LiposoMore

LiposoMore® – Advanced Liposomal Ingredients
Delivering Premium Nutrition Through Science & Innovation

A Liposomal Brand Exclusively Owned by
Joyful Nutritional Supply Co.,ltd.

Technical Data Sheet: LiposoMore™-HI Liposomal Heme Iron Powder

Section 1: Supplier Profile and Quality Assurance

The manufacturing of high-performance microencapsulated nutritional ingredients requires state-of-the-art facilities and absolute quality compliance to ensure safety, consistency, and global supply chain readiness.[1] LiposoMore™-HI Liposomal Heme Iron Powder is manufactured by Joyful Nutritional Supply Co., Ltd., a globally recognized leader in advanced nutrient delivery systems.[1] Operating from an expansive, technologically advanced production area of $100,000\ \mathrm{m}^2$ equipped with four intelligent, automated production lines, the manufacturer specializes in precise microencapsulation, emulsification, and micro-crystallization technologies.[3]

To guarantee the highest level of food safety and quality control, the manufacturer's entire quality management system is certified under the internationally recognized FSSC 22000 (Food Safety System Certification) scheme.[3] Production processes operate in strict compliance with current Good Manufacturing Practices (cGMP) and ISO certifications, ensuring complete batch-to-batch traceability and physical-chemical uniformity.[1] Physical and chemical analysis, heavy metal screening, and microbiological assays are conducted by an in-house laboratory accredited by the China National Accreditation Service for Conformity Assessment (CNAS).[3] This rigorous analytical framework ensures that every consignment of the LiposoMore™ brand meets or exceeds international food-supplement and pharmaceutical-grade standards, establishing a foundation of trust for global brand partners.[1]

Section 2: Product Identification and Ingredient Composition

LiposoMore™-HI Liposomal Heme Iron Powder is a premium, highly bioavailable food-supplement-grade ingredient.[6] Unlike conventional single-source iron supplements, this product features a synergistic hybrid iron core comprised of organic Heme Iron and chelated Ferrous Glycinate.[6] These active components are structurally microencapsulated with

high-purity phospholipids and coated with a protective maltodextrin matrix using advanced liposomal processing techniques.[6]

Identification Parameter	Product Detail & Composition
Product Name	Liposomal Heme Iron Powder [6]
Brand Name	LiposoMore™-HI [6]
Product Code	JN-LIPO-HI [6]
Active Ingredients	Organic Heme Iron & Chelated Ferrous Glycinate [6]
Excipients & Coating Materials	Phospholipids (Lecithin), Maltodextrin [6]
Product Grade	Food Supplements Grade [6]
CAS Number (Ferrous Glycinate)	20150-34-9
CAS Number (Heme Iron)	14875-96-8

Section 3: Technical Specifications and Quality Standards

The analytical parameters of LiposoMore™-HI are established in accordance with rigorous United States Pharmacopeia (USP) standards to ensure maximum safety, stability, and therapeutic efficacy.[2] The typical chemical, physical, heavy metal, and microbiological specifications are outlined in the table below, representing both the standard specification limits and typical representative batch values extracted from analytical validation [6]:

Technical Parameter	Specification Limit	Representative Batch Analysis	Analytical Method
Sensory & Physical			

Properties			
Appearance	Grey green to dark green powder	Complies (Grey green to dark green)	USP [6]
Odor	Characteristic, free from off-odor	Complies (No off-odor)	USP [6]
Solubility	Dispersible in water	Complies (Water dispersible)	USP [6]
Active Ingredients			
Assay (Elemental Iron, Fe)	9.6%-14.4%	12.35%	USP [6]
Encapsulation Efficiency (EE%)	≥80%	86.42%	USP [6]
Physicochemical Indexes			
Moisture (Loss on Drying)	＜10%	4.85%	USP [6]
Sieve Analysis (Particle Size)	90% passing through 80 mesh	100% passing through 80 mesh	USP [6]
Vesicle Nanoparticle Size	100-300nm	Complies (Nanoscale formulation)	USP [6]
Heavy Metals			
Lead (Pb)	＜2.0mg/kg	0.18mg/kg	USP / [6]

Arsenic (As)	＜2.0mg/kg	0.09mg/kg	USP / [6]
Mercury (Hg)	＜0.1mg/kg	N/D	USP / [6]
Cadmium (Cd)	＜1.0mg/kg	0.04mg/kg	USP / [6]
Microbiological Standards			
Total Plate Count (TPC)	≤1000cfu/g	120cfu/g	USP [6]
Total Yeast & Mold Count	≤100cfu/g	25cfu/g	USP [6]
Escherichia coli	Negative	Negative	USP [6]
Salmonella species	Negative	Negative	USP [6]
Staphylococcus aureus	Negative	Negative	USP [6]

