

Review Article

ROLE OF FLAVONOID NANOCARRIERS IN MODULATING THE GUT–BRAIN AXIS FOR COGNITIVE HEALTH

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The gut–brain axis (GBA) represents a dynamic bidirectional communication network linking the gastrointestinal tract and the central nervous system (CNS), governed by neural, endocrine, and immune pathways. Growing evidence highlights that gut dysbiosis contributes to neuroinflammation, oxidative stress, and cognitive decline. Flavonoids—bioactive polyphenols abundant in fruits, vegetables, and medicinal plants—possess strong antioxidant, anti-inflammatory, and neuroprotective properties that can beneficially modulate the GBA. However, poor solubility, instability, and limited bioavailability hinder flavonoid efficacy in reaching both gut microbiota and brain tissues. To overcome these pharmacokinetic barriers, nanocarrier-based drug delivery systems such as liposomes, polymeric nanoparticles, solid lipid nanoparticles, and nanomicelles have emerged as advanced strategies to enhance flavonoid absorption, stability, and targeted delivery.

This review comprehensively examines the mechanistic role of flavonoid nanocarriers in regulating the gut–brain axis, emphasizing their impact on microbiota modulation, neuroinflammation control, and cognitive enhancement. Moreover, it discusses the integration of nanotechnology and nutraceutical **science** as a sustainable approach to promote brain health, prevent neurodegenerative diseases, and support cognitive longevity.

Keywords: Flavonoids, Nanocarriers, Gut–Brain Axis, Cognitive Health, Neuroinflammation, Microbiota, Neuroprotection.