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

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

Comprehensive Technical Monograph and Product Data Sheet: LiposoMore™ Liposomal Ferric Pyrophosphate- Liposomal iron

1. Executive Summary

LiposoMore™ Liposomal Ferric Pyrophosphate, manufactured by Joyful Nutritional Supply Co., Ltd., represents a paradigm shift in mineral delivery technology. By harnessing the principles of biomimetic chemistry, this advanced ingredient encapsulates micronized ferric pyrophosphate within a sophisticated, dual-layer matrix of starch and lecithin.[1] This "supramolecular" structure is engineered to withstand the acidic environment of the stomach, prevent the generation of pro-oxidant free iron ions in the gastrointestinal lumen, and facilitate absorption via alternative pathways—specifically, transcytosis through M-cells (microfold cells) in the Peyer's patches of the lymphatic system.

This comprehensive Technical Data Sheet (TDS) and Product Monograph provides an exhaustive analysis of LiposoMore™. It synthesizes data from the product's Certificate of Analysis (COA) , proprietary manufacturing standards, and the broader scientific literature regarding liposomal iron technologies. The report is structured to serve as a definitive resource for product development scientists, regulatory affairs specialists, and brand managers, detailing the physicochemical specifications, superior pharmacokinetic profile, competitive positioning, and formulation versatility of LiposoMore™. Key highlights include its validated high iron content (7-9%), exceptional heavy metal purity (Lead <3ppm, Arsenic <1ppm), and successful application in challenging matrices such as infant formulas and functional dairy beverages.

2. Company Profile: Manufacturing Excellence and Quality Assurance

2.1 Corporate Identity and Strategic Vision

Joyful Nutritional Supply Co., Ltd. operates at the forefront of the nutritional ingredient industry, positioning itself not merely as a raw material supplier but as a "Boutique Customized Solution Provider". Headquartered in the innovation hub of Shenzhen, China, at No. 2045 Songbai Road, Baoan District, the company has integrated advanced material science with nutritional physiology to develop a portfolio of high-performance mineral salts.

The company's strategic vision focuses on resolving the inherent limitations of standard minerals—solubility, taste, and bioavailability—through technological intervention. Unlike commodity suppliers that provide bulk salts, Joyful Nutritional employs proprietary technologies such as **lipidization** (liposomal encapsulation), **micronization**, and **microencapsulation** to transform basic minerals into functional ingredients. This approach is particularly evident in the LiposoMore™ brand, which addresses the "unmet needs" of the iron supplement market: high absorption without side effects.

2.2 Manufacturing Infrastructure

The production of LiposoMore™ occurs within a state-of-the-art facility spanning over 10,000 square meters. This facility is designed to meet the rigorous demands of the global pharmaceutical and infant nutrition sectors.

- **Intelligent Production Lines:** The facility houses four automated, intelligent production lines capable of precision stoichiometry and controlled environmental processing. This automation minimizes human error and ensures batch-to-batch consistency, a critical parameter for maintaining the delicate structure of liposomal carriers.[2]
- **Specialized Processing Units:** The plant is equipped with high-shear homogenizers for emulsification, ultra-fine milling equipment for micronization (reducing particle size to nanometer or micrometer scales to enhance surface area), and specialized spray-drying towers designed to dehydrate liposomal suspensions without compromising the integrity of the phospholipid bilayer.[3]

2.3 Quality Assurance and Accreditation

Joyful Nutritional Supply's commitment to quality is evidenced by its comprehensive certification portfolio and rigorous internal standards.

- **CNAS Accredited Laboratory:** The company maintains an in-house testing center accredited by the **China National Accreditation Service for Conformity Assessment (CNAS)**. This laboratory operates in accordance with **ISO/IEC 17025** general requirements for the competence of testing and calibration laboratories. This accreditation ensures that the analytical data provided in the COA (e.g., ICP-MS for heavy metals) is internationally recognized and legally defensible.[2]
- **Food Safety Management Systems:** The manufacturing operations are certified under **ISO 22000** and **FSSC 22000** (Food Safety System Certification). These standards

integrate the principles of Hazard Analysis and Critical Control Points (HACCP) with prerequisite programs, ensuring proactive identification and mitigation of food safety risks.[2]
- **cGMP Compliance:** Adherence to **Current Good Manufacturing Practice (cGMP)** ensures that LiposoMore™ is produced, processed, packaged, and held under conditions that preserve its identity, strength, quality, and purity. This is particularly vital for the US market, where cGMP compliance is a prerequisite for dietary supplement ingredients under 21 CFR Part 111.[2]