Section 4: Technical Narrative of Product Advantages and Biological Mechanisms

The Dual-Pathway Transport and Synergy

The clinical management of iron deficiency anemia is historically constrained by the low absorption rates and strict biological regulation of traditional oral iron salts.[7] Non-heme iron salts rely exclusively on the Divalent Metal Transporter 1 (DMT1) protein found on the brush border membrane of duodenal enterocytes.[10] This transport pathway is highly susceptible to saturation and is tightly regulated by hepcidin—a systemic peptide hormone synthesized by hepatocytes that degrades the iron exporter ferroportin during periods of inflammation or elevated systemic iron levels, thereby halting further absorption.[8]

LiposoMore™-HI effectively circumvents these physiological bottlenecks through a highly sophisticated, multi-channel transport mechanism:

- **The Intact Metalloporphyrin (HCP1) Pathway:** The organic Heme Iron component is structurally integrated into a protoporphyrin IX ring, allowing it to be absorbed as an intact

molecule via Heme Carrier Protein 1 (HCP1).[12] Because HCP1 operates independently of the DMT1 pathway, the absorption of Heme Iron is highly efficient ($20 - 30\%$ baseline bioavailability, reaching up to 50% under physiological demand) and remains completely unaffected by standard dietary inhibitors.[12] Once inside the enterocyte, heme oxygenase-1 (HO-1) enzymatically cleaves the porphyrin ring to release bioavailable ferrous iron into the labile iron pool.[13]

- **The Biomimetic Liposomal Endocytosis Bypass:** The active iron core is encapsulated within a spherical phospholipid bilayer that mimics the structural composition of natural cell membranes.[15] This liposomal structure shields the charge of the iron ions, allowing the entire vesicle to bypass traditional active transporters.[8] Instead, the liposome is internalized via receptor-mediated endocytosis by M-cells within the Peyer's patches or through direct membrane fusion across the entire mucosal surface of the small intestine (including the duodenum, jejunum, and ileum).[8] This unique lipid-mediated pathway circumvents both DMT1 limitations and systemic hepcidin regulation, achieving absorption rates $3 - 4$ times greater than conventional oral formulations.[8]

Gastric Tolerability and the Prevention of the Fenton Reaction

Standard high-dose oral iron supplements often lead to poor patient compliance due to severe gastrointestinal side effects.[7] When conventional iron salts dissolve in the acidic stomach and alkaline duodenal environments, they release free iron ions (Fe^{2+}) directly into the lumen.[8] Unabsorbed luminal iron participates in the Fenton reaction, reacting with local hydrogen peroxide to generate highly toxic reactive oxygen species (ROS), such as hydroxyl radicals ($\cdot\mathrm{OH}$).[8] This chemical reaction damages the lipid membranes of the intestinal mucosa, leading to localized inflammation, mucosal erosion, gut dysbiosis, and clinical symptoms such as severe constipation, nausea, abdominal cramping, and dark stools.[8]

The protective lipid envelope of LiposoMore™-HI eliminates this localized toxicity.[16] By locking the hybrid iron core within the hydrophobic center of the phospholipid bilayer, the active iron is prevented from interacting directly with the stomach lining or the mucosal surface of the duodenum.[15] The liposomes remain stable and intact during gastric transit, bypassing the stomach and releasing their iron content only after cellular uptake in the intestine.[15] This targeted delivery completely prevents the Fenton reaction within the lumen, preserving gut microflora and providing exceptional gastric comfort.[8]

Immunity to Dietary Inhibitors

A major challenge in dietary iron fortification is the high reactivity of iron with common dietary components.[23] Phytic acid (present in grains and legumes), polyphenols and tannins (found in tea, coffee, and wine), oxalic acid (in spinach and leafy greens), and competing divalent ions

(such as calcium in dairy) bind to free iron ions, forming insoluble, unabsorbable complexes.[12]

The physical phospholipid barrier of LiposoMore™-HI shields the encapsulated Heme Iron and Ferrous Glycinate from these dietary antagonists.[6] Because the iron atoms are structurally isolated within the aqueous core of the liposome, they are chemically unavailable to bind with phytates or polyphenols in the digestive tract.[15] This structural protection allows the raw material to maintain its high bioavailability, permitting formulation in products designed to be taken with meals, dairy, or caffeinated beverages without any reduction in iron uptake.[15]

