

Curcumin and Sperm Biology: From Cryopreservation Defense to Genetic Regulation

Abstract

Curcumin, a polyphenolic compound derived from turmeric, has emerged as a potent bioactive with multifaceted roles in male reproductive biology. Recent studies in diverse animal models and human populations consistently demonstrate curcumin's ability to safeguard sperm quality against a variety of insults including oxidative stress, toxicants (such as bisphenol A, heavy metals, and nicotine), metabolic dysfunction, and cryopreservation-induced damage. Its mechanisms encompass antioxidant action, modulation of apoptotic pathways, stabilization of chromatin and membrane structure, and favorable regulation of gene expression linked to sperm viability and motility (e.g., PRDX5, caspase-3, Bcl-2, O-GlcNAcylation). Curcumin nano-formulations and its synergistic application with other protective agents further boost outcomes. While curcumin's benefits extend to improved DNA integrity, sperm motility, and fertilizing capacity, dose-dependent antifertility or inhibitory effects have been noted in some studies, highlighting the need for precise clinical translation. Collectively, this review compiles current evidence and mechanistic insights, positioning curcumin as a promising adjunct or therapeutic agent in male reproductive medicine and fertility preservation(1-60).

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