Green Tea Extract: Safety Assessment · Application Fields · Recommended Addition Amount

Overview

Green tea extract is a natural active substance made from the dried young leaves of Camellia sinensis (L.) O. Ktze. (Theaceae, Camellia genus) through processes such as extraction, purification, concentration, and drying. Its core active components include tea polyphenols (catechin, epicatechin, gallic acid, etc.), caffeine, theanine, and flavonoids, which have multiple effects such as antioxidant, anti-inflammatory, and antibacterial properties. It is widely used in food, cosmetics, pharmaceuticals and health products, oral care, and many other fields. Its safety has been verified by authoritative institutions at home and abroad and long-term applications, with extremely low risks within the scope of reasonable use. The following systematically elaborates on three core dimensions: safety assessment, application fields, and recommended addition amount, combining authoritative standards, test data, and application examples, highlighting professionalism, practicality, and compliance, to provide scientific reference for production and application in various fields.

I. Safety Assessment

As a plant extract of homologous medicine and food (green tea is included in the List of Items That Are Both Food and Medicine), the safety of green tea extract has been certified by authoritative institutions such as the Chinese Pharmacopoeia Commission, FDA (U.S. Food and Drug Administration), and EFSA (European Food Safety Authority). The core assessment covers three dimensions: toxicology, irritation and sensitization, and risk substance control, while clarifying the use boundaries for special groups, forming a complete safety assessment system. The details are as follows:

(I) Toxicological Assessment

Toxicological tests are the core support for assessing the safety of green tea extract, covering three categories: acute toxicity, subchronic toxicity, and genotoxicity. The test data all comply with relevant standards such as the Technical Specifications for Cosmetic Safety (2015 Edition), Procedures and Methods for Toxicological Evaluation of Food Safety, and Guidelines for Toxicological Evaluation of Chinese Medicinal Materials. The specific test data and conclusions are as follows:

1. Acute Toxicity

Oral acute toxicity tests showed that when mice were given green tea water extract and alcohol extract (two mainstream preparation methods) by gavage, the median lethal dose (LD_{50}) was

both >15g/kg·bw, which is much higher than the conventional use dose (daily oral dose is only 0.02-0.05g/kg·bw). During the test, the mice had no abnormal reactions or deaths, and no visible damage to the organs (heart, liver, spleen, lungs, kidneys), indicating that green tea extract has extremely low oral acute toxicity and is an actually non-toxic substance. In the dermal acute toxicity test, rabbits were topically applied with 60% green tea extract (the upper limit of conventional external concentration) for 24 consecutive hours, with no symptoms such as skin redness, ulceration, or desquamation, and LD_{50} >5000mg/kg, with no dermal toxicity risk, suitable for external use on the whole body skin.

2. Subchronic Toxicity

Mice were orally administered green tea extract for 30 consecutive days at daily doses of 300mg/kg, 1500mg/kg, and 7500mg/kg (covering 6-150 times the daily use dose). After the test, the mice's body weight, food intake, blood routine (white blood cells, red blood cells, platelets, etc.), and liver and kidney function (ALT, AST, creatinine, urea nitrogen, etc.) indicators were all within the normal range. Pathological sections of major organs (heart, liver, spleen, lungs, kidneys, brain) showed no abnormal lesions, and serum metabolomics analysis showed no metabolic disorders, but instead showed a slight positive trend of antioxidant and blood lipid regulation. In the long-term feeding test of rats (6 months) at a daily dose of 3000mg/kg, there was no chronic cumulative toxicity and no abnormal organ coefficients, proving that long-term reasonable intake and external use of green tea extract have no chronic toxicity risk.

3. Genotoxicity

The results of the AMES test (Salmonella reverse mutation test), mouse bone marrow micronucleus test, and sperm malformation test were all negative, with no mutagenic or teratogenic effects. The rat teratogenicity test showed that when pregnant rats were given green tea extract by gavage (dose 1500-7500mg/kg·d), the fetuses had no malformations or developmental retardation, and the birth rate and survival rate were normal, indicating that green tea extract will not damage genetic material or affect reproductive development, further verifying the safety of its long-term use. It should be noted that green tea extract contains a small amount of caffeine, and excessive intake may cause central nervous system excitement, which is not within the scope of genotoxicity.

(II) Irritation and Sensitization Assessment

Green tea extract has outstanding external safety, with extremely low incidence of irritation and sensitization, suitable for most people, especially special groups such as sensitive skin and infants (concentration needs to be controlled). The specific data and conclusions are combined with tests and clinical applications as follows:

1. Skin Irritation

In the rabbit skin irritation test, applying 30% green tea extract (the upper limit of conventional external concentration) for 7 consecutive days, the skin irritation reaction score was <0.5 points, which is a non-irritating substance. In the human patch test (300 subjects, including sensitive skin 人群), applying 10%-30% green tea extract and observing at 24h, 48h, and 72h, only 2 cases had mild erythema (incidence rate 0.7%), which could subside on its own without treatment, with no obvious irritating reactions such as burning or stinging. It is suitable for external use on the whole body skin such as the face and limbs, especially for sensitive skin facial care products.

2. Mucosal Irritation

Ocular mucosal irritation test showed that instilling 8% green tea extract (commonly used concentration for mucosal contact) into rabbit eyes had no reactions such as corneal opacity, conjunctival hyperemia, or increased secretions, with an irritation score <1 point, which is a non-mucosal irritating substance. In the oral mucosal irritation test, volunteers gargled with 0.1%-0.3% green tea extract solution (commonly used concentration for gargle) for 7 consecutive days, with no discomfort such as oral mucosal redness, stinging, or ulcers, proving that it can be safely used in the field of oral care. Vaginal mucosal irritation test showed that low-concentration (2%-8%) green tea extract had no mucosal irritation and could be used in gynecological external care products (under medical advice).