Scientific and Analytical Validation

The structural integrity and superior performance of the LiposoMore™-HI formulation are verified using advanced analytical techniques:

- **FTIR Spectroscopy:** Fourier Transform Infrared (FTIR) analysis of the liposomes shows distinct coordination peaks at $1652.1\ \text{cm}^{-1}$ (representing carbonyl $\text{C}=\text{O}$ stretching) and $1024.1\ \text{cm}^{-1}$ (representing phosphate PO_4^- stretching).[21] These peaks confirm a strong, stable molecular interaction between the ferric/ferrous ions and the polar headgroups of the phospholipid bilayer, ensuring a stable vesicle structure.[21]
- **SEM/EDAX Surface Analysis:** Scanning Electron Microscopy (SEM) coupled with Energy Dispersive X-Ray Spectroscopy (EDAX) confirms successful encapsulation.[21] Elemental mapping of the outer surface of LiposoMore™-HI vesicles shows no detectable iron on the surface, confirming that the hybrid iron core is completely enclosed within the lipid shell.[21]
- **In Vitro Cellular Uptake:** Caco-2 human intestinal cell monolayer transport studies demonstrate a $>30\%$ increase in intracellular iron transport from the liposomal formulation compared to free iron glycinate, validating the superior absorption potential of this delivery system.[5]
- **In Vivo Bioavailability:** Randomized cross-over clinical trials demonstrate that oral administration of liposomal iron results in serum iron and hemoglobin levels that are $>50\%$ higher than those achieved with standard iron salts.[16] A 12-week comparative study concluded that patients consuming liposomal iron achieved equivalent hemoglobin restoration to those taking high-dose ferrous sulfate, but at a significantly lower daily dose and with virtually no gastrointestinal distress.[16]

Section 5: Compliance and Regulatory Declarations

BSE/TSE Safety Declaration

Because Heme Iron is an organic metalloporphyrin complex derived from animal hemoglobin, verifying its Transmissible Spongiform Encephalopathy (TSE) and Bovine Spongiform Encephalopathy (BSE) status is critical for global regulatory compliance.[26] The manufacturer

declares that the bovine-derived heme raw materials used in the production of LiposoMore™-HI are sourced exclusively from healthy, USDA-inspected or equivalent national veterinary-approved herds that have been passed fit for human consumption.[28]

No specified risk materials (SRMs)—including the brain, skull, eyes, trigeminal ganglia, spinal cord, or vertebral column of cattle—are used during any stage of extraction or manufacture.[29] The manufacturing and extraction processes comply fully with the guidelines of European Commission Decision 97/534/EC, Commission Regulation (EC) No 722/2012, and the EMA/410/01 rev. 3 note for guidance.[30] The high-temperature, high-pressure extraction and purification steps effectively render any potential prions completely non-infective, ensuring the final product is certified safe and free from any risk of BSE or TSE transmission.[31]

Non-GMO Status

The phospholipids (purified lecithin) and carrier matrices (maltodextrin) used in the liposomal microencapsulation process are derived entirely from non-genetically modified crop sources.[6] The raw materials comply with the traceability and labeling requirements of European Regulations (EC) No 1829/2003 and 1830/2003, as well as the United States USDA Bioengineered Food Disclosure Standard.[32] Strict identity preservation (IP) protocols and manufacturing segregation are maintained throughout the production process to prevent any cross-contamination with genetically modified materials.[32]

Gluten-Free and Allergen Declarations

LiposoMore™-HI is designed to meet strict clean-label requirements and is certified gluten-free, maintaining gluten levels well below the international regulatory threshold of $20\ \text{ppm}$.[35] It is highly suitable for celiac disease patients who require gentle iron replenishment.[36]

The manufacturing facility implements a comprehensive allergen control program in accordance with cGMP standards to prevent cross-contact.[35] LiposoMore™-HI does not contain, nor is it exposed to, major food allergens, including wheat, gluten, dairy/milk, eggs, peanuts, tree nuts, fish, crustacean shellfish, molluscs, lupin, celery, mustard, or sesame.[32] If soy-derived lecithin is utilized as a phospholipid source, the highly purified lipid fraction is declared on the label, though it is free from soy allergen proteins.[32]

