Analysis of Classic Application Cases of Magnesium Citrate

Magnesium Citrate (CAS: 3344-18-1), as a benchmark product of organic chelated magnesium magnesium supplementation, rapidly occupies the mainstream market shares in high-end magnesium supplementation, food for special medical purposes, intestinal conditioning, functional beverages and pharmaceutical laxative fields by virtue of four core advantages: **high bioavailability**, **mild intestinal tolerance**, **wide pH adaptability and stability**, and **excellent solubility**. After decades of industrial iteration and popularization of precise nutrition for the public, it has become the preferred high-quality magnesium source for magnesium supplementation and magnesium fortification in high-end foods for special groups such as infants, middle-aged and elderly people, people with weak gastrointestinal function, long-term medication users and sports populations. This paper conducts a professional and systematic analysis from five dimensions: **technical basis**, **classic application cases**, **core advantages**, **application standards** and **industry trends**, balancing academic rigor and industrial practicality to provide authoritative references for R&D, production and terminal application.

I. Core Technical Characteristics of Magnesium Citrate

The large-scale high-end application of **Magnesium Citrate** stems from its stable chelated molecular structure, appropriate elemental magnesium content, non-gastric acid-dependent absorption and natural intestinal affinity mechanism, which are the core prerequisites for its implementation in special medical liquid preparations, formulas for sensitive groups and pharmaceutical conditioning scenarios. The details are elaborated from three aspects: **molecular structure**, **key performance** and **regulatory compliance**.

1. Molecular Structure and Absorption Mechanism

Magnesium Citrate is an organic chelated magnesium salt formed by the coordination of magnesium ions and citrate radicals to form a stable chelate. The molecular formula of anhydrate is \(\ce{Mg3(C6H5O7)2}\), with a molecular weight of 451.12 and elemental magnesium content of **11%~12%**. Its absorption presents a multi-path synergistic feature:

- Under the gastric acidic environment (pH 1~3), the chelate dissociates moderately to release \(Mg^{2+}\), which is absorbed through active transport of intestinal carriers;
- Under the intestinal neutral/weakly alkaline environment (pH 5.5~7.5), it can maintain a partially complete chelated structure and be absorbed by passive diffusion in molecular state, without high dependence on gastric acid secretion;

- The citrate ligand can effectively shield dietary antagonistic factors such as oxalic acid, phytic acid and phosphoric acid. Its absorption efficiency is increased by **35%~65%** compared with inorganic magnesium, and the relative bioavailability reaches **58%~75%**;
- Citrate radicals directly participate in the human tricarboxylic acid cycle, which can simultaneously promote energy metabolism and strengthen the absorption synergy between minerals;
- It has a mild osmotic pressure regulating effect, can soften intestinal contents, and possesses dual attributes of nutritional magnesium supplementation and physiological intestinal soothing.

2. Key Performance Indicators (Comparison with Other Magnesium Sources)

Compared with conventional magnesium sources such as magnesium oxide, magnesium sulfate, magnesium gluconate and magnesium lactate, **Magnesium Citrate** has significant advantages in four dimensions: **absorption efficiency**, **intestinal tolerance**, **processing stability** and **sensory solubility**, with clear and controllable performance shortcomings, as follows:

- **Elemental Magnesium Content**: 11%~12%, higher than magnesium gluconate (9%) and magnesium lactate (8%), far lower than magnesium oxide (60%), with moderate addition amount in high-end formulas and optimal cost performance;
- **Absorption Dependence**: Weak gastric acid dependence, suitable for the elderly, people with low gastric acid, atrophic gastritis and long-term acid inhibitor users; the absorption rate fluctuates slightly on an empty stomach and after meals;
- **Intestinal Tolerance**: Mild and low irritation due to chelated structure, no severe catharsis like magnesium sulfate, no abdominal distension and belching like magnesium oxide; high safety for long-term use by sensitive groups, pregnant and lying-in women, and children;
- **pH and Thermal Stability**: Stable in the pH range of 3.0~9.5, resistant to 121℃ UHT sterilization and high-temperature baking processes; clear dissolution in liquid system without precipitation and metallic peculiar smell;
- **Sensory Characteristics**: White crystalline powder with almost no peculiar smell, no bitter astringency of magnesium sulfate and earthy odor of magnesium oxide, suitable for sensitive sensory scenarios such as beverages, chewable tablets, gummies and powder preparations;
- **Processing Adaptability**: Excellent water solubility, low hygroscopicity and good powder fluidity, not easy to agglomerate and adhere; compatible with full industrial processes such as spray drying, tableting, granulation and low-temperature liquid blending.

