

Variation of Metabolite and Hormone Contents in Human Milk



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KEYWORDS

• Metabolite • Amino acid • Leptin • Insulin • Body mass index • Human milk

KEY POINTS

- Animal studies show that the lactation period contributes to metabolic programming of offspring health and bioactivity of orally ingested leptin and insulin.
- Levels of many small molecules in human milk are influenced by stage of lactation.
- Variability of small molecule concentrations seems higher in preterm milk than in term milk.
- Maternal body mass index influences milk leptin levels.

Human milk (HM) is the optimal nutrition for infants born at term during the first months of life by itself and thereafter in combination with complementary feeding¹ and for pre-term infants if fortified with protein and other nutrients.^{2,3} HM is a complex mixture of nutrients with variable composition. The energy content shows large interindividual variation from 50 to 86 kcal/100 mL (mean [M] \pm 2 standard deviation [SD]), as determined in a recent meta-analysis.⁴ The variance of the energy content primarily reflects high variation of the fat content but also protein and, to a lesser extent, lactose contents as shown in the analysis of 2554 expressed HM samples in Denmark (Table 1).⁵ Milk changes with duration of lactation, in particular protein content decreases (Fig. 1) whereas fat content increases.⁶ Other factors associated with variation in milk composition include duration of gestation, maternal diseases such as diabetes mellitus or malnutrition, genotype, and maternal diet.⁷ Energy and macronutrient supply to the breastfed term infant may modulate growth and body composition. For example, higher contribution of protein to total milk energy content at 4 to 8 weeks of lactation has recently been found to predict a higher body mass index at the age of 1 year (Fig. 2).⁸

Disclosure Statement: The authors have nothing to disclose.

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Table 1 Variation of macronutrient and energy content in 2554 human milk samples collected from 224 mothers						
Percentiles (%)	2.5	10	50	90	97.5	Ratio 97.5/2.5
Protein (g/L)	6.3	6.9	8.6	11.4	14.3	2.3
Fat (g/L)	18.4	23.8	36.1	54.6	89.0	4.8
Lactose (g/L)	64.2	68.4	72.4	75.2	76.5	1.2
Energy (kcal/L)	500	557	668	840	1115	2.3

Modified from Michaelsen KF, Skafte L, Badsberg JH, et al. Variation in macronutrients in human bank milk: influencing factors and implications for human milk banking. *J Pediatr Gastroenterol Nutr* 1990;11(2):229–39.

More information has become available in recent years on the concentrations of small molecules and hormones in HM and their variability. This article aims to identify recent information obtained on a broader spectrum of the small molecules in milk by searching the Web site “Web of Science” (Available at: <http://www.ipscience.thomsonreuters.com/product/web-of-science/>. Accessed September 15, 2016) for articles identified by the keywords “metabolomics” and “human milk OR breast milk” (45 articles) and the references in the articles deemed relevant. The discussion of hormones in milk is limited to leptin and insulin, although the presence of a series of further hormones and their potential relevance for the infant has been described. The studies mentioned were identified from the review by Andreas and colleagues⁹ or from a “Web of Science” search for articles published after 2014 matching the search terms (human milk OR breast milk) and (insulin OR leptin).

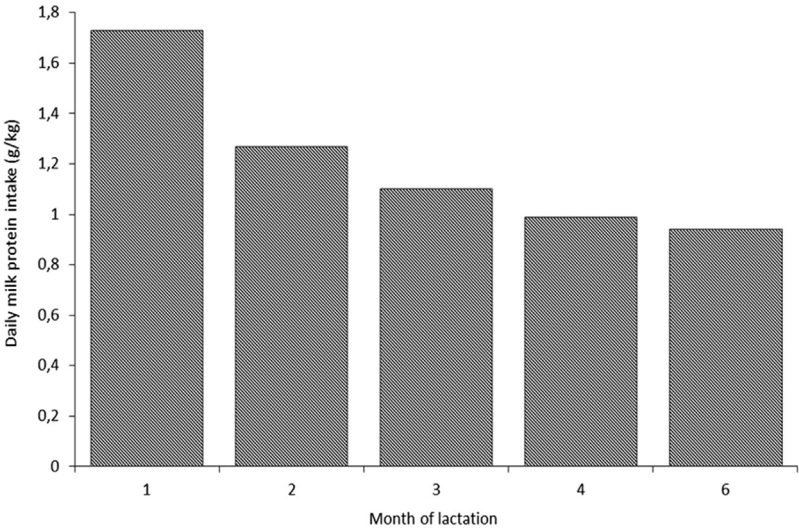


Fig. 1. During the first 6 months of lactation, the protein supply to an exclusively breastfed infant decreases to about 55% of the initial values due to decreasing milk protein concentration. Milk protein intake is calculated as 75% of crude protein intake. (Data from World Health Organization. Protein and amino acid requirements in human nutrition. World Health Organ Tech Rep Ser 2002;935:265.)

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