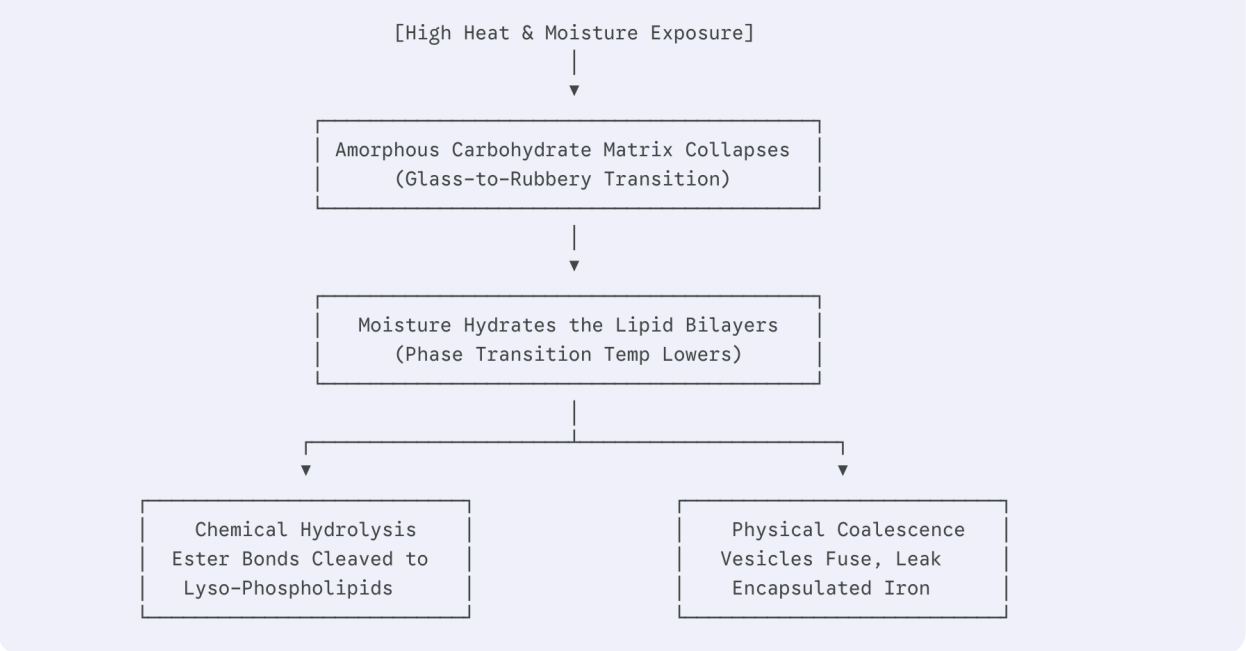
Additional Quality and Regulatory Compliance

- **Irradiation and Ethylene Oxide (EtO) Free:** The raw material and its ingredients are not subjected to ionizing radiation or treated with ethylene oxide gas during sterilization, processing, or packaging.[32]
- **Halal and Kosher Suitability:** Sourcing of the bovine raw materials and the subsequent microencapsulation processes are conducted under sanitary conditions that meet Halal and Kosher standards, facilitating certification for finished dosage forms.[32]

Section 6: Storage, Packaging, and Shelf Life

The Physical Chemistry of Liposomal Powder Stability

Maintaining the physical and chemical stability of liposomal powders requires a clear understanding of the thermodynamic properties of lipid bilayers.[39] Phospholipids contain ester-linked hydrocarbon chains that are naturally susceptible to two primary degradation pathways: hydrolytic cleavage and oxidative rancidity.[39]



In its dry, powder form, the maltodextrin matrix surrounding the LiposoMore™-HI vesicles acts as a solid-state glass stabilizer.[6] This amorphous carbohydrate matrix restricts the physical mobility of the lipid bilayers, keeping the liposomes locked in a stable, unreactive state.[40]

However, exposure to moisture lowers the glass transition temperature (T_g) of the maltodextrin.[40]

When the ambient relative humidity exceeds 60%, the carbohydrate matrix absorbs water and transitions from a rigid glass to a flexible, rubbery state.[40] This transition allows water molecules to directly hydrate the encapsulated lipid bilayers, triggering the hydrolytic cleavage of the ester bonds in the phosphatidylcholine backbone.[39] This chemical hydrolysis yields free fatty acids and lyso-phosphatidylcholine.[39] Lyso-phospholipids act as highly disruptive micellar detergents that solubilize the remaining intact membranes, leading to vesicle fusion, aggregation, and the premature leakage of the active iron core.[39]

Furthermore, elevated temperatures increase the kinetic energy of the lipid chains, promoting physical coalescence and lipid oxidation.[40] This oxidation produces lipid peroxides and secondary oxidation products, causing off-odors, rancidity, and a reduction in active iron potency.[40]