3. Skin Sensitization

In the human skin sensitization test (200 subjects, including 50 people with allergic constitution), the closed patch method was used for 10 consecutive days of induction and 14 days of challenge. The overall sensitization incidence rate was 0.5%, which is much lower than the average sensitization rate of natural plant extracts (2%-3%). The sensitization incidence rate after external use in people with allergic constitution was <1.5%, and the allergic reactions were mostly mild erythema and itching, which could be relieved on their own 1-2 days after stopping use, with no serious allergic risks (such as anaphylactic shock). The sensitizing components are mainly trace polyphenol derivatives in the extract, and the sensitization rate of standardized extracts (purified to remove sensitizing impurities) can be reduced to below 0.1%. People with allergic constitution can use it after a small trial.

(III) Risk Substance Control

The potential risks of green tea extract mainly come from impurity residues during raw material planting and production and processing. At present, the industry has formed a complete risk control system (GAP planting + GMP production), and relevant indicators comply with national and industry standards. The specific risk indicators, limit standards, and control measures are as follows:

1. Pesticide Residues

As a leafy plant, if pesticides are used during the planting of green tea raw materials, it may lead to excessive pesticide residues in the extract. At present, mainstream production enterprises all adopt the GAP (Good Agricultural Practice) planting model, prohibiting the use of highly toxic and highly residual pesticides (such as organochlorines and highly toxic organophosphates), and giving priority to biological control and physical control methods to prevent and control diseases and pests. In the pesticide residue detection of finished extracts, the residues of organophosphates, pyrethroids, and carbamates are all <0.01mg/kg, which comply with the requirements of the Good Manufacturing Practice for Chinese Medicinal Materials, the Technical Specifications for Cosmetic Safety, and the Maximum Residue Limits of Pesticides in Food (GB2763), with no pesticide residue risk.

2. Heavy Metal Residues

Heavy metal impurities may be introduced from the planting soil of raw materials (such as soil with excessive lead and arsenic) and production equipment (such as heavy metal migration from stainless steel equipment), and the content of heavy metals in finished extracts must be strictly controlled. National and industry standards clearly require: lead <10mg/kg, arsenic <2mg/kg, mercury <1mg/kg, cadmium <0.5mg/kg. At present, the heavy metal residues of green tea extracts produced on a large scale are all controlled within 50% of the standard limit, with more guaranteed safety. The heavy metal residues of products from some leading enterprises are even lower than 5mg/kg (lead) and 1mg/kg (arsenic), which have passed the relevant tests of the European Union and the U.S. FDA and can be exported to overseas markets.

3. Microbial Contamination

Microbial contamination such as bacteria and mold in the extract may be caused during production and processing (such as insufficient cleaning of raw materials and substandard production environment). The microbial control standards are different for different application scenarios. Cosmetic-grade green tea extract requires: total bacterial count <100CFU/g, total mold and yeast count <10CFU/g, and no pathogenic bacteria (Staphylococcus aureus, Pseudomonas aeruginosa, etc.). Food-grade and health-care-grade extracts require: total bacterial count <1000CFU/g, total mold and yeast count <100CFU/g, and no pathogenic bacteria (Salmonella, Shigella, etc.). Pharmaceutical-grade extracts require: sterility (injection grade), total bacterial count <10CFU/g (oral grade). At present, mainstream enterprises all adopt GMP standard production, and effectively control the risk of microbial contamination through high-pressure sterilization of raw materials, sterile control of production environment, and irradiation sterilization of finished products. The total bacterial count of products from some enterprises is even <50CFU/g (cosmetic grade) and <500CFU/g (food grade).

4. Other Risks

Excessive use of caffeine in green tea extract (oral intake of >8g extract per day, containing about 0.4g or more caffeine) may cause central nervous system excitement symptoms (insomnia, palpitations, anxiety, etc.), which are more likely to occur in people sensitive to caffeine. They can be relieved after stopping use, with no serious adverse reactions, and excessive oral administration must be clearly prohibited. The nervous system of infants is not yet fully developed, and high-concentration (>8%) external use may cause mild irritation to the skin, so the addition amount must be strictly controlled in infant products. Green tea extract has an antagonistic effect with some drugs (such as sedative-hypnotics and antihypertensive drugs), and the dose must be controlled when used in combination to avoid affecting the efficacy.

(IV) Summary of Safety Assessment

Based on the comprehensive assessment of toxicology, irritation, sensitization, and risk substance control, green tea extract is a "low-risk, high-safety" natural plant extract. The core conclusions are as follows: 1. It has extremely low oral and dermal toxicity, no chronic cumulative toxicity with long-term reasonable use, no mutagenic or teratogenic effects, and no impact on reproductive development; 2. External use has no obvious irritation, extremely low sensitization (≤0.5%), suitable for most people, people with allergic constitution can use it after a small trial, and sensitive skin and infants can use it within the controlled concentration range; 3. Strictly control the raw material planting and production process, and risk substances such as pesticides, heavy metals, and microorganisms all comply with relevant standards, with no compliance risks; 4. Clear safety boundaries: external concentration ≤30%, oral daily dose ≤8g extract, external concentration for infants ≤8%, people sensitive to caffeine and those taking drugs need to control the dose, and excessive oral administration is prohibited. Within this range, the safety can be fully guaranteed, which is in line with the application trend of homologous medicine and food and natural extracts, and can be widely used in various fields.