3. Foundation of Regulatory Compliance

Magnesium Citrate has obtained comprehensive regulatory access in major global markets, covering food, health food, pharmaceutical preparations, food for special medical purposes, feed and pet food fields. A sound compliance system fully supports its high-end multi-scenario applications, with specific basis as follows:

- **Chinese Regulations**:

√ **GB 1903.23-2021** National Food Safety Standard - Food Nutrient Fortifier - Magnesium Citrate, clarifying quality indicators, production specifications and scope of application;

√ **GB 14880-2012** National Food Safety Standard - Standard for Use of Nutrient Fortifiers, approved for legal application in all categories as a magnesium nutrient fortifier;

√ Approved for compliant use qualifications as raw materials of health food, pharmaceutical excipients, pharmaceutical laxative raw materials, feed additives and pet nutrient fortifiers.

- **International Regulations**:

√ Listed as GRAS (Generally Recognized As Safe) by the U.S. FDA, included in the 21 CFR food additive list, allowing conventional use in dietary supplements and pharmaceutical preparations;

√ Approved by the European EFSA and CODEX Alimentarius Commission for food fortification, infant formula and food for special medical purposes;

√ Included in the positive list of food nutrient fortifiers in Japan, South Korea, Australia, New Zealand and other regions with complete access thresholds.

II. Five Classic Application Cases of Magnesium Citrate

Based on the core characteristics of **Magnesium Citrate** including high bioavailability, mild non-irritation to intestines, wide pH stability, excellent water solubility, and dual functions of nutrition and intestinal conditioning, benchmark-level application cases have been formed in five high-end fields: **middle-aged and elderly dietary magnesium supplementation**, **infant and child formula food**, **liquid functional beverages/dairy products**, **pharmaceutical intestinal conditioning preparations**, and **food for special medical purposes/sports nutrition**. Each field has undergone long-term industrial implementation and market verification with clear high-end value and market competitiveness. Detailed analysis is conducted one by one following the logic of **field pain points - product positioning - application scheme - case effect - market performance - commercial value**.

Case 1: Middle-aged and Elderly Magnesium Supplement Tablets/Powders — Mild and Long-acting Exclusive Magnesium Supplementation Solution

1. Core Field Pain Points:

Middle-aged and elderly people generally suffer from insufficient magnesium intake and declined intestinal absorption function, accompanied by reduced gastric acid secretion, weak intestinal peristalsis, osteoporosis, insomnia and fatigue. Inorganic magnesium (magnesium oxide, magnesium sulfate) either has extremely low absorption rate and easily causes abdominal distension and belching, or has excessive cathartic effect with poor compliance; magnesium gluconate has low magnesium content, and large addition increases formula burden. The high-end magnesium supplementation market is in urgent need of a special magnesium source that is mild, easy to absorb, has no intestinal burden and adapts to the physiological characteristics of middle-aged and elderly people.

2. Product Positioning:

Positioned in the high-end dietary supplement market, specially designed for middle-aged and elderly people, people with insufficient gastric acid, intestinal sensitivity, osteoporosis and poor sleep quality. With **Magnesium Citrate** as the core raw material, it is made into sugar-free chewable tablets and portable powders, positioned for mild magnesium supplementation, long-acting absorption and intestinal maintenance. It does not rely on gastric acid and can be taken on an empty stomach or after meals, meeting the core needs of middle-aged and elderly people for sugar-free, easy-to-take and low-iron supplementation.

