Analysis of the Unique Properties of Polydextrose

Overview

Polydextrose is a highly branched, randomly cross-linked water-soluble dietary fiber refined from glucose, sorbitol, and citric acid via high-temperature vacuum polycondensation. With a main chain of β-1,6 glycosidic linkages, it has an average molecular weight of approximately 3,200 and a maximum molecular weight of less than 22,000. Featuring excellent physicochemical stability, comprehensive health functions, and broad processing adaptability, it serves as a core functional ingredient in food, health care products, and pharmaceutical applications, providing a one-stop solution for the development of sugar-reduced, fat-reduced, and high-fiber products.

I. Core Physicochemical Properties

1. Basic Characteristics and Solubility

- **Appearance:** White to off-white powder/granules, odorless, neutral taste, nearly non-sweet; refined-grade product purity ≥ 90.0%.
- **Solubility:** Solubility reaches 70%–80% at 25°C, significantly higher than sucrose, sorbitol, and xylitol. Solubility increases further with rising temperature, forming colorless and transparent solutions suitable for high-solids formulations.
- **pH and Stability:** 10% aqueous solution has a pH of 2.5–7.0 (nearly neutral for refined grade). It is acid-resistant, heat-resistant, and alkali-resistant, with stable structure at 200°C and no degradation after open storage for over 90 days at 25°C/45°C/60°C, adapting to extreme processing scenarios such as baking, extrusion, and high-temperature sterilization.

2. Rheological and Textural Properties

- **Viscosity Regulation:** Viscosity is higher than that of sucrose at the same concentration and decreases with increasing temperature (consistent with sucrose behavior). It can be used as a thickener and stabilizer to optimize product texture.
- **Gelation and Moisture Retention:** The molecule contains abundant hydroxyl groups, enabling efficient water absorption under high humidity and regulating water activity in food. It forms a gel-like structure with water, mimicking a fatty mouthfeel, increasing bulk, improving texture, and reducing sugar/fat usage.
- **Anti-Crystallization and Freezing Point Adjustment:** Amorphous structure forms a transparent glassy substance upon cooling without crystallization. Its freezing point is lower than sucrose, inhibiting ice crystal growth in frozen foods and enhancing smoothness and freeze-thaw stability.

3. Energy and Metabolic Properties

- Low Caloric Value: Caloric coefficient is only 1 kcal/g, one-fourth that of sucrose (4 kcal/g), meeting the demand for low-energy food development.
- Indigestibility: Human α-amylase cannot break down its β-glycosidic linkages. It does not raise blood glucose or cause dental caries, with a relative glycemic response of only 5–7 (glucose = 100), suitable for diabetic populations and sugar-controlled applications.

II. Core Functional Properties

1. Intestinal Health and Prebiotic Function

- **Regulation of Intestinal Microecology:** As a highly effective prebiotic, it reaches the colon intact and is fermented by beneficial bacteria such as Bifidobacterium and Lactobacillus to produce short-chain fatty acids (SCFAs), promoting the growth of beneficial bacteria, inhibiting harmful bacteria, and optimizing the intestinal flora structure.
- **Promotion of Intestinal Peristalsis:** Increases fecal volume, shortens intestinal transit time, reduces colonic pressure, improves constipation, decreases contact time between harmful intestinal substances and the intestinal wall, and lowers the risk of intestinal diseases.
- **Adsorption of Harmful Substances:** The molecular structure contains ion exchange sites, which efficiently adsorb bile acids, cholesterol, and carcinogens, reducing human absorption, assisting in blood lipid regulation, and protecting the intestinal mucosa.

2. Metabolic Regulation and Weight Management

- **Enhancement of Satiety:** Forms a viscous film in the small intestine to entrap dietary fats, reducing caloric absorption by approximately 30%. Daily intake of 8g stimulates the secretion of the satiety signal GLP-1, prolonging satiety and supporting weight control.
- **Stabilization of Postprandial Blood Glucose:** Delays glucose absorption, reduces postprandial blood glucose peaks and fluctuations, suitable for low-GI foods, sugar-controlled foods, and foods for special medical purposes.

3. Nutrient Absorption and Bone Health

- **Promotion of Mineral Absorption:** SCFAs produced by fermentation acidify the intestinal environment, increasing the absorption rate of calcium and iron by approximately 40%, supporting bone health and nutritional supplementation for products targeting the elderly, children, and pregnant women.

4. Processing Adaptability and Texture Optimization

- **Sugar/Fat Replacement:** Replaces 20%–50% of sucrose/fat, reducing calories while retaining taste, suitable for baked goods, dairy products, frozen foods, confectionery, and other categories, achieving "sugar reduction without quality loss, fat reduction without flavor loss".
- **Anti-Aging and Water Retention:** Delays starch retrogradation and inhibits moisture migration, extending the shelf life of baked goods by approximately 50% and improving the softness and freshness of bread and pastries.
- **Clean Label Compatibility:** Aligns with the global clean label trend, allowing labeling as "dietary fiber" and "prebiotic", meeting consumer health demands and enhancing product premium and market competitiveness.

III. Unique Performance Advantages

1. Unique Structure: Random Cross-Linking + High Branching, Comprehensive Functions

- Unlike linear dietary fibers (e.g., inulin, resistant dextrin), its randomly cross-linked and highly branched structure delivers high stability, high solubility, and strong moisture retention, while integrating full-dimensional functions including prebiotic activity, satiety enhancement, glycemic control, and mineral absorption promotion with no single functional weakness.
- Controllable molecular weight distribution (average degree of polymerization ~20) ensures stable functional performance independent of raw material sources, suitable for large-scale industrial production.

2. Processing Tolerance: Stable Performance Under Extreme Conditions, Full-Scenario Adaptability

- Resistant to 200°C high temperature, acid, alkali, and freezing, compatible with all food processing techniques including baking, extrusion, high-temperature sterilization, freezing, and spray drying without degradation, denaturation, or impact on product flavor and texture.
- Excellent compatibility with proteins, starches, oils, fats, sweeteners, and other ingredients, with no incompatibilities, simplifying formulation development.

3. Broad Applicability: Multi-Domain Coverage, Cost Reduction and Efficiency Improvement

- Food Industry: Dairy products (yogurt, milk powder), baked goods (bread, biscuits), beverages (functional drinks, instant solid drinks), frozen foods (ice cream, desserts), confectionery, meat products, etc., enhancing fiber content, optimizing texture, and reducing costs.
- Health Care Products: Dietary fiber supplements, probiotic synergistic products, sugar/weight control formulas, strengthening health claims.
- Pharmaceutical / Personal Care: Pharmaceutical excipients, dietary fiber-based medicines, moisturizers, etc., expanding application boundaries.

4. Cost-Effectiveness: Large-Scale Production + Low Cost, Strong Market Penetration

- Mature production technology and readily available raw materials result in lower costs than high-end dietary fibers such as inulin and fructo-oligosaccharides. Solid form offers a 36-month shelf life with low transportation and storage costs, outstanding cost-effectiveness, suitable for the mass market and large-scale applications.

IV. Commercial Value Summary

With its unique randomly cross-linked structure, excellent physicochemical stability, comprehensive health functions, and broad processing adaptability, polydextrose has become a core ingredient for the sugar-reduced, fat-reduced, and high-fiber upgrading of the food industry. Its five core values—low calorie, prebiotic activity, glycemic control, mineral absorption promotion, and texture optimization—meet consumer health needs while helping enterprises reduce costs, improve efficiency, and enhance competitiveness. As an all-round solution for functional foods, health care products, and pharmaceuticals, it boasts broad market prospects.