of breast milk from the last breast-feeding, seem to influence the lipid concentration of the breast milk at the next meal.(3)

The highest lipid content was identified 30 minutes after the end of the breast-feeding, the concentration gradually decreasing with the dairy secretion required for the next breast-feeding. Interestingly, the rate of decrease in lipid concentration after 30 minutes differs from mother to mother.

The fact that the lipids increase their concentration immediately after the end of the breast-feeding is due to the theory of fat globule adsorption to the alveolar cell membranes and they are released only when the mammary gland is almost empty.

Only this theory is not shared in the case of proteins. Consequently, a more biological response than a physical one is a more attractive mechanism to the changes observed in breast milk composition when breast-feeding.(5)

Figure no. 2. Changes in lipid concentration in breast milk depending on the breast-feeding moment



Legend: On the horizontal axis there are indicated are the moments before and after breast-feeding (a. Before breast-feeding b) the end of breast-feeding c. 30 minutes after breast-feeding d. 1 hour after breast-feeding 1.5 hours after breast-feeding f. 2 hours after breast-feeding, 2.5 hours after breast-feeding); the vertical axis shows the lipid concentration (%) corresponding to each moment).

The question was also whether these larger, than initially thought, changes in breast milk are beneficial to the infant or they simply reflect the physiological changes associated with dairy secretion.

Changes in the composition of breast milk are limited

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by mobilizing maternal nutrition stocks, as well as by changing the infant's needs, resulting in personalized breast milk that reflects balance in maternal diet, the metabolism, the transport and dairy secretion and that meets the infant's growth and evolution requirements.

Increasing the concentration of the lipids at the end of breast-feeding is involved in the control of appetite on short term, as well as in the development of the appetite's control system for infants.(6)

However, changes in the milk composition from the beginning to the end of breast-feeding are not considered to be significant in the end.

Breast milk contains 87% water, 1% protein, 3.8% lipids and 7% lactose, the latter providing the highest proportion of energy and it also helps in the development of the central nervous system.(2)

The most significant macronutrient is represented by the protein, in proportion of 0.9 to 1.2g/dL, with certain variations during lactation.

The proteins are represented by whey and casein fractions. While the proportion of protein in breast milk fluctuates according to the needs of the infant (the whey being much easier to digest), in the cow's milk there is a much higher concentration of casein than whey, which makes them much more difficult to digest.(2)

The whey, by its alpha-lactalbumin, lactoferrin and Ig A composition, has a significant, bioactive, anti-infective and protection function of the intestinal mucosa. It is found, however, in a reduced proportion in cow's milk, namely 18%.(2)

Casein is represented by fractions α-, β- and κ- and it is found to be in a proportion of 13% (the almost lowest concentration of any species that were studied).

The mucins of the milk are founded into the membrane of fat cells.(7,8)

Non-protein azote (nucleotides, amino acids, free peptides) represent 25% of the whole quantity of nitrogen in breast milk. In terms of the role of fats contained in breast milk, arachidonic acid, eicosapentaenoic acid and docosahexaenoic acid, acids derived from the two essential fatty acids - linoleic acid and alpha-linolenic acid, they interfere with infant growth in inflammatory responses, in immunity, sight, cognitive development and motor system development.(2) It is the main source of energy, contributing to 44% of energy released by the breast milk.

The lipids are formed by fat globules which are dispersed in that form and containing a non-polar lipid nucleus, triacylglycerols founded in endoplasmic reticulum from mammary epithelial cells. Therefore, the membrane of globule, the fat one, from milk contains bioactive factors, in large quantity, such as glycerophospholipids, some sphingolipids, also sphingomyelin, much glycolipids and cholesterol, and not the last, proteins which are glycosylated.(9)

Triacylglycerols represent 98% of fat from breast milk with the properties largely affected by their composition in fatty acids.

Breast milk contains over 200 fatty acids that are found in variable concentrations. The palmitic acid represents the main of fat acids, saturated ones.