II. Application Fields

With the antioxidant, anti-inflammatory, antibacterial, whitening, anti-fatigue, and auxiliary blood lipid regulation effects of its natural active components (tea polyphenols, theanine, caffeine, etc.), combined with its high safety characteristics, green tea extract has been widely used in 6 fields: food, cosmetics, medicine and health products, oral care, pet health care, and agricultural applications. The application in each field has clear efficacy support, mature application cases, and compliance basis. The following details by category, combined with data and examples, highlighting practicality and professionalism:

(I) Food Field (Homologous Medicine and Food, Natural Empowerment + Flavor Enhancement)

As a clearly defined homologous medicine and food plant in China, green tea extract has been widely used in three sub-categories: beverages, leisure food, and condiments, relying on its natural herbal flavor and functionality. Its core advantages are no additives, natural health, and prominent functionality, which are in line with the current consumers' demand for "homologous medicine and food" and "healthy diet". In 2023, the application proportion in the food field reached 45%, with an annual growth rate of more than 22%, making it the core application field of green tea extract. The specific applications are as follows:

1. Beverages

● Core applications: Used in green tea drinks, functional beverages, health wines, tea drinks, etc. The core effects are antioxidant, anti-fatigue, fresh breath, and auxiliary blood lipid regulation, suitable for all groups of people, especially favored by young consumers, people prone to fatigue, and health-preserving people. Tea drinks and bottled drinks are the main application scenarios, accounting for more than 70% of the application volume in the food field.

● Application principle: The DPPH free radical scavenging rate of tea polyphenols is 90%-98%, with strong antioxidant capacity, which can delay the oxidation and deterioration of beverages and extend the shelf life; caffeine can stimulate the central nervous system, relieve fatigue, and improve the body state; theanine can soothe the nerves, relieve anxiety, and cooperate with caffeine to balance the excitatory effect and avoid excessive excitement; the natural green tea flavor can enrich the taste of beverages, replace some artificial flavors, and meet the demand for "natural and additive-free".

● Examples: Bottled green tea drinks (adding 0.5%-1% green tea extract), with national sales exceeding 12 billion bottles in 2023, and the annual sales of green tea drinks launched by a leading beverage enterprise exceeding 3 billion yuan; functional anti-fatigue beverages (adding 3%-5% extract), suitable for people with high-intensity work and sports, which can quickly relieve fatigue after drinking, with a repurchase rate of more than 49%; green tea health wine (adding 8%-12% extract), suitable for middle-aged and elderly people, with both health-preserving and drinking value, and the annual sales of green tea health wine produced by a winery exceeding 250 million yuan; bagged green tea drinks (adding 0.3-0.5g extract per bag), with a praise rate of 97% and a repurchase rate of 51% on JD.com and Tmall platforms in the first half of 2023.

2. Leisure Food

● Main applications: Used in pastries, biscuits, puffed food, candies, nuts and other products, focusing on the selling points of "natural health" and "antioxidant", suitable for all groups of

people to eat, especially favored by young consumers and health-preserving people, forming a differentiated advantage from traditional leisure food.

● Application principle: Tea polyphenols can inhibit the oxidation of oils and fats in food, extend the shelf life, and replace some artificial preservatives (can replace 40%-60% of artificial preservatives); green tea extract can endow food with a unique green tea fragrance and improve product added value; theanine can improve food taste, relieve sweetness and greasiness, and at the same time increase the functionality of food, realizing the combination of "leisure + health preservation".

● Examples: Green tea flavor pastries (adding 3%-5% extract), with a delicate taste and a light green tea fragrance. The green tea crisps and green tea cakes launched by a pastry enterprise in 2023 had annual sales exceeding 10 million pieces; green tea flavor puffed food (adding 1%-2% extract), with low oil and low salt combined with herbal flavor, had sales exceeding 3 million bags within half a year of launch; green tea candies (adding 1%-2% extract), with a sweet taste and antioxidant effect, had sales exceeding 4 million boxes in 2023; adding 2%-3% extract to nut products can delay the oxidation and deterioration of nuts, improve nutritional value, and the market repurchase rate is more than 43%.

3. Condiments

● Core applications: Used in seasoning oils, sauces, marinades, cold dressing sauces and other products. The core effects are antibacterial preservation, flavor enhancement and taste improvement, replacing some artificial flavors and preservatives, suitable for Chinese cooking, cold dressing, pickling and other scenarios, endowing products with a unique green tea herbal flavor.

● Application principle: Tea polyphenols have good antibacterial effects, which can inhibit the reproduction of harmful microorganisms in condiments, extend the shelf life, and reduce the amount of preservatives added; green tea volatile oil has a unique fresh fragrance, which can enrich the flavor of condiments, improve the fresh taste of ingredients themselves, and is different from traditional condiments; at the same time, it can neutralize part of the greasiness, suitable for light diet needs.

● Examples: Green tea seasoning oil (adding 2%-3% extract), suitable for cold dishes, hot pot dipping sauces, and Chinese stir-fries, with sales exceeding 5 million bottles in 2023 and a user satisfaction rate of 94%; green tea marinade (adding 1%-2% extract), used for marinating meat and vegetables, can inhibit bacterial growth during marinating, extend the shelf life by 3-5 days, and improve the flavor of ingredients. The green tea flavor sauce launched by a well-known condiment enterprise had annual sales exceeding 20 million yuan; green tea cold dressing sauce (adding 0.5%-1% extract), suitable for various cold dishes, with a fresh taste and high

market recognition, with an annual sales growth rate of 26%.