2.4 Research and Development Partnerships

To maintain its technological edge, Joyful Nutritional Supply has established strategic research collaborations with leading academic institutions, including the **Southern University of Science and Technology** and **Shenzhen University of Technology**.[2] These partnerships focus on biotechnology applications and the characterization of mineral-lipid interactions, allowing the company to continuously refine the LiposoMore™ delivery system. The R&D team manages specialized databases for "Physical Properties Research" and "Application Tests," ensuring that LiposoMore™ is not just chemically pure but also functionally robust in diverse food matrices.[2]

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3. Product Identity and Technical Specifications

3.1 Product Nomenclature and Composition

- **Commercial Brand Name:** LiposoMore™ -Fe
- **Descriptive Name:** Liposomal Ferric Pyrophosphate
- **Active Ingredient:** Ferric Pyrophosphate ($Fe_4(P_2O_7)_3$)
- **CAS Number (Active):** 10058-44-3
- **Encapsulation Matrix:** Starch (Carrier/Stabilizer) and Lecithin (Phospholipid Emulsifier)
- **Physical Form:** Microencapsulated powder
- **Solubility Profile:** Dispersible in water (forming a stable suspension)

The product is defined as "Microencapsulated iron pyrophosphate coated with starch and lecithin with liposomal technology".[1] This definition highlights the tripartite structure of the particle:

1. **Core:** Micronized Ferric Pyrophosphate, an insoluble iron salt chosen for its white color and lack of organoleptic reactivity.
2. **Inner Membrane:** A phospholipid bilayer derived from lecithin, which mimics the cell membrane and facilitates M-cell transport.
3. **Outer Matrix:** A starch-based shell that provides structural integrity during spray drying and storage, preventing the liposomes from fusing or degrading.[1]

3.2 Certificate of Analysis (COA) Specifications

The following specifications constitute the release criteria for LiposoMore™, as authorized by the Quality Assurance department of Joyful Nutritional Supply. These parameters ensure the product's safety, potency, and organoleptic suitability.

3.2.1 Organoleptic and Physical Properties

Parameter	Specification	Result (Typical)	Importance
Appearance	White to light yellow powder	Pass	Ensures no color alteration in finished products (e.g., milk, yogurt).[1]
Odor	Odorless	Pass	Absence of rancid lipid notes or metallic iron smell; critical for palatability.[1]
Solubility	Dispersible in water	Pass	Allows for use in liquid suspensions and beverages without rapid sedimentation.[1]
Loss on Drying	＜10%	5.11%	Controls moisture content to prevent microbial growth and lipid oxidation during storage.[1]

3.2.2 Assay and Potency

Parameter	Specification	Result (Typical)	Importance
Iron (Fe) Purity	7% – 9%	8.1%	Confirms the elemental iron content. At ~8%, a 175mg dose

			delivers ~14mg of iron (100% RDI).[1]

3.2.3 Heavy Metal Contaminants (Safety Profile)

Heavy metal testing is conducted via Inductively Coupled Plasma Mass Spectrometry (ICP-MS), the gold standard for trace element analysis, offering superior sensitivity compared to traditional colorimetric assays.

Parameter	Specification	Result (Typical)	Regulatory Context
Total Heavy Metals	≤10ppm	10 ppm	General purity indicator.[1]
Lead (Pb)	≤3ppm	＜3ppm	Complies with USP/FCC limits. Critical for infant nutrition safety.[1]
Arsenic (As)	≤0.1 ppm	＜0.1ppm	Exceptionally low limit, suitable for long-term supplementation.[1]
Mercury (Hg)	≤1.0 ppm	＜1.0 ppm	Strictly controlled due to neurotoxicity risks.[1]
Cadmium (Cd)	≤1.0 ppm	＜1.0 ppm	Complies with strict international standards for food additives.[1]

3.2.4 Microbiological Standards

Microbial purity is verified using United States Pharmacopeia (USP) methods, ensuring the ingredient is safe for direct consumption and incorporation into sensitive formulations.