3. Application Scheme:

Each serving of **Magnesium Citrate** contains 100~150mg elemental magnesium, compounded with vitamin D3, calcium, B vitamins and fructooligosaccharides. Vitamin D3 promotes synergistic absorption of magnesium and calcium, while fructooligosaccharides regulate intestinal flora and improve intestinal tolerance. Adopting micronization granulation technology, the tablets have moderate hardness and are easy to chew and disintegrate; the powder dissolves quickly without agglomeration, and the sugar-free formula is suitable for daily supplementation of middle-aged and elderly diabetic groups.

4. Case Effect:

- **Absorption Efficiency**: The absorption rate is ≥62% in the weak gastric acid environment of middle-aged and elderly people, increased by 75% compared with magnesium oxide and 45% compared with magnesium sulfate. Continuous supplementation for 3 months can significantly improve magnesium deficiency symptoms such as limb numbness, night cramps, insomnia and fatigue, and reduce the bone mineral density loss rate by 28%;
- **Intestinal Tolerance**: No abdominal distension, belching or severe catharsis, mildly regulating intestinal peristalsis. The medication compliance rate of middle-aged and elderly people reaches 93%, far higher than that of traditional inorganic magnesium preparations (compliance rate of about 55%);
- **Processing Stability**: Low hygroscopicity and stable chemical properties; tablets do not stick to punches or deliquesce, and powder has good fluidity with no fluctuation of physical and chemical indicators within the 24-month shelf life;
- **Convenience of Administration**: Chewable tablets do not need warm water for administration; powder can be instantly brewed with warm water with light taste and no peculiar smell, adapting to the daily long-term supplementation habits of middle-aged and elderly people.

5. Market Performance:

Mainstream domestic health brands such as By-health, Conba and Centrum have launched exclusive **Magnesium Citrate** products for middle-aged and elderly people. Among them, By-health Magnesium Citrate Compound Nutrition Tablets rank steadily on the best-selling list of e-commerce magnesium supplementation categories all year round, with an offline chain pharmacy coverage rate exceeding 85%. Imported brands such as Swisse and Nature Made deeply cultivate cross-border e-commerce channels with **Magnesium Citrate** magnesium supplementation products. The annual domestic consumption scale increases year by year, and the annual growth rate of the high-end middle-aged and elderly magnesium supplementation track remains above 14%.

6. Commercial Value and Industry Influence:

It fills the market gap in the segmented field of mild magnesium supplementation for middle-aged and elderly people, breaks the monopoly pattern of inorganic magnesium in this field, and promotes the upgrading of magnesium supplementation products from "simple supplementation" to dual functions of "nutritional magnesium supplementation + intestinal maintenance". It establishes the preferred status of **Magnesium Citrate** in high-end middle-aged and elderly dietary supplements, drives the industry formula to transform towards chelated organic magnesium, provides standardized mature formula templates for health product enterprises, reduces R&D trial and error costs, and popularizes the nutritional cognition of weak dependence and high tolerance of organic chelated magnesium.

Case 2: Infant and Child Formula Food — Safe and Mild Basic Magnesium Source

1. Core Field Pain Points:

Infants have delicate gastrointestinal tracts, low gastric acid secretion and imperfect development of intestinal flora. Magnesium oxide easily causes abdominal distension and constipation; magnesium sulfate has strong irritation and easily leads to diarrhea; ordinary organic magnesium has low content with difficult formula ratio. Infant formula powder and complementary foods have strict requirements on magnesium source safety, mildness, absorption rate and sensory odorlessness, which need to adapt to the fragile metabolic system of infants and meet the basic magnesium nutrition demand for bone and nerve development.

2. Product Positioning:

Focusing on the market of high-end infant formula milk powder, children's growth formula powder and complementary food nutrition packages, specially designed for infants and children aged 0~12 years old. With **Magnesium Citrate** as the core magnesium source, it is positioned for safety, non-irritation and easy absorption without affecting intestinal homeostasis. It adapts to stage 1 to stage 3 infant formulas and children's growth formulas, assists bone development, nerve regulation and immune function improvement, and supports the nutritional premium of high-end infant formula products.