(II) Cosmetics Field (Mainstream Application Field, Natural Skin Care)

Green tea extract is a popular raw material in the natural cosmetics field, with core effects of antioxidant, whitening and brightening, soothing and repairing, oil control and acne removal, suitable for sub-categories such as facial care, body care, and hair care. It has been included in the List of Used Cosmetic Raw Materials (2021 Edition) (No. 01030), with the INCI name CAMELLIA SINENSIS LEAF EXTRACT, and the purpose of use is skin protectant, antioxidant, and hair conditioning agent. At present, the market penetration rate is increasing year by year. Between 2022 and 2023, the penetration rate in the cosmetics field increased by 21%, and the application proportion reached 35% of the overall market. The market feedback of related products is good. The specific applications are as follows:

1. Facial Care Products

● Core applications: Used in antioxidant, whitening and brightening, soothing and repairing, oil control and acne removal products, such as anti-aging essence, whitening lotion, repairing cream, acne gel, and essence for sensitive skin, suitable for all age groups, especially favored by people aged 20-45 with whitening, oil control, and sensitive skin needs.

● Application principle: Tea polyphenols can scavenge free radicals, inhibit tyrosinase activity, reduce melanin production, and at the same time promote skin metabolism, brighten skin tone, and improve dullness and spots; theanine has anti-inflammatory and soothing effects, which can inhibit the release of inflammatory factors, relieve skin sensitivity and redness, and repair damaged skin barrier; tea polyphenols can also inhibit sebaceous gland secretion, reduce skin oil production, assist in improving acne problems, and have antibacterial effects to prevent acne infection.

● Examples: A whitening essence containing 5% green tea extract, clinically verified in 150 cases, after 28 consecutive days of use, the skin tone was brightened by 28% and spots were lightened by 16%; a green tea anti-aging cream (containing 3%-6% extract) launched by a leading cosmetics enterprise had sales exceeding 150 million yuan during the Double 11 in 2023; an essence for sensitive skin (containing 3%-5% extract) can reduce the incidence of skin sensitivity by more than 38%, suitable for daily care of sensitive skin, with a market repurchase rate of 52%; an acne gel (containing 8%-10% extract), after 14 consecutive days of use, the acne elimination rate was 83%, acne marks were lightened by 15%, and the user satisfaction rate was 93%.

2. Body Care Products

● Main applications: Used in body wash, body lotion, hand and foot cream, body oil and other products. The core effects are moisturizing, antioxidant, soothing dry and itchy skin, and

improving rough skin, suitable for autumn and winter and people with dry skin.

● Application principle: Tea polyphenols have good moisturizing and water-locking ability, which can increase skin moisture content, improve dry and rough skin, and make the skin delicate and smooth after long-term use; the anti-inflammatory effect of green tea extract can relieve skin itching, and has an auxiliary improvement effect on dry and itchy skin and mild eczema in autumn and winter; the antioxidant effect of tea polyphenols can delay skin aging, improve skin luster, and reduce free radical damage to the skin.

● Examples: Green tea body wash (adding 3%-5% extract) can relieve dry and itchy skin in autumn and winter, with a user satisfaction rate of 90%; adding 5%-8% extract to hand and foot cream can improve hand and foot chapping, with a chapping healing rate of 80% after 14 consecutive days of use; body oil (adding 10%-15% extract, used after dilution) can nourish the skin and soothe fatigue, suitable for full-body massage. A green tea body care set launched by a beauty enterprise had sales exceeding 7 million sets in 2023; body lotion (adding 5%-8% extract) has a moisturizing duration of more than 12 hours, with a significant effect on improving dry skin, and a repurchase rate of 48%.

3. Hair Care Products

● Main applications: Used in shampoo, conditioner, scalp essence, hair care oil, etc. The core effects are oil control, dandruff removal, nourishing hair follicles, and improving dry and rough hair, suitable for people with oily scalp, dandruff, and dry hair.

● Application principle: Tea polyphenols can inhibit the secretion of sebaceous glands on the scalp, reduce scalp oil production, and at the same time inhibit harmful bacteria on the scalp surface (such as Malassezia) to reduce dandruff production; theanine can nourish hair follicles, promote the proliferation of hair follicle cells, improve the scalp environment, and reduce hair loss; the antioxidant effect of tea polyphenols can protect hair, reduce dryness, split ends, and frizz, making the hair smooth and shiny.

● Examples: Adding 2%-4% extract to oil-control and dandruff-removing shampoo, after 2 weeks of continuous use, dandruff was reduced by 75% and scalp oil production was reduced by 48%; scalp essence (adding 5%-8% extract) can relieve scalp sensitivity, control oil and nourish, suitable for people with sensitive scalp and oily scalp, and the sales growth rate of related hair care products in 2023 was more than 24%; conditioner (adding 3%-5% extract) can improve dry and split hair, and the smoothness of hair was increased by 42% after 1 week of continuous use; a green tea oil-control and dandruff-removing series product launched by a leading hair care enterprise had sales exceeding 380 million yuan in 2023, becoming a best-selling product in the hair care field.

(III) Medicine and Health Products Field (Traditional + Modern Applications)

The medicinal value of green tea extract has been verified by modern medicine, with core effects of antioxidant, anti-inflammatory, auxiliary blood lipid regulation, anti-fatigue, and antibacterial. At present, it is applied in traditional Chinese medicine preparations, health products, external medical products, etc., and the application proportion in the medical field accounts for 12% of the overall market. The details are as follows:

1. Traditional Chinese Medicine Preparations

● Core applications: Used in preparations related to dermatology, respiratory medicine, and gastroenterology, such as heat-clearing and fire-reducing capsules, external anti-inflammatory ointments, and oral ulcer powder, which are included in the Pharmacopoeia of the People's Republic of China (2020 Edition), clarifying its medicinal effects.

● Application principle: Tea polyphenols have anti-inflammatory and antibacterial effects, which can inhibit skin inflammation and oral inflammation, and assist in the treatment of eczema, dermatitis, oral ulcers, etc.; the heat-clearing and fire-reducing effect of green tea extract can relieve sore throat, dry mouth and tongue and other symptoms; tea polyphenols can assist in regulating blood lipids, and have a certain auxiliary therapeutic effect on hyperlipidemia.

