SOUTH ASIA PEDIATRIC ASSOCIATION

SUMMARY: LACTATION TO HEALTH: THE ROLE OF BIOACTIVES IN HUMAN MILK

Editor: Dr Arun Wadhwa (MD - Pediatrics), ACVIP Member, 2020 & 2022, Delhi
Expert Reviewer : Dr Jamal Raza, Executive Director, Sindh Institute of Child Health & Neonatology, Pakistan

The Role of Bioactives in Human Milk

Human milk bioactives enhance breastfeeding benefits beyond nutrition, impacting infant health, immunity, and development. These active molecules—proteins, carbohydrates, and lipids—are essential during rapid neonatal growth. Infant formula cannot match the complexity or functionality of human milk, highlighting its unique value.

Key Types of Human Milk Bioactives

1. **Proteins and Peptides**
   - **Lactoferrin:** Inhibits bacterial growth by binding iron and supporting immune cell activity.
   - **Secretory IgA (sIgA):** Protects the gut lining, preventing pathogen adhesion.
   - **Lysozyme:** Enhances microbiome health by combating infections.
2. **Carbohydrates**
   - **Human Milk Oligosaccharides (HMOs):** Unique prebiotics that nourish beneficial gut bacteria and act as decoys to trap pathogens.
3. **Milk Fat Globule Membrane (MFGM)**
   - Supports brain development and immune function with bioactive proteins and lipids.
4. **Cytokines and Growth Factors**
   - **EGF & TGF-β:** Promote gut health and immune tolerance, reducing allergy risks.
5. **Hormones and Cellular Components**
   - **Leptin:** Helps regulate metabolism and reduce obesity risks.
   - **Exosomes and miRNAs:** Contribute to immune and developmental pathways

Mechanism of Action

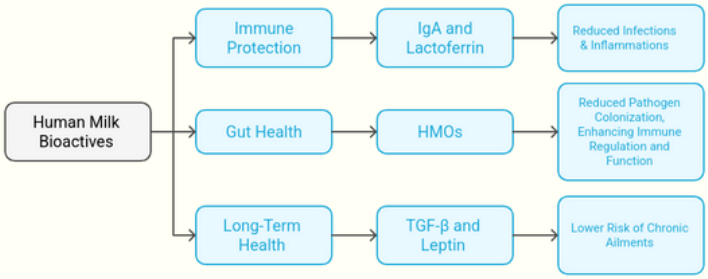
- **Immune Defense:** Bioactives like sIgA and lactoferrin neutralize pathogens and enhance immune response.
- **Gut Health:** HMOs foster beneficial gut bacteria and block harmful microbes.
- **Cognitive Growth:** MFGM aids in brain development and myelination.
- **Long-Term Benefits:** Components like leptin and TGF-β reduce risks of chronic conditions, including obesity and allergies.

Challenges in Replicating Bioactives

- **Structural Complexity:** Synthetic HMOs and bioactive proteins only partially mimic their natural counterparts.
- **Missing Components:** Essential bioactives like exosomes, miRNAs, TGF-β, and sIgA remain absent in formula due to technical limitations.
- **Reduced Bioactivity:** Bovine-derived proteins in formula lack the efficacy of human proteins.

Conclusion

Human milk is unparalleled in providing comprehensive nutrition and immune protection through its bioactives. While formula has made advancements, it cannot fully replicate the benefits of human milk, reinforcing breastfeeding as the gold standard for infant health.



Benefits of Bioactives on Infant Health

Feature	Human Milk Oligosaccharides (HMOs)	Mainstream Prebiotics
Targeted Bacteria	*Bifidobacteria infantis*, specific to neonates	Broad spectrum (*Bifidobacteria*, *Lactobacillus*)
Dual Functionality	Prebiotic + Decoy receptor	Prebiotic only
Structural Diversity	Over 200 types	Limited (FOS, GOS, inulin)
Immune Modulation	Direct and indirect	Indirect via SCFAs
Tailored for Neonates	Yes	No (Designed for general use)

Comparison of HMOs and Mainstream Prebiotics in Infant