Analysis of Unique Properties of Lactitol

Overview

Lactitol (also known as lactosorbitol, CAS: 585-86-4) is a disaccharide alcohol functional sweetener prepared by catalytic hydrogenation and reduction of lactose, with the chemical structure of 4-O-β-D-galactopyranosyl-D-sorbitol. Since the 1980s, it has obtained regulatory recognition from global authoritative institutions including China, the European Union and JECFA. It is a low-calorie, low-glycemic and prebiotic sugar alcohol raw material. Featuring **low calorie, low GI, excellent acid-base and thermal stability, prebiotic activity, strong anti-caries effect and mild intestinal regulation**, it is one of the mainstream sugar alcohol sweeteners in the current market that meets the demands of sugar-free & sugar-reduced products, intestinal health and oral care.

I. Physical and Chemical Properties

1. Basic Chemical Information

- Chinese Name: Lactitol (Lactosorbitol)
- English Name: Lactitol
- Molecular Formula: $C_{12}H_{24}O_{11}$
- Molecular Weight: 344.32
- Structure: Disaccharide alcohol, linked by a β-1,4 glycosidic bond between galactose and sorbitol
- Source: Industrially produced mainly from lactose via catalytic hydrogenation, concentration, crystallization and drying; available in three crystalline forms: anhydrous, monohydrate and dihydrate.

2. Sensory and Physical Properties

- Appearance: White to off-white crystalline powder or colorless transparent liquid, odorless
- Sweetness: 30%–40% (relative to 100% sucrose), mild and pure taste without obvious after-bitterness or metallic odor
- Sweetness Quality: Fresh and soft flavor close to sucrose; compounded with high-intensity sweeteners to mask undesirable aftertastes
- Cooling Sensation: Weak endothermic dissolution with mild oral cooling feeling and no irritating coldness
- Solubility: Easily soluble in water (solubility ≈180g/L at 20°C), slightly soluble in ethanol, insoluble in organic solvents such as benzene, ether and chloroform
- Melting Point: 146°C–148°C (anhydrous type)
- Calorie Value: ≈2.4kcal/g (about 10kJ/g), equivalent to 60% of sucrose (4kcal/g)

3. Stability

- **Thermal Stability:** Excellent heat resistance (stable at ≤180°C), suitable for pasteurization, UHT sterilization, high-temperature baking and spray drying processes
- **pH Stability**: Broad stability within pH 3.0–7.0, applicable to acidic beverages, fermented foods and neutral systems; long-term heating stability slightly decreases at pH < 2 or pH > 8
- **Maillard Reaction:** Free of free reducing aldehyde groups, no Maillard browning reaction, maintaining clear

original color of food during processing

- **Caramelization：** No caramelization reaction at high temperature with extremely weak coloring, ideal for light-colored confectionery, baked goods and transparent beverages
- **Hygroscopicity：** Extremely low hygroscopicity, far lower than sorbitol and maltitol; powder resists moisture absorption and caking, suitable for dry foods such as candies and biscuits
- **Crystallinity：** Good crystallinity with uniform anhydrous crystal particles, applicable to hard candy and tablet candy production; controllable crystallization of aqueous solution with minimal sanding

II. Functional Characteristics

1. Metabolic Traits: Low-Calorie & Low-Glycemic, Non-Insulin-Dependent, Partially Fermented in Intestines

- **GI Value≈3**：Extremely low glycemic response, much lower than sucrose (GI=65), causing no significant postprandial blood glucose fluctuation
- **Absorption Mechanism：** Only 2%–3% slowly absorbed in the small intestine, while 97%–98% directly enters the large intestine for fermentation and utilization by intestinal microorganisms
- **Non-Insulin-Dependent：** Metabolism does not stimulate insulin secretion or affect insulin sensitivity, suitable for diabetic patients
- **Non-Cariogenic：** Cannot be fermented and utilized by oral Streptococcus mutans, producing no acid and no enamel corrosion

2. Physiological Functions

(1) Blood Glucose and Metabolic Regulation (Diabetes & Weight Management Friendly)

- Low glycemic and low insulin response with stable postprandial blood glucose and no blood glucose peak
- Applicable Groups：Partial sucrose replacement for type 1/type 2 diabetes, impaired glucose tolerance, obesity and weight-control populations
- Auxiliary Lipid Regulation：Long-term sucrose replacement mildly reduces serum cholesterol and triglycerides to improve blood lipid profiles

(2) Intestinal Health Regulation (Prebiotic + Mild Laxative)