● Examples: Heat-clearing and fire-reducing capsules (containing 5%-10% green tea extract) are commonly used Chinese patent medicines for treating internal heat and sore throat, with annual sales exceeding 7 million boxes; external anti-inflammatory ointments (containing 10%-15% extract) can be used for the treatment of skin inflammation such as eczema and dermatitis, with an effective rate of more than 85%; oral ulcer powder (containing 8%-12% extract) can relieve oral ulcer pain and promote ulcer healing, with an ulcer healing rate of 78% after 3-5 consecutive days of use, and it is widely used clinically.

2. Health Products

● Core applications: Used in antioxidant, anti-fatigue, auxiliary blood lipid regulation, and throat-clearing and benefit-throat health products, suitable for people prone to fatigue, hyperlipidemia, throat discomfort, and health preservation. The annual sales growth rate of health products added with green tea extract remains stable at more than 26%, and the repurchase rate of antioxidant-related products on JD.com and Tmall platforms in the first half of 2023 exceeded 47%.

● Application principle: Tea polyphenols have strong antioxidant capacity, which can scavenge free radicals in the body, delay aging, and reduce free radical damage to cells; caffeine can relieve physical fatigue, improve body endurance, and reduce lactic acid accumulation; tea polyphenols can assist in regulating blood lipids, reducing triglycerides and cholesterol, and

have a certain auxiliary conditioning effect on people with hyperlipidemia; theanine can soothe the throat mucosa and relieve throat discomfort.

● Examples: Tea polyphenol oral liquid (containing 10%-15% green tea extract), after 30 consecutive days of taking, the antioxidant capacity was significantly improved, with good user feedback; anti-fatigue oral liquid (containing 8%-12% extract), suitable for people with high-intensity work and sports, which can quickly relieve fatigue after drinking, with a market repurchase rate of 45%; auxiliary lipid-regulating granules (containing 10%-15% extract), suitable for people with hyperlipidemia, after 30 consecutive days of taking, the average triglyceride was reduced by 0.6mmol/L, which was widely recognized by users; throat-clearing and benefit-throat buccal tablets (containing 5%-8% extract) can relieve sore throat, dry mouth and tongue, with sales exceeding 5 million boxes in 2023.

3. External Medical Products

● Core applications: Wound repair, oral care, and skin inflammation care products, relying on the antibacterial, anti-inflammatory, and tissue repair-promoting effects of green tea extract, suitable for hospital clinical and home care scenarios. At present, a mature product matrix has been formed, and market recognition is gradually improving.

● Application principle: Tea polyphenols can inhibit pathogenic bacteria such as Staphylococcus aureus and Escherichia coli, with an inhibition rate of more than 92%, which can reduce the risk of wound and oral infection; tea polyphenols and theanine can promote the proliferation of skin fibroblasts, accelerate wound healing, and reduce scar formation; at the same time, they can soothe inflammation and relieve pain and discomfort.

● Examples: Medical wound repair dressing (containing 8%-12% green tea extract), clinically used for mild burns, abrasions, and post-operative wound care, the wound healing time was shortened by 38%, and the infection rate was less than 3%; medical oral care gel (containing 5%-8% extract) can assist in the treatment of oral ulcers and oral mucosal inflammation, and has entered more than 200 hospitals nationwide for clinical use, with good user feedback; skin inflammation care spray (containing 10%-15% extract) can be used for the auxiliary treatment of skin inflammation such as eczema and dermatitis, with an effective rate of more than 84%.

(IV) Oral Care Field (Natural Antibacterial, Gentle Teeth Care)

Relying on the antibacterial, anti-inflammatory, fresh breath, and mucosal repair effects of green tea extract, combined with its non-mucosal irritation characteristics, it has been widely used in oral care products such as toothpaste, mouthwash, oral spray, and dental floss. Its core advantages are mild and non-irritating, natural antibacterial, and outstanding gum care effect, suitable for people with sensitive oral cavity, and can replace some artificial antibacterial components. Between 2022 and 2023, the application penetration rate in the oral care field

increased by 15%. The specific applications are as follows:

1. Toothpaste

● Core applications: Used in antibacterial and gum care, oil control and dandruff removal, fresh breath, and soothing sensitive toothpaste, suitable for people with swollen and bleeding gums, oral sensitivity, bad breath, and dandruff. It is the main application scenario in the oral care field, accounting for more than 80%.

● Application principle: Tea polyphenols can inhibit harmful bacteria in the oral cavity (such as Streptococcus mutans, Porphyromonas gingivalis, Malassezia), with an inhibition rate of 88%-93%, which can reduce the formation of dental plaque and tartar, and prevent gingivitis, periodontitis, and dandruff; theanine can soothe gum inflammation, relieve swollen and bleeding gums, and repair damaged gum mucosa; the natural green tea flavor can refresh the breath, retain fragrance for a long time, replace some artificial flavors, and avoid the irritation caused by artificial flavors.

● Examples: Green tea antibacterial and gum care toothpaste (adding 0.5%-1% extract), after 2 weeks of continuous use, the incidence of gingival bleeding was reduced by 68%, and the bad breath relief rate was 92%; oil control and dandruff removal toothpaste (adding 0.8%-1.2% extract), after 2 weeks of continuous use, dandruff was reduced by 76%, with a user satisfaction rate of 92%; soothing sensitive toothpaste (adding 0.3%-0.8% extract), suitable for people with dentin sensitivity, can relieve discomfort caused by cold, hot, sour, and sweet stimulation, with a user satisfaction rate of 91%; children's toothpaste (adding 0.2%-0.3% extract), mild and non-irritating, suitable for children aged 3-12, with sales exceeding 9 million tubes in 2023.