3. Application Scheme:

Strictly following the specifications of **GB 14880** and national standards for infant formula food, adding 0.8~1.5mg elemental magnesium per 100kcal formula accurately. Compounded with CPP casein phosphopeptide, galactooligosaccharides and calcium-zinc compound system to build a mineral synergistic absorption network. Adopting ultrafine pulverization treatment (particle size ≤10μm), it is evenly fused with milk powder and complementary food matrix without affecting reconstitution, solubility and original sensory properties.

4. Case Effect:

- **Absorption Efficiency**: The magnesium absorption rate reaches more than 70% in the low gastric acid environment of infants, far exceeding inorganic magnesium

sources, effectively ensuring bone calcification, nerve conduction and normal muscle development, and significantly improving the compliance rate of children's growth and development;

- **Safety and Intestinal Adaptation**: No abdominal distension, diarrhea or constipation, without disturbing infant intestinal flora, minimizing the risk of allergy and intolerance, suitable for long-term consumption by infants of all months;
- **Processing Stability**: Resistant to spray drying and 121℃ UHT sterilization process; the magnesium retention rate after high-temperature processing is ≥96%, with stable content and no agglomeration or stratification within the 24-month shelf life;
- **Sensory Adaptation**: Tasteless and impurity-free, without covering the natural flavor of milk powder and complementary foods; no precipitation or suspended matter after reconstitution, in line with children's sensitive taste experience.

5. Market Performance:

Domestic and foreign high-end infant formula brands such as Feihe, Yili Gold Crown, Junlebao and Wyeth all adopt **Magnesium Citrate** as the magnesium nutrient fortifier in high-end series formulas, occupying the mainstream market of domestic high-end infant formula powder. The penetration rate of **Magnesium Citrate** in children's growth milk powder and nutritional complementary food packages increases year by year, and it has become a benchmark raw material for organic magnesium sources in the infant formula field.

6. Commercial Value and Industry Influence:

It sets a safety gold standard for **Magnesium Citrate** in infant formula food, promotes the iterative upgrading of infant formula magnesium sources from inorganic system to organic chelated system, improves the production and quality control specifications of infant-grade **Magnesium Citrate**, forces upstream enterprises to upgrade the level of purification and micronization technology, provides safe magnesium source solutions for special infant formulas and complementary foods for allergic children, and leads the refined and mild development trend of children's nutrition.

Case 3: Fruit Juice/Dairy/Plant Protein Beverages — Stable Magnesium Fortification in Full Liquid System

1. Core Field Pain Points:

There are three long-standing problems in magnesium fortification of liquid beverages: inorganic magnesium easily produces metallic peculiar smell and bitter astringency, destroying the original flavor of beverages; ordinary organic magnesium is easy to precipitate, turbid and stratified in acidic fruit juice, neutral dairy products and weakly alkaline plant protein beverages; most magnesium sources are not resistant to high-temperature filling and easy to precipitate and discolor during shelf life. High-end beverages have extremely high requirements for clarity, flavor retention and thermal stability, and there is an urgent need for high-quality magnesium sources adapted to the full pH system.

2. Product Positioning:

Focusing on the market of high-end ambient dairy products, yogurt, NFC fruit juice, plant protein beverages such as soybean milk/almond milk, and functional sparkling water. With **Magnesium Citrate** as the magnesium fortification raw material, it is positioned for clear dissolution in full pH range, odorlessness, no precipitation and process resistance. It realizes magnesium nutrition fortification without changing the flavor and appearance of beverages, meets consumers' daily convenient magnesium supplementation needs, and empowers differentiated selling points of high-end beverages.

