NUCOREBIO · FORMULATION SCIENCE SERIES

Bioavailability Enhancement Guide

Delivery Matrices, Absorption Enhancers & Formulation Strategies That Maximize Ingredient Efficacy

Ingredient potency at the point of ingestion is only one half of the efficacy equation. The other half — often neglected in commercial formulation — is bioavailability: what fraction of the ingested dose reaches the target tissue in an active form. A 1000 mg dose of an ingredient with 5% oral bioavailability delivers the same systemic exposure as 50 mg of the same ingredient at 100% bioavailability. This guide covers the core strategies NuCoreBio employs to maximize bioavailability across different ingredient classes.

Ingredient Class	Typical Raw Bioavailability	Primary Limiting Factor	Maximum Achievable (with optimization)	NuCoreBio Strategy
Fat-soluble vitamins (A, D, E, K)	20–80%	Lipid absorption required	90–95% (with fat vehicle)	Softgel with MCT oil carrier
Water-soluble vitamins (B, C)	40–90%	Saturable intestinal transporters	85–95% (split dosing)	Divided doses, time-release formats
Standard botanical extracts	5–30%	Poor GI solubility, first-pass metabolism	30–65% (with enhancers)	Piperine, phospholipid complex, nanoemulsion
Curcumin (example)	< 1% (unformulated)	Rapid hepatic conjugation + low solubility	30–40% (Meriva® or liposomal)	Phytosome or BCM-95® technology
Standard collagen hydrolysate	30–45%	Requires further intestinal digestion	85–94% (tripeptide MCT)	Pre-hydrolyzed to MW < 500 Da
Peptides (MW < 500 Da)	75–94%	Minimal — absorbed intact via PepT1	90–95%	Enzymatic hydrolysis to target MW
Minerals (oxide forms)	3–12%	Poor ionization in neutral gut pH	25–40% (chelated forms)	Bisglycinate, glycinate, malate forms
Minerals (chelated forms)	25–40%	Amino acid chelate competition	40–55%	Optimized chelation ratio

— STRATEGY 01

Phospholipid Complexation (Phytosome® Technology)

Phospholipid complexation — commercially known as Phytosome® technology (Indena, Italy) — forms a 1:1 or 1:2 molar complex between a polyphenolic ingredient and phosphatidylcholine (PC) from soy or sunflower lecithin. The PC molecule acts as a natural amphiphile: its hydrophilic choline head maintains water dispersibility, while its lipophilic fatty acid tails dramatically improve intestinal absorption and lymphatic uptake. This "embedding" within a phospholipid matrix also protects the active from first-pass hepatic conjugation, the primary elimination pathway for most polyphenols.

Ingredient	Standard Extract BA	Phytosome® BA	Improvement Factor	Clinical Note
Silybin (Milk Thistle)	1–3%	10–18%	6–9× increase	Giacomelli et al., 2000
Ginkgo biloba	40–60%	75–85%	1.5–2× increase	Improved by phospholipid solubilization
Curcumin (standard)	< 1%	30–40% (Meriva®)	30–40× increase	Most dramatic phytosome benefit
Quercetin	5–10%	20–30%	3–4× increase	Izzo et al., 2010; human PK study
Boswellic acids	5–15%	25–35%	3–5× increase	Gum resin: poor solubility improved significantly
Grape seed OPCs	10–20%	30–50%	2–3× increase	Anthocyanin fraction most benefited
Phosphatidylserine	70–80%	N/A — already phospholipid	—	PS IS the phospholipid; high native BA

— STRATEGY 02

Black Pepper Extract (Piperine) as Bioavailability Enhancer

Piperine (1-piperoylpiperidine), the primary alkaloid of *Piper nigrum*, is the most widely used non-specific bioavailability enhancer in nutraceuticals. Its mechanism is multi-factorial: (1) inhibition of intestinal and hepatic CYP3A4 (a major first-pass metabolism enzyme for many supplements and drugs), (2) inhibition of P-glycoprotein (P-gp) efflux transporter, reducing intestinal efflux of absorbed compounds back into the gut lumen, (3) increased intestinal membrane permeability via transient tight junction modulation, and (4) inhibition of intestinal glucuronidation and sulfation (phase II conjugation pathways that inactivate polyphenols before systemic circulation).