Long-chain of fatty acids, the polyunsaturated-chain, are affected, in a major way, by the diet of mother.

Approximately 75% of the linoleic acid contained in the breast milk is derived directly from the diet, while 30% is provided from maternal deposits, which are quickly transferred in case of diminishing the intake of foods. So, the changes of maternal diets lead to changes in maternal deposits, if the changes persist.(10,11)

In breast milk, the two important carbohydrates, lactose and oligosaccharides, are part of the non-nutritive bioactive molecules.(1)

The lactose concentration in breast milk (6,7 g per 100 mL) exceeds from the concentration of the others (e.g. species) and reflects the increased nutritional requirements of the brain of human body.(7) On the other hand, the lactose, as a main galactose source, is very important component, inclusively in the development promoting of the whole (central) nervous system. Oligosaccharides (1 up to 10 g/L in mature form of milk and 15 up to 23 g/L in the colostrum form of milk) are present in a fucosylated (35-50%), glyco-engineering (12-14%) or neutral, non-fucosylated form (42-55%).

The specific composition of oligosaccharides can be significantly affected by maternal genetic factors.(12,13,14)

The different composition of the oligosaccharides is due to the specific enzyme (the transferase one) which is founded in the milk lactocytes. The 2 genes responsive by the modelling of this composition are: Secretor Gene Group and Lewis Gene one. This variation is known as an hypothese of oligosaccharide composition that may support human survival, because pathogens have different affinity depending on the specific oligosaccharide structures.(15,16,17)

Some experimental studies have demonstrated that one type of oligosaccharide is highly protective, especially against of necrotizing enterocolitis risk.

Oligo-saccharides work like prebiotics, also as a metabolic substrate for bacteria, thus ensuring the "good" bacteria growth, such as Bifidobacterium and Bacteroides. Furthermore, it modulates several infected mucous and systemic immune functions.

Absorbed in the blood, it affects the binding of monocytes, lymphocytes and neutrophils and the formation of thrombocyte and neutrophil as a complex.

Also has been suggested that the complex can manage certain function of modulations, concerning on growth and development of some organs, other those of the intestine.

In addition to macronutrients, breast milk contains a significant number of micronutrients, such as: vitamins A, B1, B2, B6, B12, D and iodine, which participate in a multitude of biological functions.(1)

Vitamin D and K are found to be insufficient in breast milk, leading to rickets and coagulation disorders, compared to milk in formula with a significantly higher (vitamin D) content.(2) Therefore, in the case of natural nutrition, it is recommended to supplement these two vitamins.(1)

The breast milk, rich in the small RNA molecules, can regulate the gene of expression of post-transcriptional kind of level, can modulate the multiple cellular functions of cell cycle, the proliferation, and also the differentiation, the apoptosis and the immune response.(18)

Breast milk is identified as the most important and the first probiotic, due to the diversity of microbial kind of community, that includes over two hundred of phylotypes.(19) By the way, the question about how bacteria is reach in the mammal gland has not yet a good enough response, also why is ultimately incorporated into breast milk. Some studies are suggested the theory of an entero-mammary pathway which brings bacteria (presented in maternal intestine to the mammary gland through lymphatic and blood circulation.(20)

Recent research also indicates that breast milk contain not the only immune factors, also the non-immune factors, as the stem cells. The most specific role (mainly, functional) linked with the stem cells is a challenge, not yet well known; finally,

the finding demonstrated the possible benefits of evolution for the new-born that is breast-fed.

CONCLUSIONS

1. Breast milk is a dynamic, multi-facets product that contains nutrients and bioactive factors, necessary for the health and evolution of the infant.
2. Its composition varies depending on the stage of lactation and between prematurely born infants and term infants.
3. While there have been performed many studies on the composition of breast milk, its components are still being identified, multi-population studies leading to a better understanding of the role of breast milk in the health and evolution of the infant.

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