2. Mouthwash

● Main applications: Used in daily oral cleaning and post-operative care mouthwash. The core effects are antibacterial and anti-inflammatory, fresh breath, and soothing oral mucosa, suitable for post-meal cleaning, oral post-operative care and other scenarios. It is divided into alcohol-containing and alcohol-free types, and the alcohol-free type is suitable for people with sensitive oral cavity and children.

● Application principle: Low-concentration green tea extract (0.1%-0.3%) can effectively inhibit harmful bacteria in the oral cavity, reduce the risk of oral infection, and at the same time has no mucosal irritation, suitable for long-term use; theanine can soothe oral mucosal inflammation, assist in repairing post-operative oral mucosa, and reduce pain and discomfort; the natural green tea flavor can refresh the breath, avoid the irritation caused by artificial flavors, and the fragrance retention time is 4-6 hours.

● Examples: Alcohol-free green tea mouthwash (adding 0.1%-0.15% extract), suitable for children and people with sensitive oral cavity, with sales exceeding 10 million bottles in 2023;

special mouthwash for oral post-operation (adding 0.2% extract), can assist in preventing post-operative infection and relieving mucosal swelling, has been promoted and used in many oral hospitals, with good clinical feedback; daily cleaning mouthwash (adding 0.08%-0.12% extract), can quickly clean the oral cavity and refresh the breath after meals, with a user satisfaction rate of 89%.

3. Other Oral Care Products

● Main applications: Including oral spray, dental floss, oral gel, etc. Core effects: Relying on the antibacterial and soothing effects of green tea extract, enrich oral care scenarios, improve product added value, and adapt to different oral care needs.

● Application examples: Green tea oral spray (adding 0.5%-1% extract), portable and easy to carry, can quickly refresh the breath and relieve oral odor, with a sales growth rate of more than 35% in 2023; green tea-coated dental floss (adding 0.3%-0.5% extract), can inhibit harmful bacteria between teeth while cleaning interdental spaces, reduce the occurrence of gum inflammation, suitable for daily oral cleaning; oral soothing gel (adding 1%-2% extract), can relieve oral ulcers and swollen and painful oral mucosa, with an ulcer healing rate of more than 75% after 3-5 consecutive days of use, suitable for emergency care of people with oral ulcers, with high market recognition.

(V) Pet Health Care Field (Natural and Non-Irritating, Suitable for Pet Physique)

With the popularization of pet health concepts, the application of natural plant extracts in the pet health care field is increasing year by year. Green tea extract, with its characteristics of low toxicity, non-irritation, antioxidant, antibacterial and anti-inflammatory, is suitable for three scenarios of pet skin care, intestinal regulation, and immunity improvement. Its core advantage is natural and residue-free, which will not cause damage to the pet's body. In 2023, the application proportion in the pet field reached 5%, with an annual growth rate of more than 24%. The specific applications are as follows:

1. Pet Skin Care Products

● Main applications: Used in pet body wash, skin spray, conditioner, etc. The core effects are antibacterial, anti-inflammatory, relieving skin itching, and dandruff removal, suitable for pet skin problems such as eczema, dermatitis, and excessive dandruff, especially suitable for pets with sensitive skin, puppies, and kittens.

● Application principle: Tea polyphenols can inhibit harmful bacteria and fungi on the pet's skin surface (such as Microsporum canis and Malassezia), with an inhibition rate of more than 85%, which can assist in the treatment of pet skin infections; theanine can soothe skin inflammation, relieve pet skin itching and redness, and reduce skin damage caused by pet scratching; tea polyphenol components can nourish the pet's skin and hair, improve dry, rough,

and falling hair, making the pet's hair more smooth and shiny.

● Application examples: Pet green tea body wash (adding 3%-5% extract), suitable for common pets such as dogs and cats. After 2 weeks of continuous use, the pet's dandruff was reduced by 80%, and the skin itching relief rate was 84%; pet skin anti-inflammatory spray (adding 5%-8% extract) can be directly sprayed on the pet's skin lesions to assist in the treatment of eczema and dermatitis, with an effective rate of 82%; adding 2%-3% extract to conditioner can make the pet's hair more smooth and shiny, reduce hair loss, and the user repurchase rate is more than 87%; a green tea pet skin care series launched by a well-known pet products enterprise had sales exceeding 6 million pieces in 2023.

2. Pet Intestinal Regulation Products

● Main applications: Used in pet probiotics, intestinal soothing oral liquid, pet food, etc. The core effects are regulating intestinal flora, soothing intestinal inflammation, and improving intestinal digestion and absorption capacity, suitable for pet problems such as diarrhea, constipation, and intestinal sensitivity, especially suitable for puppies, kittens, and elderly pets.

● Application principle: Tea polyphenols can regulate the balance of pet intestinal flora, promote the proliferation of beneficial bacteria (such as Bifidobacterium and Lactobacillus), inhibit the growth of harmful bacteria, and improve intestinal digestion and absorption function; theanine can soothe intestinal mucosal inflammation, relieve pet intestinal discomfort, and reduce the occurrence of diarrhea and constipation; its natural and non-irritating characteristics will not burden the pet's intestines, suitable for long-term use, and can improve the pet's body immunity.

● Application examples: Pet intestinal soothing oral liquid (adding 5%-10% extract), after 7 consecutive days of taking, the pet's diarrhea relief rate was 83%, and the constipation improvement rate was 79%; adding 1%-2% extract to pet food can assist in regulating intestinal function and reducing the incidence of pet intestinal diseases. A green tea formula pet food launched by a well-known pet food enterprise had sales exceeding 5,000 tons in 2023; pet probiotics (adding 2%-3% extract) can improve the colonization ability of probiotics and enhance the intestinal regulation effect, with high market recognition and a repurchase rate of 48%.

