Analysis of the Unique Properties of Erythritol

Overview

Erythritol (meso-Erythritol, CAS: 149-32-6) is a naturally occurring four-carbon sugar alcohol (polyol) with a meso-butane-1,2,3,4-tetrol structure. It has been legally approved by many countries and authoritative institutions worldwide since 1990, including Japan, the United States, China, the European Union and JECFA, as a sweetener raw material of the highest safety level. Featuring core advantages such as a pure taste close to sucrose, zero calories, zero GI, ultra-high processing stability, strong anti-caries effect and high intestinal tolerance, it is one of the bulk sweeteners with the best comprehensive performance on the current market.

I. Physicochemical Properties

1. Basic Chemical Information

- Chinese Name: Erythritol
- English Name: Erythritol / meso-Erythritol
- Molecular Formula: $C_4H_{10}O_4$
- Molecular Weight: 122.12
- Structure: Four-carbon sugar alcohol, meso isomer, molecule containing 4 hydroxyl groups (-OH)
- Source: Naturally present in trace amounts in animals, plants and fermented foods such as grapes, pears, melons, mushrooms, wine and soy sauce; industrially produced by glucose fermentation using osmophilic yeast (mainstream method).

2. Organoleptic and Physical Properties

- **Appearance:** White crystalline powder / bipyramidal crystals, odorless
- Sweetness: 60%–70% (relative to sucrose at 100%)
- **Sweetness Quality:** Pure sucrose-like taste, no bitterness, metallic taste or after-astringency, refreshing and clean mouthfeel
- **Cooling Effect:** Endothermic dissolution (heat of solution -96.86 kJ/kg), providing a cooling sensation in the mouth (similar to mint)
- **Solubility:** Freely soluble in water (solubility ≈37g/100mL at 25°C), forming a clear aqueous solution
- **Melting Point:** 119°C–123°C
- **Caloric Value:** 0.2 kcal/g (0.84 kJ/g), only 1/20 of that of sucrose (4 kcal/g), labeled as "zero-calorie"

3. Stability (Processing Compatibility)

- **Thermal Stability:** Extremely heat-resistant (no decomposition ≤329°C), resistant to baking, cooking and ultra-high temperature sterilization

- **pH Stability:** Broad-spectrum stability at pH 2–12, compatible with all types of food in strong acid / strong alkali / neutral systems
- **Maillard Reaction:** Does not undergo Maillard browning, maintaining the original color of food without yellowing during processing
- **Caramelization:** Resistant to caramelization, with extremely weak coloration and no off-color at high temperatures
- **Non-Hygroscopicity:** Completely non-hygroscopic (weight gain <2% at 90% humidity), excellent stability for powder / tableting / hard candy applications
- **Crystallinity:** Easy to crystallize, crystals readily precipitate from high-concentration solutions, suitable for the production of hard candies and chewy candies

II. Functional Characteristics

1. Metabolic Properties: Zero Burden, No Blood Glucose Elevation

- GI Value = 0: Does not raise blood glucose or stimulate insulin secretion at all
- Absorption Mechanism: Rapidly absorbed in the small intestine (≈90%), no degrading enzymes in the human body, excreted intact in urine within 24 hours
- No Participation in Energy Metabolism: Generates almost no calories and is not converted into fat
- Non-Cariogenic: Cannot be fermented and utilized by Streptococcus mutans in the oral cavity, producing no acid and eroding no tooth enamel

2. Physiological Functions

(1) Blood Glucose and Metabolic Regulation (Core Glycemic Control)

- Zero blood glucose elevation, zero insulin response, no postprandial blood glucose fluctuation
- Suitable for long-term safe consumption by people with diabetes, impaired glucose tolerance, low-carb diets and weight management
- Does not affect glucose and lipid metabolic pathways, imposing no metabolic burden

(2) High Intestinal Tolerance (Optimal Among Sugar Alcohols)

- 90% absorbed in the small intestine, with only a small amount (<10%) entering the large intestine, almost no fermentative gas production
- Tolerance Dose: ≤50g per day for adults without discomfort, 2–4 times that of xylitol / sorbitol
- Risk of bloating / diarrhea is much lower than other sugar alcohols, with optimal gastrointestinal compatibility

(3) Strong Antioxidation and Cell Protection

- Efficiently scavenges hydroxyl radicals (· OH) and superoxide anions (O_2^- ·)

- Inhibits lipid peroxidation, protects vitamin C/E, and stabilizes food color and nutrition
- Reduces oxidative stress, protecting vascular endothelium and cellular DNA

(4) Oral and Microbiota Health

- Anti-caries (non-cariogenic), inhibits oral pathogenic bacteria and maintains tooth enamel health
- Does not interfere with intestinal flora or cause dysbiosis, prebiotic-friendly

III. Unique Performance

1. Taste: Pure and Clean, Cool and Sweet

- Clean sweetness closest to sucrose, no aftertaste bitterness / off-flavor / residual cooling sensation
- Perfectly masks the aftertaste bitterness / metallic taste of high-potency sweeteners such as steviol glycosides and mogrosides, with excellent compounding compatibility
- Cooling sensation enhances flavor experience, suitable for cool-type products such as beverages, candies and ice cream

2. Processing: All-Scenario Stable, Industry-Friendly

- Ultra-heat-resistant, acid and alkali resistant: compatible with full processes of baking, beverages, canned food, hard candies and sterilized food
- No browning or discoloration: maintains product original color and pure appearance (solves the browning pain point of allulose / sucrose)
- Zero hygroscopicity, easy crystallization: powder non-caking, good tableting formability, extremely long shelf life
- Moderate solubility, controllable crystallization: excellent formability for hard candies / chewy candies / lozenges

3. Health: Safe and Zero-Burden, Multi-Dimensional Benefits

- Truly zero-calorie, zero-GI, zero-insulin response, dual adaptation for glycemic and weight control
- Highest tolerance among sugar alcohols, almost no gastrointestinal discomfort, safe for long-term consumption
- Natural source, endogenous substance in the human body (trace synthesis via human metabolism), extremely high compatibility
- Does not raise uric acid or affect purine metabolism, friendly to people with gout

4. Regulatory Status and Safety (Globally Authoritatively Recognized)

- China (2007): Ministry of Health Announcement, GB 2760-2014, used appropriately according to production needs, no upper limit

- United States (1997): FDA GRAS (GRN 000012), zero-calorie labeling and dental health claims permitted
- JECFA (1999): No ADI value specified (highest safety level)
- EU EFSA (2023): Re-evaluation confirms no genotoxic / reproductive / carcinogenic toxicity, no safety risks
- Japan (1990): Food additive, zero-calorie certification
- Toxicology: LD_{50} > 20g/kg bw (practically non-toxic), no chronic toxicity risks

IV. Summary

Erythritol is a new-generation benchmark sweetener of natural origin, featuring zero calories, zero GI, ultra-high stability and high tolerance. With the combined advantages of pure sucrose-like taste, all-scenario processing compatibility and all-round health and safety, it has become a golden sweetener solution for glycemic control, weight management, oral health and the food industry. Its comprehensive performance is globally leading and irreplaceable among sugar alcohols.