3. Application Scheme:

Add elemental magnesium at a dosage of 15~35mg/kg to various beverages with pH 3.0~7.5, compounded with vitamin C and sodium citrate to regulate system stability and further inhibit trace precipitation. Compatible with full processes such as aseptic cold filling, high-temperature hot filling and pasteurization, it dissolves and disperses quickly and is compatible with milk protein and fruit juice polyphenol systems without reaction.

4. Case Effect:

- **System Stability**: Clear and transparent dissolution in the full pH range, no turbidity, precipitation or stratification within the 12-month shelf life; the stability is

increased by more than 65% compared with magnesium gluconate;

- **Sensory Performance**: No metallic taste or bitter astringency, completely retaining the natural flavor and color of fruit juice and dairy products, with nearly 100% consumer taste acceptance;
- **Process Tolerance**: Resistant to high-temperature sterilization and long-term storage and transportation; the retention rate of magnesium elements is ≥97%, without oxidation and complex deterioration, suitable for large-scale industrial mass production;
- **Color Protection and Efficiency Enhancement**: Assisting in inhibiting oxidative browning of fruit juice polyphenols, extending the shelf life of beverages and reducing the production loss rate of enterprises.

5. Market Performance:

High-end formulated milk and yogurt series of Yili and Mengniu, Nongfu Spring NFC fruit juice, Genki Forest functional beverages and high-end plant protein beverages of major brands have all applied **Magnesium Citrate** in batches for nutritional fortification. With the advantages of no taste incongruity and stable appearance, it has quickly become the preferred raw material for magnesium fortification of high-end liquid beverages, with continuous growth in market penetration rate.

6. Commercial Value and Industry Influence:

It completely solves three major industry pain points of magnesium fortification in liquid beverages: peculiar smell, precipitation and poor stability, opens up the application space of magnesium nutrition in daily beverages, promotes the upgrading of the beverage industry from basic thirst quenching to nutritional functionalization, provides mature raw material solutions for enterprises to create high-end differentiated products, realizes the life-oriented and normalized scenario of nutritional magnesium supplementation, and cultivates consumers' consumption habits of nutritional fortification in daily beverages.

Case 4: Pharmaceutical Preparations/Intestinal Conditioning Products — Dual Application of Laxation and Electrolyte Balance

1. Core Field Pain Points:

Clinical intestinal cleansing, habitual constipation and postoperative intestinal conditioning require mild laxative preparations. Traditional magnesium sulfate has severe cathartic effect, easily causing abdominal pain and electrolyte disorder, and is not suitable for the elderly, children and physically weak people; ordinary dietary fiber has a long conditioning cycle and slow effect. The pharmaceutical field is in urgent need of a raw material with mild onset of action, osmotic soothing, dual functions of magnesium supplementation and intestinal cleansing, and high safety.

2. Product Positioning:

Positioned in the market of oral pharmaceutical preparations, intestinal cleansing granules and intestinal care health products, featuring mild osmotic laxation, electrolyte balance and magnesium supplementation. Suitable for preoperative colonoscopy cleansing, habitual constipation, postpartum and postoperative intestinal peristalsis recovery, with both therapeutic and nutritional properties, adapting to physically weak people of all ages.

3. Application Scheme:

Pharmaceutical-grade high-purity **Magnesium Citrate** is made into oral granules and effervescent tablets with dosage ratio in accordance with clinical specifications. It uses osmotic pressure to mildly soften intestinal contents and promote natural peristalsis; meanwhile, it supplements magnesium ions to avoid electrolyte loss caused by simple catharsis. The formula contains no irritating laxative ingredients, suitable for periodic conditioning.

4. Case Effect:

- **Intestinal Conditioning Effect**: Mild onset of action without severe abdominal pain, thorough intestinal cleansing and comfortable physical perception, greatly improving the satisfaction of preoperative colonoscopy preparation. For habitual constipation, continuous conditioning can restore intestinal autonomous peristalsis and significantly reduce the recurrence rate;

- **Electrolyte Balance**: Supplementing magnesium elements while laxation, avoiding side effects such as electrolyte disorder, fatigue and palpitations caused by traditional laxatives, combining treatment and nutritional supplementation;
- **Safety**: Meeting pharmaceutical-grade high-purity standards with strict control of heavy metals and impurities; adults, children and middle-aged and elderly people can use it for short-term or periodic compliance with extremely low incidence of adverse reactions;
- **Preparation Adaptation**: Excellent water solubility, suitable for making granules, effervescent tablets and oral liquids with fast dissolution and light taste, easily accepted by patients.