Parameter	Specification	Method	Result (Typical)

Total Plate Count	**≤1000cfu/g**	USP	＜100cfu/g
Molds & Yeasts	**≤100cfu/g**	USP	＜10cfu/g
E. Coli	Negative /10 gram	USP	Negative
Salmonella	Negative / 25 grams	USP	Negative
Staphylococcus Aureus	Negative / 10 gram	USP	Negative

3.3 Stability and Shelf Life

The product has a demonstrated retest interval of **24 months** from the date of manufacture when stored under recommended conditions.[1] The liposomal encapsulation provides a significant stability advantage:

- **Oxidative Stability:** The starch/lecithin matrix acts as a barrier to oxygen, preventing the ferrous/ferric transition that typically leads to rancidity in iron-fortified foods.
- **Thermal Stability:** LiposoMore™ is engineered to withstand standard food processing temperatures, including pasteurization (High-Temperature Short-Time, HTST), making it suitable for dairy applications.[7]
- **pH Stability:** The matrix protects the iron core from acid hydrolysis in the stomach, ensuring the payload remains intact until it reaches the absorption sites in the intestine.[8]

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4. The Science of LiposoMore™: Mechanism of Action

The superior performance of LiposoMore™ is rooted in its unique pharmacokinetic profile, which circumvents the physiological bottlenecks associated with conventional iron salts.

4.1 Biological Barriers to Conventional Iron

Traditional iron supplements, such as ferrous sulfate, dissociate in the gastric acid to release free iron ions (Fe^{2+}). These ions are absorbed primarily in the duodenum via the **Divalent Metal Transporter 1 (DMT-1)**. However, this pathway is fraught with limitations:

1. **Low Efficiency:** Absorption rates are typically low (5-15%), leaving unabsorbed iron in the gut.
2. **Hepcidin Blockade:** In response to inflammation or high iron stores, the liver secretes

hepcidin, a peptide hormone that binds to and degrades ferroportin (the iron exporter), effectively locking iron inside the enterocytes and preventing its release into the bloodstream. This is a primary cause of Anemia of Chronic Disease (ACD).[9]

3. **Oxidative Damage:** Free unabsorbed iron in the colon catalyzes the Fenton reaction, producing reactive oxygen species (ROS) that damage the gut mucosa and alter the microbiome, leading to side effects like constipation, nausea, and bloating.[11]

4.2 The "Trojan Horse" Mechanism: M-Cell Transcytosis

LiposoMore™ utilizes a sophisticated delivery system to bypass these barriers. The lecithin layer creates a "liposome-like" structure that mimics a chylomicron (a fat globule).

- **Gastric Bypass:** The lipid-starch shell resists degradation by gastric acid and pepsin. This prevents the release of free iron ions in the stomach, thereby eliminating the direct irritation of the gastric mucosa that causes nausea and pain.[11]
- **M-Cell Uptake:** Instead of relying on the DMT-1 transporter, the intact liposomal particles are recognized by **M-cells (Microfold cells)** located in the Peyer's patches of the ileum. M-cells are specialized epithelial cells that sample particulate matter and macromolecules from the gut lumen.[13]
- **Lymphatic Transport:** Once transcytosed by M-cells, the liposomes enter the lymphatic system, effectively bypassing the portal vein and the liver's "first-pass" metabolism. They are transported via the thoracic duct directly into the systemic circulation.
- **Hepatocyte Delivery:** Circulating liposomes are eventually taken up by the liver (hepatocytes) and macrophages, where enzymes break down the phospholipid shell, releasing the iron for utilization in erythropoiesis (red blood cell production) or storage as ferritin.[9]

4.3 Proven Bioavailability Advantages

This alternative absorption pathway renders LiposoMore™ highly effective, even in challenging clinical scenarios.

- **Bioavailability:** Studies comparing microencapsulated ferric pyrophosphate to standard iron salts have demonstrated absorption rates that are **2.7 to 3.5 times higher** than ferrous sulfate and ferrous fumarate.[15]
- **Hepcidin Independence:** Because M-cell uptake is not regulated by ferroportin, LiposoMore™ can effectively deliver iron even when hepcidin levels are elevated due to inflammation, making it an ideal solution for patients with inflammatory conditions or chronic kidney disease (CKD).[9]
- **Rapid Hemoglobin Recovery:** Clinical trials in pediatric populations have shown that liposomal iron leads to a faster and more significant increase in hemoglobin (Hb) and ferritin levels compared to conventional iron polymaltose complexes after 6 months of supplementation ($P < 0.001$).[16]

5. Comparative Market Analysis and Competitor Landscape

To understand the value proposition of LiposoMore™, it is essential to benchmark it against other iron sources and specific branded competitors in the market.

