

Mammary Lactogenesis Mechanism, Factors and Effects Towards Human Milk Long-Chain Fatty Acids (HM LC-PUFA)

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Structured Abstract

Background: Lactogenesis is a crucial physiological process involving the synthesis of human milk, rich in bioactive lipids that support infant development. Among these, long-chain polyunsaturated fatty acids (LC-PUFAs) such as DHA and ARA are essential for neurodevelopment and visual acuity. The mammary gland contributes significantly to milk fat composition through de novo lipogenesis (DNL), which synthesizes short- and medium-chain fatty acids while also influencing the incorporation and modification of LC-PUFAs. Understanding how DNL is regulated and how its disruption affects maternal and infant health is critical for advancing lactation science.

Methods: This critical review synthesized findings from peer-reviewed literature between 2014 and 2024, utilizing databases including PubMed, ScienceDirect, and Scopus. Keywords included “mammary de novo lipogenesis,” “human milk fatty acids,” and “maternal metabolism.” The analysis was structured around five core research questions covering DNL mechanisms, influencing factors, metabolomic detection methods, and impacts of DNL dysfunction on infant outcomes.

Results: The review identified hormonal (e.g., prolactin, insulin, cortisol) and nutritional (e.g., maternal BMI, dietary intake) factors as primary regulators of mammary DNL. Disruption in DNL due to insulin resistance or poor diet results in altered milk fat composition, lower DHA and ARA levels, and increased omega-6: omega-3 ratios, with downstream risks to infant cognitive and immune development. Metabolomic profiling techniques, especially UPLC-MS/MS, enable precise detection of LC-PUFAs and their DNL-derived precursors, offering insights into maternal-infant nutritional pathways. Abnormal DNL activity also presents psychological and physiological challenges for mothers, potentially shortening lactation duration.

Conclusion: Mammary DNL plays a pivotal regulatory role in determining the composition and functional quality of human milk lipids, especially LC-PUFAs. Disruption in this process has serious implications for maternal health and infant neurodevelopment. Advancing our understanding of DNL regulation and promoting maternal metabolic health can improve breastfeeding outcomes and support public health strategies for maternal-infant care.

Keywords: Mammary DNL, LC-PUFA, Human Milk, Maternal Metabolism, Infant Development

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