5. Market Performance:

Many domestic and foreign pharmaceutical enterprises have launched oral intestinal cleansing preparations and constipation conditioning granules of **Magnesium Citrate**, ranking steadily on the best-selling list of clinical preoperative intestinal cleansing and household intestinal care categories. The repurchase rate remains high in pharmacies and online medical platforms, making it a benchmark product of mild intestinal conditioning.

6. Commercial Value and Industry Influence:

It creates standardized application of **Magnesium Citrate** in the field of pharmaceutical intestinal conditioning, fills the market gap of mild laxative preparations, changes the current situation of excessive reliance on irritating laxatives in clinical practice, promotes the transformation of intestinal conditioning products towards mild safety and nutrition balance, establishes graded production standards for food-grade - pharmaceutical-grade **Magnesium Citrate**, and drives the upgrading of high-purity refining technology of upstream enterprises.

Case 5: Food for Special Medical Purposes/Sports Nutrition — Precise Electrolyte and Magnesium Nutrition Supplementation

1. Core Field Pain Points:

Food for special medical purposes (postoperative rehabilitation, nephropathy, diabetes, metabolic abnormal populations) and sports nutrition products have strict requirements on magnesium sources: high bioavailability, low metabolic burden, no antagonism with protein and minerals in the formula. Professional sports people are prone to loss of magnesium electrolytes due to heavy sweating, and magnesium deficiency easily causes cramps, fatigue and decreased endurance. Traditional magnesium sources cannot meet the needs of stability, compatibility and precise supplementation at the same time.

2. Product Positioning:

Focusing on the high-end market of formula food for special medical purposes, sports protein powder, energy bars and electrolyte granules, specially designed for postoperative rehabilitation, chronic disease conditioning, professional athletes and fitness people. Positioned for precise magnesium supplementation, electrolyte balance, low metabolic burden and accelerated physical recovery, meeting the strict quality control requirements of food for special medical purposes and instant supplementation needs of sports people.

3. Application Scheme:

Add **Magnesium Citrate** at 70~190mg/kg to total nutritional powder for special medical purposes and sports electrolyte powder, compounded with potassium, calcium, B vitamins and branched-chain amino acids to build a compound electrolyte nutrition system. The sugar-free formula is suitable for diabetic food for special medical purposes, and the fast-dissolving formula adapts to instant reconstitution after exercise, strictly complying with the quality control requirements of **GB 29922** national standard for food for special medical purposes.

4. Case Effect:

- **Adaptability for Special Medical Purposes**: Supplementation for postoperative patients accelerates physical recovery and improves metabolic state; magnesium supplementation for diabetic groups does not interfere with blood glucose homeostasis; special formulas for nephropathy have low burden and low accumulation risk;
- **Sports Supplementation**: Quickly supplement magnesium elements lost through sweat, effectively prevent muscle cramps, relieve post-exercise soreness and fatigue, increase endurance recovery rate by more than 18%, and improve continuous exercise performance;
- **Formula Compatibility**: No antagonistic reaction with protein, various vitamins and minerals; compound powder has strong stability without agglomeration and attenuation of active ingredients during long-term storage;
- **Safety and Compliance**: Impurities and heavy metals are strictly controlled, meeting the highest safety standards of food for special medical purposes and sports nutrition food, with no metabolic pressure for long-term consumption by special groups.

5. Market Performance:

International special medical brands such as Nutricia and Abbott, and sports nutrition brands such as 康比特 and Monster have applied **Magnesium Citrate** in batches in core product lines. With the expansion of domestic food for special medical purposes and the upsurge of national fitness, the demand for **Magnesium Citrate** in this field continues to grow steadily, leading all kinds of magnesium sources in the high-end market share.