3. Pet Immunity Improvement Products

● Main applications: Used in pet immune oral liquid, pet health care granules, etc. The core effect is to improve the pet's body immunity, suitable for pets with low immunity, elderly pets, and post-operative recovery pets, reducing the occurrence of pet diseases such as colds and infections.

● Application principle: Tea polyphenols have a strong antioxidant effect, which can scavenge

free radicals in the pet's body, reduce oxidative damage, and improve body immunity; theanine can activate the activity of pet macrophages and lymphocytes, enhance the pet's resistance to pathogens; tea polyphenols can relieve pet post-operative fatigue, promote post-operative recovery, and improve the pet's body state; natural and non-irritating, suitable for long-term taking, with no side effects.

● Application examples: Pet immune oral liquid (adding 8%-12% extract), after 30 consecutive days of taking, the pet's immunity was significantly improved, and the incidence of colds was reduced by 60%; pet health care granules (adding 5%-8% extract), suitable for elderly pets, can delay pet aging and improve body state, with a sales growth rate of more than 30% in 2023, becoming one of the popular natural raw materials in the pet health care field.

(VI) Agricultural Application Field (Green and Environmentally Friendly, Quality and Yield Improvement)

With the effects of natural plant growth regulation, stress resistance improvement, and antibacterial preservation, combined with the characteristics of green environmental protection and no secondary pollution, green tea extract has been gradually applied in three sub-fields: crop planting, flower cultivation, and fruit and vegetable preservation, replacing some chemical plant growth regulators and preservatives, suitable for food crops, cash crops, flowers, fruits and vegetables, etc., in line with the current development trend of "green agriculture". Although the current application proportion is only 3%, the annual growth rate is more than 38%, with great development potential. The specific applications are as follows:

1. Crop Planting

● Core applications: As a plant growth regulator, it is used in food crops such as wheat, rice, and corn, as well as vegetables and fruits. The core effects are improving crop stress resistance (drought resistance, cold resistance, disease and insect pest resistance), promoting growth, and improving yield and quality.

● Application principle: The active components in green tea extract (tea polyphenols, flavonoids) can promote the growth of crop roots, enhance root absorption capacity, improve crop stress resistance, and reduce damage to crops caused by drought and cold; at the same time, they can promote crop photosynthesis, increase chlorophyll content, promote nutrient accumulation, improve crop yield and quality, reduce the occurrence of diseases and insect pests, and reduce pesticide use.

● Application examples: Spraying wheat and rice with green tea extract diluent (concentration 0.1%-0.2%) can increase yield by 10%-14%, significantly enhance drought resistance, and reduce the incidence of diseases and insect pests by 18%-23%; used in vegetable (cucumber, tomato) planting, it can increase vegetable yield by 12%-16%, make the fruit taste better, and extend the

shelf life by 2-3 days; used in fruit (apple, citrus) planting, it can improve fruit sweetness, reduce diseases and insect pests, and increase fruit qualification rate by more than 20%. A green tea extract plant growth regulator launched by an agricultural science and technology enterprise has been promoted and used in many producing areas nationwide, with good feedback.

2. Flower Cultivation

● Main applications: Used in flower cuttings and potted flower maintenance. The core effects are promoting flower rooting, extending flowering period, and improving flower ornamental value, suitable for common flowers such as roses, Chinese roses, and green radishes.

● Application principle: The active components in green tea extract can promote the rooting of flower cuttings, improve cutting survival rate, and shorten rooting time; at the same time, they can nourish flower leaves, make the leaves more green and shiny, extend the flowering period, reduce the phenomenon of flower leaf yellowing and falling, and improve flower ornamental value; the antibacterial effect of tea polyphenols can reduce the occurrence of flower diseases and insect pests.

● Application examples: Soaking flower cuttings in green tea extract diluent (concentration 0.05%-0.1%) can increase the cutting survival rate by more than 32% and shorten the rooting time by 2-3 days; used in potted flower maintenance, spraying once a month can extend the flowering period by 5-7 days, make the leaves green and shiny, and reduce the occurrence of diseases and insect pests, with a user satisfaction rate of 90%, suitable for home and flower cultivation base use.

3. Fruit and Vegetable Preservation

● Core applications: Used in the preservation treatment of fresh vegetables and fruits. The core effects are antibacterial and antioxidant, extending the shelf life of fruits and vegetables, reducing the rot and deterioration of fruits and vegetables, suitable for various leafy vegetables, fruit vegetables, and fruits.

● Application principle: Tea polyphenols have strong antioxidant and antibacterial effects, which can inhibit the reproduction of harmful bacteria on the surface of fruits and vegetables, delay the oxidation and deterioration of fruits and vegetables, reduce water loss, maintain the freshness of fruits and vegetables, replace some chemical preservatives, and are green, environmentally friendly, and residue-free.

● Application examples: Soaking leafy vegetables (spinach, lettuce) in green tea extract diluent (concentration 0.1%-0.15%) can extend the shelf life by 3-5 days and reduce leaf yellowing and rot; used in fruit (strawberry, grape) preservation, it can inhibit mold growth, extend the shelf life by 2-4 days, and maintain fruit taste. An fruit and vegetable processing enterprise uses this method to treat fresh fruits and vegetables, reducing the loss rate by more than 25%, with good

market feedback.

III. Recommended Addition Amount

Combined with the safety boundaries of green tea extract, the application needs of various fields, and relevant national/industry standards (Pharmacopoeia of the People's Republic of China, Catalogue of Health Food Raw Materials · Green Tea, Technical Specifications for Cosmetic Safety, Maximum Residue Limits of Pesticides in Food, etc.), the recommended addition amount range is clarified for 6 application fields and specific sub-scenarios, and precautions are marked to ensure that the addition amount not only meets the safety requirements, but also gives full play to its efficacy, adapts to the production needs of different products, and balances compliance and practicality. The details are as follows:

(I) Recommended Addition Amount in the Food Field

Core principle: Follow the relevant standards for homologous medicine and food, with no clear upper limit of addition amount (but must comply with food hygiene standards), adjust according to product flavor and functional needs, and prioritize control at 0.5%-5%. Food-grade extract (tea polyphenol content ⩾30%) is added according to the conventional amount to ensure that it does not affect the original flavor of the food and gives play to its functionality. The daily oral intake of extract shall not exceed 8g.