Target Ingredient	Dose Range	Piperine Used	BA Improvement	Primary Mechanism	Caution
Curcumin	1000 mg	20 mg (BioPerine®)	+2000%	CYP3A4 inhibition + tight junction	Drug interactions (CYP3A4 substrate drugs)
Resveratrol	100–200 mg	5–10 mg	+229% AUC	P-gp inhibition + glucuronidation block	Monitor warfarin co-administration
Coenzyme Q10	100 mg	5 mg	+2× Cmax	Lipid absorption enhancement	Mild; well-tolerated
Beta-Carotene	10–25 mg	5 mg	+60%	Intestinal membrane permeability	Generally safe
Fisetin	50 mg	10 mg	+3× AUC estimate	CYP3A4 + glucuronidation	Limited human data
Water-soluble vitamins	Varies	5–10 mg	+10–40%	Transporter upregulation	Generally safe

CYP3A4 DRUG INTERACTION ALERT

DRUG INTERACTION WARNING FOR PIPERINE: Piperine at ≥20 mg significantly inhibits CYP3A4 and CYP1A2. This raises plasma levels of drugs metabolized by these enzymes, including: cyclosporine (2× AUC), carbamazepine, certain statins, and numerous chemotherapy agents. Standard supplement doses (5–10 mg piperine) have lower risk, but clients targeting oncology or polypharmacy consumers should be advised. DO NOT use piperine at doses >20 mg without medical oversight.

— STRATEGY 03

Liposomal and Nanoemulsion Delivery Systems

Liposomal encapsulation surrounds the active ingredient in a phospholipid bilayer vesicle (50–400 nm diameter), mimicking the structure of human cell membranes. This confers three critical advantages: (1) protection from gastric acid degradation, (2) lymphatic absorption bypassing first-pass hepatic metabolism, and (3) enhanced cellular uptake via membrane fusion. Nanoemulsion systems (oil-in-water emulsions, droplet size 10–200 nm) achieve similar BA improvements through enhanced micellar solubilization in the intestinal lumen. Both technologies are particularly valuable for highly lipophilic ingredients with poor aqueous solubility.

Technology	Particle Size	Best Applications	BA Increase	Cost Premium	Key Brand
Standard Liposome	100–400 nm	Vitamin C, glutathione, curcumin	3–8× increase	Moderate (+30%)	LiposomalPro™
Nanoemulsion (NE)	10–100 nm	Fat-soluble vitamins, CBD, CoQ10	2–5× increase	Low-moderate (+15–25%)	Various
Solid Lipid Nanoparticle	100–1000 nm	Astaxanthin, vitamin D, ubiquinol	3–10× increase	Moderate-high	Emulsome®
Microemulsion	10–100 nm	CoQ10, vitamin E, carotenoids	2–4× increase	Moderate	Self-emulsifying systems
Proliposome	< 500 nm	Curcumin, resveratrol, quercetin	5–15× increase	High	Phytosome® (Indena)
Cyclodextrin Inclusion	< 10 nm (complex)	Boswellic acids, quercetin, EGCG	2–6× increase	Moderate	Wacker CDs

— STRATEGY 04

Mineral Chelation and Form Selection

Mineral bioavailability is heavily determined by the chemical form used. Inorganic mineral salts (oxides, carbonates, sulfates) require gastric acid ionization before absorption, making them unreliable in individuals with hypochlorhydria (common in those over 50 and PPI users). Amino acid chelates — where the mineral is covalently bonded to an amino acid ligand — are absorbed via the intact chelate through di/tripeptide transporters (PepT1), bypassing the ionization requirement entirely.

Mineral	Preferred Form	Inferior Form	BA Ratio (preferred:inferior)	Clinical Note
Magnesium	Bisglycinate / glycinate	Magnesium oxide	8–12:1 advantage	Oxide is 4% absorbed; bisglycinate ~45%

Mineral	Preferred Form	Inferior Form	BA Ratio (preferred:inferior)	Clinical Note
Zinc	Zinc bisglycinate	Zinc sulfate / oxide	3–4:1 advantage	Bisglycinate 45–60% vs. sulfate 15–20%
Iron	Iron bisglycinate (ferrochel)	Ferrous sulfate	3–5:1 advantage	Ferrochel: 4× higher serum ferritin increase per mg
Calcium	Calcium malate / citrate	Calcium carbonate	2–3:1 advantage	Carbonate requires HCl; malate pH-independent
Chromium	Chromium picolinate	Chromium chloride	7–10:1 advantage	Picolinate ligand dramatically enhances GI transport
Selenium	Selenomethionine (organic)	Sodium selenite	2–3:1 advantage	Organic form: 88% retention vs 50% for inorganic
Copper	Copper bisglycinate	Copper sulfate / oxide	2–4:1 advantage	Chelated form better tolerated GI