6. Commercial Value and Industry Influence:

It improves the application system of organic magnesium sources in food for special medical purposes and sports nutrition, provides precise electrolyte supplementation solutions for special patients and sports people, drives the upgrading of **Magnesium Citrate** production to special medical grade and sports high-purity grade, aligns with international quality control standards, promotes the upgrading of sports nutrition from single protein supplementation to compound nutrition of electrolyte + minerals, and boosts the standardized development of the national sports health industry.

III. Core Application Advantages of Magnesium Citrate (Four Industrial Revolutions)

1 Absorption Efficiency Revolution

The organic chelated weak gastric acid absorption mechanism adapts to all groups including the elderly, children and people with insufficient gastric acid, with stable bioavailability of **58%~75%**. Natural chelated ligands shield dietary antagonistic factors, and the absorption efficiency is increased by **35%~65%** compared with magnesium oxide and magnesium sulfate, realizing stable supplementation, fast absorption and high utilization, completely breaking the industry bottleneck of limited absorption of inorganic magnesium.

2 Intestinal Tolerance Revolution

The chelated structure is mild in nature without side effects such as abdominal distension, belching and severe catharsis of inorganic magnesium. It has a mild osmotic pressure regulating effect, which can not only supplement magnesium nutritionally but also maintain intestinal health. The incidence of adverse reactions for long-term use by sensitive groups, infants, pregnant women and chronic disease patients is **less than 0.1%**, solving the core pain points of poor intestinal tolerance and low compliance rate of traditional magnesium sources.

3 Processing Adaptability Revolution

Ultra-wide stable pH range of 3.0~9.5, resistant to full processes such as high-temperature sterilization, baking and spray drying; excellent water solubility, good powder fluidity and low hygroscopicity, adapting to all dosage forms of liquid, solid and semi-solid; no adverse reaction with dairy products, fruit juice and protein matrix, without precipitation and peculiar smell, fully meeting the industrial production needs of high-end food.

4 High-end Scenario Revolution

Global full-dimensional regulatory compliance covering food, infant formula, special medical use, medicine, oral cavity, feed and other fields; tasteless sensory property and strong formula compatibility break the flavor and system barriers of traditional magnesium sources, supporting the nutritional premium of high-end products; accurately adapting to the precise nutritional needs of special groups, building differentiated competitive barriers of organic chelated magnesium, leading the upgrading of magnesium nutrition from basic supplementation to high-end, scenario-based and precise development.

IV. Application Scenarios and Addition Standards of Magnesium Citrate

1 Food Fortification Field

- **Formulated Milk/Yogurt/Ambient Dairy Products**: 15~30mg/kg elemental magnesium, clear dissolution and odorless, adapting to full high and low temperature processing technology;
- **Infant Formula Food**: 0.8~1.5mg elemental magnesium per 100kcal, safe and mild, adapting to infant physiological metabolism;
- **Formulated Milk Powder/Children's Nutrition Powder**: 85~180mg/kg elemental magnesium, assisting bone and nerve development;
- **Grain Baking/Leisure Food**: 30~120mg/kg elemental magnesium, high temperature resistance without affecting molding and taste;
- **Solid Beverage/Jelly**: 50~170mg/kg elemental magnesium, good dispersion, instant dissolution without stratification;
- **Fruit Juice/Plant Protein Beverage**: 15~35mg/kg elemental magnesium, stable in full pH range with color protection and browning inhibition.

2 Health Food/Pharmaceutical Field

- **Daily Magnesium Supplementation for Adults**: 100~150mg elemental magnesium per day, available on an empty stomach or after meals, improving fatigue, insomnia and limb numbness;
- **Middle-aged and Elderly/People with Insufficient Gastric Acid**: 120~180mg elemental magnesium per day, mild and long-acting, maintaining intestinal and bone health;
- **Children and Adolescents**: 60~100mg elemental magnesium per day, safe and non-irritating, assisting growth and development;
- **Pharmaceutical Intestinal Conditioning**: Prepared according to clinical standard dosage for preoperative intestinal cleansing and relief of habitual constipation;
- **Postoperative/Chronic Disease Rehabilitation**: Supplemented by compound formula to balance electrolytes and promote physical recovery.

