Certain proteins in breast milk found to be essential for a baby's healthy gut

September 13 2023

Credit: CC0 Public Domain

More than 320 million years of mammalian evolution has adapted breast milk to meet all the physiological needs of babies: It contains not only nutrients, but also hormones, antimicrobials, digestive enzymes, and growth factors. Furthermore, many of the proteins in breast milk, for example casein and milk fat globule membrane proteins, aren't just

sources of energy and molecular building blocks, but also directly stimulate immunity, at least under preclinical conditions.

Likewise, the gut microbiome, composed of bacteria, archaea, and fungi, plays a vital role in the regulation of the immune system. This raises the possibility that the immune-boosting function of breast milk proteins might be two-pronged: not only by stimulating the immune system directly, but also indirectly, by regulating the abundance of gut microbes which in turn impact immunity.

Now, a study by Chinese researchers in *Frontiers in Microbiology* finds the first evidence for the latter, roundabout, immunity-regulating function of breast milk proteins. The authors showed that variation in the protein composition of breast milk between mothers explains much of the variation in the abundance of key beneficial microbes in the gut of their babies, suggesting a regulatory role of these proteins on the immune function of the gut microbiome in humans.

"Here we show that the concentration of certain proteins in human breast milk predicts the abundance of specific gut microorganisms in infants, which are known to be important necessary for health," said joint senior author Dr. Ignatius Man-Yau Szeto from the Yili Maternal and Infant Nutrition Institute in Beijing. "These findings suggest that maternal proteins play a role in the early immune and metabolic development of immunity of babies."

Szeto and colleagues studied the association between the protein composition of 23 Chinese mothers—measured by ultra-performance liquid chromatography-mass spectrometry—and the diversity and abundance of beneficial gut microbes in the stools of their infants, determined through rRNA sequencing and quantitative real-time PCR.

Focus on nine proteins

"We focused on nine milk proteins, including osteopontin, lactalbumin, and κ-casein, because these were recently found to benefit the early development of infants. Their function and mechanisms haven't yet been fully discovered, so we wanted to examine their potential role in regulating the microbiome of infants," said co-senior author Dr. Ai Zhao from Tsinghua University.

The concentration of proteins in breast milk was 1.6% at 42 days after delivery, and 1.2% at three months after delivery. The most abundant proteins were casein, α-lactalbumin, and lactoferrin. Except for immunoglobulin A (an antibody important for the immune function of mucous membranes), the concentration of all studied proteins decreased from 42 days to three months post-partum. The gut microbiome of the babies was mainly composed of the bacterial genera Bifidobacterium, Escherichia, Streptococcus, and Enterobacter.

Link to probiotics

The researchers found the strongest associations between the concentrations of breast milk proteins and two beneficial bacteria that were relatively rare within the gut microbiome of the babies: Clostridium butyricum and Parabacteroides distasonis, both used as probiotics for humans and domestic animals.

For example, variation in the concentration of κ-casein in mother's milk explained much of the variation in abundance of C. butyricum in the gut of their babies, while variation in the concentration of osteopontin explained much of the variation in abundance of P. distasonis. The first of these bacteria is known to regulate gut homeostasis and combat inflammatory bowel disease. The second, to counter diabetes, colorectal cancer, and inflammatory bowel disease in humans.

"The results of this study suggest that specific proteins in breast milk can influence the abundance of certain gut microbes in infants, playing an important role in early immune and metabolic development," concluded the authors.

The authors cautioned that further studies are necessary.

"Our findings are based on correlations, which are not enough to establish a direct causal effect. Future cohort studies and clinical trials, where breast milk or formula is fortified with functional proteins, are needed to prove this," said Szeto.

More information: Functional proteins in breast milk and their correlation with the development of the infant gut microbiota: A study of mother-infant pairs, *Frontiers in Microbiology* (2023). DOI: 10.3389/fmicb.2023.1239501

Provided by Frontiers