— STRATEGY 05

Enzymatic Pre-Hydrolysis for Peptide Optimization

NuCoreBio's core proprietary technology — targeted enzymatic hydrolysis — represents the most sophisticated approach to bioavailability optimization for protein-derived ingredients. The intestinal brush border expresses a highly specific di/tripeptide transporter (PepT1, SLC15A1) that actively transports intact di- and tripeptides (MW 250–500 Da) into the enterocyte with absorption rates up to 94%. Larger polypeptides must be further digested before PepT1 can transport them, introducing variability and significant losses. Our enzymatic cascade precisely cleaves protein substrates to the PepT1-optimal MW range.

Protein MW Range	Primary Transport Mechanism	Intestinal Absorption Rate	Time to Peak Plasma	NuCoreBio Technology
> 10,000 Da (intact protein)	Pinocytosis only	< 1%	2–4 hours (if at all)	Not used in formulas
3,000–10,000 Da (standard hydrolysate)	Requires further pancreatic digestion	20–40%	90–150 min	Starting material for hydrolysis
1,000–3,000 Da (partial hydrolysate)	Mixed: PepT1 + passive diffusion	40–65%	60–90 min	Intermediate specification
500–1,000 Da (short peptide)	Predominantly PepT1-mediated	65–85%	30–60 min	Minimum target specification
< 500 Da (di/tripeptide — MCT, our spec)	Active PepT1 transport — highly efficient	85–94%	30–45 min (Bio-Speed™ onset)	NuCoreBio target MW

BIO-SPEED™ TECHNOLOGY — NUCOREBIO PROPRIETARY

NuCoreBio's Bio-Speed™ Matrix Technology builds on this principle. By combining (1) pre-hydrolyzed peptide actives at MW < 500 Da, (2) fast-dissolving excipients (no enteric coating), (3) immediate-release rapid-perception triggers (ginger extract, niacin), and (4) phospholipid co-formulation for lipophilic components, we engineer formulas where consumers perceive effects within 30–45 minutes. This perceived efficacy is the single most powerful driver of re-purchase in the supplement market.

— STRATEGY 06

Dosage Form Selection and Bioavailability Impact

The physical dosage form itself significantly impacts bioavailability, independent of formulation chemistry. Disintegration time, dissolution rate, and GI transit characteristics differ meaningfully between formats.

Dosage Form	Disintegration Time	Typical BA vs. Solution	Best Applications	Limitations
Hard Capsule (HPMC)	5–15 min	85–95%	Most supplements; clean label friendly	Moisture-sensitive ingredients may degrade
Hard Capsule (Gelatin)	3–10 min	90–100%	Standard; lowest cost	Not vegan; slightly faster dissolution than HPMC
Soft Gelatin Capsule	10–20 min	90–95% (lipid-soluble)	Fat-soluble actives: CoQ10, D3, K2, astaxanthin	Cannot fill water-soluble powders efficiently
Compressed Tablet	15–45 min	70–90%	High-dose ingredients; cost-effective	Slower dissolution; binders reduce BA if not validated
Chewable Tablet / Gummy	< 5 min (pre-chewed)	85–95%	Consumer compliance; palatability	Sugar/gelatin content; stability concerns
Powder (dissolved in water)	Instant (dissolved)	95–100%	Pre-workout, proteins, electrolytes	Stability; palatability; dosing accuracy
Sublingual (under tongue)	< 2 min	80–95% (bypasses first-pass)	CBD, B12, melatonin, peptides	Volume limited to < 1 mL
Enteric-Coated (delayed release)	60–90 min post-ingestion	Variable; bypasses stomach	Probiotics, peppermint oil, certain enzymes	Not needed for most actives — delays onset unnecessarily
Liposomal Liquid	< 15 min	3–8× increase vs standard	Glutathione, vitamin C, curcumin	Stability; cost; palatability

NUCLEO FORMULATION RECOMMENDATION

NuCoreBio formulation recommendation: For maximum bioavailability and the fastest consumer-perceived onset, our preferred format is HPMC capsule (immediate release) with pre-hydrolyzed peptide actives and phospholipid co-formulation for lipophilic components. This combination achieves Bio-Speed™ onset (30–45 min) while maintaining vegan compliance and label cleanliness. For bioavailability consultations on your specific formula: Mc5896538@outlook.com | WhatsApp: +86 15866920149 | NCB-REF-012 · v2.0 · 2026