3 Special Medical/Sports Nutrition and Feed Field

- **Total Nutritional Formula for Special Medical Purposes**: 70~190mg/kg, low metabolic burden and strong formula compatibility;
- **Sports Electrolyte Granules/Protein Powder**: 80~200mg/kg, quickly supplementing magnesium and relieving sports fatigue and cramps;
- **Livestock and Poultry Feed**: 45~90mg/kg elemental magnesium, improving bone development and stress resistance of livestock and poultry;
- **Aquatic and Pet Food**: 35~75mg/kg elemental magnesium, promoting crust and bone development and maintaining electrolyte balance.

V. Industry Trends and Future Prospects

1 High-end and Segmentation Trend

The grading standards of food-grade, pharmaceutical-grade, special medical-grade, infant formula-grade and pet-grade are continuously improved; high-purity low-heavy metal, nano-micronized, sustained-release and liposome-targeted **Magnesium Citrate** become the mainstream of R&D; customized special models are developed for different ages, constitutions and diseases to expand emerging segmented scenarios such as precision medicine, elderly health care and children's complementary foods.

2 Green Manufacturing and Bio-based Trend

Traditional chemical synthesis technology is upgraded to biological fermentation coupled with green refining; clean production technologies such as low energy consumption, zero wastewater and mother liquor recycling are popularized; the proportion of synthetic routes of bio-based citric acid combined with natural mineral magnesium sources increases, conforming to the industrial orientation of carbon neutrality, green food and organic raw materials.

3 Formula Compound and Functional Trend

Compound premixes of **Magnesium Citrate + Vitamin D3 + Calcium Zinc + Prebiotics** are gradually standardized; customized compound formulas are launched for middle-aged and elderly bone maintenance, children's growth, sports electrolytes and intestinal conditioning; it extends from single magnesium supplementation to multi-functional compound directions such as bone health, sleep regulation, intestinal maintenance and immune enhancement to improve product added value.

4 Industrial Concentration and Globalization Trend

Domestic production capacity gradually gathers to leading compliant enterprises, forming a full industrial chain layout of synthesis - refining - micronization - application R&D; domestic high-purity **Magnesium Citrate** continues to export to the EU, Japan, South Korea, Australia and other markets. China has gradually become the core supply base of global high-end **Magnesium Citrate**, breaking the monopoly pattern of international brands in the high-end pharmaceutical and special medical-grade markets.

VI. Conclusion

With six core characteristics of **high bioavailability**, **weak gastric acid-dependent absorption**, **mild intestinal tolerance**, **wide pH thermal stability**, **excellent water solubility** and **low sensory peculiar smell**, **Magnesium Citrate** builds an irreplaceable industrial barrier in the field of organic chelated magnesium, forming a complete application system covering high-end nutritional supplementation - infant formula - liquid beverage fortification - pharmaceutical intestinal conditioning - special medical and sports nutrition.

The five classic application cases fully cover all high-end tracks including mass consumption, special groups, pharmaceutical industry and sports health, fully verifying its core value of high efficiency, safety, stability, easy processing and high adaptability. Mature industrial implementation and good market commercial returns have been realized in all scenarios, continuously promoting the iterative upgrading of food, health food, pharmaceutical and special medical industries towards refinement, mildness and high-end development.

As the preferred organic magnesium source for high-end magnesium supplementation and food nutritional fortification, **Magnesium Citrate** will rely on process purification, dosage form innovation, compound formula R&D and green manufacturing upgrading to continuously expand new application scenarios such as precise health care, pet nutrition and functional prepared food, providing core high-quality magnesium raw material support for national precise health, quality upgrading of food industry and stable supply of global nutritional raw material supply chain.