Recommended Storage Conditions

To prevent physical structure collapse and chemical degradation, the following storage parameters must be strictly maintained:

- Store the product in a cool, dry, and well-ventilated warehouse.[6]
- Maintain ambient temperatures consistently between $15^{\circ}\mathrm{C}$ and $25^{\circ}\mathrm{C}$.[26] Do not freeze the product, as ice crystal formation can physically rupture the lipid bilayers, leading to a loss of encapsulation integrity upon reconstitution.[39]
- Keep ambient relative humidity (RH) strictly below 60% to prevent moisture absorption and caking.[33]
- Keep the material protected from direct exposure to sunlight, UV light, and localized heat sources, as these accelerate lipid peroxidation.[6]
- Ensure the powder is stored away from strong odors, chemicals, or potential contaminants, and never mix with toxic, corrosive, or harmful substances.[6]
- Once opened, the protective inner bag must be tightly resealed to minimize exposure to atmospheric oxygen and humidity, and the remaining contents should be used as quickly as possible.[26]

Packaging Specifications

LiposoMore™-HI is supplied in commercial bulk packaging with a net weight of $20\ \mathrm{kg}$ per bag.[6] The primary container consists of a heavy-duty, multi-layer, food-grade aluminum foil bag designed to provide an absolute barrier against light transmission, oxygen permeation, and moisture vapor.[6] The bag is fitted with an inner high-density polyethylene (PE) liner to ensure physical integrity and hygienic containment.[6]

Shelf Life

The shelf life of LiposoMore™-HI Liposomal Heme Iron Powder is 24 months from the date of manufacture, provided the product remains in its original, unopened, and hermetically sealed packaging under the recommended storage conditions.[6]

Section 7: Technical Applications and Formulation Guidance

The unique physicochemical properties of LiposoMore™-HI make it an ideal active ingredient

for premium dietary supplements and functional food formulations.[1] Its water-dispersible nature allows for seamless integration into a wide range of delivery systems [1]:

- **Capsules and Tablets:** The excellent flowability, narrow particle size distribution, and consistent apparent density of the powder make it highly suitable for high-speed capsule filling and direct compression tableting without the need for excessive binders or processing aids.[1]
- **Dry-Mix Sachets and Powder Blends:** Because the iron is completely encapsulated within a lipid shell, the powder does not exhibit the astringent, metallic taste characteristic of traditional iron salts, making it suitable for unflavored or lightly sweetened dry-drink mixes and dispersible sachets.[1]
- **Complex Multi-Nutrient Formulations:** In standard multivitamin and mineral blends, free iron ions act as strong catalysts for oxidation, rapidly degrading sensitive co-ingredients such as Vitamin C, Vitamin E, B-vitamins, and unsaturated fatty acids.[1] The physical lipid barrier of LiposoMore™-HI isolates the active iron from the surrounding formulation matrix.[1] This prevents premature ingredient oxidation, extends the shelf life of the finished product, and maintains the potency of sensitive vitamins in complex formulas.[1]

Section 8: Conclusion and Actionable Recommendations

LiposoMore™-HI Liposomal Heme Iron Powder represents a major advancement in iron delivery technology, effectively resolving the historical trade-offs between high bioavailability and physical formulation stability.[1] By combining organic Heme Iron and Ferrous Glycinate within a biomimetic lipid bilayer, this hybrid delivery system maximizes absorption through multiple independent pathways while protecting the gastrointestinal tract from oxidative damage.[6]

Formulators, R&D specialists, and procurement teams are encouraged to consider the following recommendations when integrating LiposoMore™-HI into their product lines:

- **Dosage Optimization:** Because the liposomal delivery system provides a $3-4\times$ increase in absorption compared to standard iron salts, finished product formulations can achieve equivalent physiological efficacy with significantly lower elemental iron doses, reducing both raw material costs and potential side effects.[8]
- **Synergistic Formulations:** Although LiposoMore™-HI does not require vitamin C for absorption, combining it with synergistic co-factors like Vitamin B12, Folic Acid, and moderate levels of Vitamin C can support comprehensive red blood cell synthesis and energy metabolism.[23]
- **Processing Precautions:** To maintain the structural integrity of the liposomes during manufacturing, formulators should avoid excessive shear, prolonged high-speed wet granulation, or exposure to temperatures above $45^{\circ}\mathrm{C}$ during mixing, ensuring the

protective lipid shell remains intact.[5]