- Prebiotic Activity：Selectively promotes the proliferation of beneficial bacteria such as Bifidobacteria and Lactobacilli, inhibits harmful bacteria growth and optimizes intestinal microecology
- Mild Laxative Effect：Intestinal fermentation produces short-chain fatty acids to gently stimulate intestinal peristalsis, soften stool and relieve functional constipation
- High Tolerance：No obvious abdominal distension or diarrhea with daily intake ≤20g for adults, better tolerance than prebiotics such as FOS and inulin

(3) Oral Health (Powerful Anti-Caries)

- Strong Anti-Caries Performance：Inhibits oral pathogenic bacteria (Streptococcus mutans), reduces dental plaque formation, blocks acid production and lowers caries incidence
- Applicable Scenarios：Preferred sugar alcohol sweetener for sugar-free chewing gum, hard candy, children's food, toothpaste and mouthwash

(4) Liver Health (Auxiliary Blood Ammonia Reduction)

- Blood Ammonia Reduction: Reduces intestinal absorption of ammonia substances, assists in relieving symptoms of hepatic encephalopathy and protecting liver function

(5) Metabolic Safety

- No Accumulation or Residue: No in-vivo accumulation; unabsorbed portions are excreted after fermentation without metabolic residues
- No Hepatic and Renal Burden: Metabolism does not increase liver and kidney load, suitable for moderate consumption by patients with liver and kidney diseases

III. Unique Performance Advantages

1. Taste: Soft Fresh Sweetness, Low Pure Sweetness, Synergistic Blending Effect

- Mild Sweetness (30%–40% of sucrose): Moderate sweetness for independent use or compounding with high-intensity sweeteners to meet sugar reduction demands
- Pure Sucrose-Like Flavor: Free of after-bitterness, metallic taste and cooling irritation; sucrose-close taste with high consumer acceptance
- Synergistic Compounding Effect: Blended with erythritol, stevia and sucralose for complementary sweetness, mellow flavor and masked aftertaste of high-intensity sweeteners
- Flavor Stability: No sweetness attenuation or flavor deterioration after high-temperature processing, retaining the original aroma of food

2. Processing Performance: High Temperature & Acid Stability, Low Hygroscopicity, Wide Compatibility

- High Temperature and Acid Resistance with Strong Stability: Stable processing at pH 3.0–7.0 and ≤180℃, adaptable to baking, confectionery, beverages, frozen foods and other scenarios
- Low Hygroscopicity and Anti-Caking: Lower hygroscopicity than other sugar alcohols, extending shelf life of dry foods and cutting packaging costs
- Non-Browning and Non-Coloring: Free of Maillard reaction and caramelization, maintaining food clarity and improving product appearance quality
- Strong Formula Compatibility: No incompatibility with common food ingredients (acids, alkalis, salts, flavors, pigments, colloids) for flexible formula adjustment

3. Health Value: Low-Calorie Sugar Control, Dental & Liver Protection, Prebiotic Empowerment

- Low Calorie (2.4kcal/g): 60% calorie content of sucrose, reducing obesity risks with no burden for weight management
- Low GI & Low Glycemic: Safe partial sucrose replacement for diabetic patients with steady postprandial blood glucose and no glycemic peaks
- Triple Health Benefits: Dental protection, liver protection and intestinal regulation; optimal choice for children, middle-aged and elderly groups, chronic disease patients and intestinal sensitive populations
- Natural Prebiotic Modulator: Optimizes intestinal microecology to boost intestinal health and conform to the consumption trend of functional foods

4. Regulation and Safety Certification

- China (1994): Approved by GB 2760 with CNS No. 19.014, allowed for use in various foods in appropriate amounts as required by production
- European Union (1983): Approved by EFSA as E966 with confirmed safety, permitted in food and beverages with authorized health claims
- JECFA (1983): ADI value "Not Specified", the highest safety grade with no daily intake limit
- USA (1983): FDA GRAS certified, applicable to various foods, beverages, nutritional supplements and diabetes-specific foods
- Toxicology: Oral LD_{50} > 10g/kg bw (rats), practically non-toxic; more than 100 toxicological studies verify long-term edible safety with no carcinogenic, teratogenic or mutagenic risks

IV. Summary

Lactitol is an all-round sugar alcohol sweetener featured with natural sugar alcohol source, mild low sweetness, low calorie, low GI, excellent temperature stability, strong anti-caries property, prebiotic activity and auxiliary liver protection & lipid regulation. With the combined strengths of **low-calorie sugar control, universal processing adaptability, multi-dimensional health benefits (dental protection, liver care and intestinal regulation) and high-level safety & prebiotic efficacy**, it has become a mainstream sweetening and healthy solution for sugar-free confectionery, baked goods, functional beverages, yogurt & fermented milk, diabetes-specific foods, children's nutritional foods and oral care products. Among sugar alcohol sweeteners, it delivers the widest application coverage, diversified health values and stable market potential.