5.1 LiposoMore™ vs. Conventional Iron Salts

Feature	LiposoMore™ (Liposomal Fe)	Ferrous Sulfate	Ferrous Bisglycinate
Iron Content	7.0% - 9.0%	~20% - 30%	~20%
Absorption Mechanism	M-Cell Transcytosis (Lymphatic)	DMT-1 (Portal Vein)	DMT-1 / Amino Acid Transporters
Bioavailability	Very High	Low	Moderate to High
GI Side Effects	Minimal / None	High (Nausea, Constipation)	Moderate
Food Interactions	Protected (No interaction)	High (Inhibited by phytates/tannins)	Low
Taste	Neutral / Odorless	Strong Metallic	Mildly Metallic
Formulation Stability	Excellent (Non-reactive)	Poor (Pro-oxidant)	Moderate

5.2 LiposoMore™ vs. Branded Liposomal Ingredients

The market for micronized/liposomal iron is dominated by a few key players, notably **SunActive® Fe** (Taiyo Kagaku) and **LIPOFER®** (Lubrizol). LiposoMore™ is positioned as a high-quality, cost-effective alternative that matches the technical performance of these benchmarks.

- **SunActive® Fe:** Known for its dispersibility and use of polyglycerol esters/lecithin emulsifiers. It typically contains ~8% iron. LiposoMore™ matches this potency (8.1% typical) and dispersibility profile, utilizing a starch/lecithin system that is equally "clean

label" friendly.[18]

- **LIPOFER®:** Utilizes micronized ferric pyrophosphate with a starch/lecithin encapsulation. LiposoMore™ employs a directly comparable matrix composition.[1] Both products offer the benefit of preventing the metallic taste and color changes in food products.
- **Strategic Advantage of LiposoMore™:**
  - **Cost Efficiency:** As a challenger brand from a vertically integrated manufacturer, LiposoMore™ offers a competitive pricing structure without compromising on the specifications (Heavy metals <10ppm, identical iron load).
  - **Customization:** Joyful Nutritional's "Boutique Solution" model allows for the customization of particle size distributions or carrier modifications (e.g., swapping starch sources) to meet specific client formulation needs, a service often unavailable with rigid global brands.[2]

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6. Applications and Formulation Guidelines

LiposoMore™ is a versatile ingredient suitable for a wide array of product formats. Its physical stability and lack of reactivity make it the iron source of choice for "difficult" formulations.

6.1 Recommended Product Applications

1. **Infant Formula and Baby Food:**
   - *Application:* Fortification of milk powders and cereals.
   - *Advantage:* The strict control of heavy metals (Lead <3ppm, Arsenic <1ppm) meets the stringent safety requirements for infant nutrition. The neutral taste prevents flavor rejection by sensitive infants.[21]
2. **Functional Dairy and Beverages:**
   - *Application:* RTD (Ready-to-Drink) shakes, yogurts, and plant-based milks.
   - *Advantage:* Unlike ferrous sulfate, LiposoMore™ does not catalyze lipid oxidation (rancidity) in the fat phase of dairy products. It withstands pasteurization temperatures and remains suspended without sedimentation due to its dispersible nature.[21]
3. **Dietary Supplements:**
   - *Application:* Capsules, tablets, and **Direct-to-Mouth (DTM) Stick Packs**.
   - *Advantage:* The pleasant mouthfeel and lack of metallic aftertaste make it ideal for powder sachets (orodispersible powders) which are growing in popularity. It can be compressed into tablets without breaking the microcapsules, provided compression forces are optimized.[23]
4. **Gummies and Confectionery:**
   - *Application:* Iron-fortified gummies.
   - *Advantage:* Does not interact with gelling agents (pectin/gelatin) or alter the color/flavor profile of the fruit matrix.

6.2 Formulation Technical Guide

- **Dosage Calculation:** To achieve a label claim of **14mg elemental iron** (approx. 100% DV), the formulator should incorporate approximately **175mg of LiposoMore™** (assuming 8% potency).
- **Dispersion Method:** For liquid applications, it is recommended to disperse LiposoMore™ in water or the aqueous phase using moderate agitation. While water-dispersible, high-shear mixing can ensure a homogenous suspension of the microcapsules.
- **pH Considerations:** LiposoMore™ demonstrates excellent stability across a broad pH range (3.0 - 7.0). However, suspension stability (Zeta potential) is often optimized at near-neutral pH.[25]
- **Synergistic Combinations:**
  - **Vitamin C:** Often co-formulated with Ascorbic Acid (Vitamin C). While LiposoMore™ does not *require* Vitamin C for absorption (due to the M-cell pathway), Vitamin C helps maintain the reduced state of iron post-release in the liver and supports general health claims.[8]
  - **Folic Acid & B12:** Compatible with B-vitamins for comprehensive anemia support formulations (e.g., for pregnancy).[15]

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7. Regulatory Status and Compliance

LiposoMore™ is manufactured in compliance with global food safety standards and utilizes ingredients with established regulatory acceptance.

7.1 Ingredient Status

- **Ferric Pyrophosphate:**
  - **USA:** Affirmed as **Generally Recognized As Safe (GRAS)** by the FDA under **21 CFR § 184.1304** for use as a nutrient supplement in food.[26]
  - **EU:** Listed in **Directive 2002/46/EC** (Annex II) and **Regulation (EC) No 1925/2006** as a permitted source of iron for food supplements and fortification. Additionally approved as a "low-risk active substance" under **Regulation (EU) 2020/1018**.[27]
- **Lecithin:**
  - **USA:** GRAS under **21 CFR § 184.1400**.
  - **EU:** Authorized food additive (**E322**).
- **Starch:**
  - Globally accepted food ingredient.

7.2 Dietary Suitability

- **Vegetarian/Vegan:** The COA lists "Starch" and "Lecithin" as excipients. Provided the lecithin is derived from plant sources (Sunflower or Soy) and no animal processing aids are used, the product is suitable for vegetarian and vegan diets. (Specific confirmation of

lecithin source—Sunflower vs. Soy—should be requested per batch if "Soy-Free" labeling is required).[1]
- **Halal and Kosher:** Ferric Pyrophosphate and plant-based excipients are inherently compliant with Halal and Kosher dietary laws. Joyful Nutritional Supply, as a global exporter, typically aligns with these standards. *Specific batch certificates are available upon request*..[30]
- **BSE/TSE Free:** The synthetic mineral nature and plant-based coating materials ensure the product is free from Bovine Spongiform Encephalopathy (BSE) and Transmissible Spongiform Encephalopathy (TSE) risks.

7.3 Labelling Recommendations

- **US Label:** "Iron (as Ferric Pyrophosphate)" or "Liposomal Iron".
- **EU Label:** "Iron (Ferric Pyrophosphate)".
- *Note on Claims:* Formulators may be able to make structure/function claims regarding "High Absorption," "Gentle on Stomach," and "Non-Constipating" based on the scientific literature supporting liposomal iron technologies, subject to local regulatory review.[31]

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8. Safety, Toxicology, and Handling

8.1 Safety Profile

Ferric Pyrophosphate has a long history of safe use. The liposomal form further enhances safety by sequestering the iron.

- **Acute Toxicity:** High LD_{50} (Low toxicity). The encapsulation prevents acute iron toxicity ("dumping") in the stomach.[32]
- **Chronic Toxicity:** No evidence of carcinogenicity, mutagenicity, or reproductive toxicity.[34]
- **Adverse Events:** Clinical data indicates a significantly lower incidence of gastrointestinal distress (nausea, vomiting, pain) compared to ferrous sulfate, leading to better long-term compliance.[35]

8.2 Handling and Storage

- **Handling:** As with all fine powders, minimize dust generation. Use standard Personal Protective Equipment (PPE) including dust masks (N95), safety glasses, and gloves. Avoid inhalation and contact with eyes.[34]
- **Storage Conditions:** The product is hygroscopic. Store in original, tightly sealed containers in a cool, dry place, protected from direct sunlight and moisture. Recommended storage temperature is room temperature (15-25°C).[1]
- **Shelf Life:** 24 months (2 years) from the date of manufacture when stored in unopened

original packaging.[1]

8.3 Environmental Impact

Ferric pyrophosphate is considered environmentally benign in small quantities. The product components (iron, starch, lecithin) are biodegradable. Disposal should be in accordance with local environmental regulations, preventing release into waterways.[34]

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9. Conclusion

LiposoMore™ Liposomal Ferric Pyrophosphate stands as a premier solution for the modern nutritional market, addressing the "Iron Paradox"—the need for high iron intake versus the body's limited ability to absorb it without side effects. By encapsulating micronized ferric pyrophosphate in a robust starch-lecithin matrix, LiposoMore™ mimics biological transport mechanisms to deliver iron efficiently via the lymphatic system.

For manufacturers, it offers:

1. **Technical Superiority:** High dispersibility, thermal stability, and no metallic taste.
2. **Clinical Efficacy:** High bioavailability and reduced side effects, supporting consumer loyalty.
3. **Commercial Viability:** A cost-effective, high-spec alternative to branded market leaders, backed by the manufacturing excellence of Joyful Nutritional Supply Co., Ltd.

We invite you to experience the LiposoMore™ difference—where science meets nutrition to build a healthier, iron-strong future.