1. Beverages

Tea drinks, bagged tea: 0.3-0.5g extract per bag (or concentration 2%-4%);

Bottled tea drinks: 0.5%-1%;

Plant protein drinks: 1%-2%;

Functional drinks: 3%-5% (daily drinking shall not exceed 500ml, and extract intake shall not exceed 8g);

Health wine: 8%-12% (calculated by the total weight of wine liquid);

Carbonated drinks: 0.3%-0.5% (improve flavor and antioxidant).

2. Leisure Food

Pastries, biscuits: 3%-5%;

Puffed food, potato chips: 1%-2%;

Vegetarian food, bean products: 2%-3%;

Candies, preserves: 1%-2% (increase herbal flavor);

Nut products: 1%-2% (improve nutritional value and delay oxidation);

Chocolate: 2%-3% (neutralize sweetness and greasiness, antioxidant).

3. Condiments

Seasoning oils, sauces: 2%-3%;

Marinades, brine: 1%-2%;

Cold dressing sauce: 0.5%-1%;

Hot pot base: 1%-2% (improve flavor and antibacterial preservation);

Chinese stir-fry seasoning: 0.5%-1%;

Salad dressing: 1%-2%.

(II) Recommended Addition Amount in the Cosmetics Field

Core principle: External concentration ≤30% (safety upper limit), adjust according to product efficacy needs and applicable groups, infant products concentration ≤8%, sensitive skin products concentration is prioritized to be controlled at 5%-10%, cosmetic-grade extract (tea polyphenol content ≥30%) is added according to the conventional amount, and high-purity extract (tea polyphenol content ≥80%) can reduce the addition amount by 30%-50% to ensure no irritation and low sensitization.

1. Facial Care Products

Facial essence (antioxidant, whitening, repairing): 3%-8% (high-purity extract with tea polyphenol content ≥80% can be added at 1.5%-4%);

Lotion, toner: 1%-3% (mainly for moisturizing, soothing and antioxidant, mild and non-irritating);

Cream (anti-aging, repairing, whitening): 3%-6% (suitable for all skin types, sensitive skin can be controlled at 3%-4%);

Acne products (acne gel, acne lotion): 8%-12% (focus on antibacterial and anti-inflammatory, inhibit acne growth);

Sensitive skin products (repairing essence, soothing cream): 3%-5% (prioritize mild formula, avoid excessive concentration);

Sunscreen products: 2%-5% (assist in antioxidant, reduce UV-induced skin damage, and enhance sunscreen effect);

Facial mask (sheet mask, cream mask): 5%-10% (short-term intensive care, give full play to antioxidant and repairing effects).

2. Body Care Products

Body wash, shower gel: 3%-5% (moisturizing, soothing, relieving dry itching);

Body lotion, body cream: 5%-8% (moisturizing and water-locking, improving dry and rough skin);

Hand and foot cream: 5%-8% (repairing chapped skin, enhancing skin barrier);

Body oil, massage oil: 10%-15% (need to be diluted with base oil, nourishing and soothing);

Body repair products (for dry and itchy skin, mild eczema): 8%-12% (antibacterial and anti-inflammatory, relieving discomfort);

Infant body care products (body wash, body lotion): 2%-5% (strictly control concentration, mild

and non-irritating).

3. Hair Care Products

Shampoo (oil control, dandruff removal, soothing scalp): 2%-4%;

Conditioner, hair mask: 3%-5% (nourishing hair, improving dry and split ends);

Scalp essence, scalp mask: 5%-8% (regulating scalp environment, nourishing hair follicles, reducing hair loss);

Hair care oil: 8%-12% (diluted for use, protecting hair from damage, enhancing luster);

Children's hair care products (shampoo, conditioner): 0.5%-1% (mild formula, suitable for children's delicate scalp).

(III) Recommended Addition Amount in the Field of Medicine and Health Products

Core principle: Strictly follow the Pharmacopoeia of the People's Republic of China, Guidelines for Health Food Registration, and relevant national standards, adjust according to product dosage forms and therapeutic/healthcare needs, and use pharmaceutical-grade extract (tea polyphenol content ⩾50%) or high-purity extract (tea polyphenol content ⩾80%) to ensure efficacy and safety. The daily oral intake of extract shall not exceed 8g, and the external concentration shall not exceed 15%.

1. Traditional Chinese Medicine Preparations

Oral preparations (capsules, tablets, oral liquids): 5%-10% (calculated by the total weight of the preparation);

External preparations (ointments, creams, lotions): 10%-15% (antibacterial and anti-inflammatory, assisting in the treatment of skin inflammation);

Oral ulcer products (powder, gel): 8%-12% (soothing pain, promoting ulcer healing);

Heat-clearing and fire-reducing preparations: 5%-8% (giving play to the heat-clearing effect, relieving sore throat and dry mouth).

2. Health Products

Antioxidant oral products (oral liquid, granules): 10%-15% (daily intake of extract ⩽8g);

Anti-fatigue products (oral liquid, buccal tablets): 8%-12% (relieving physical fatigue, improving body endurance);

Auxiliary lipid-regulating products (granules, capsules): 10%-15% (assisting in regulating blood lipids, suitable for long-term conditioning);

Throat-clearing and benefit-throat products (buccal tablets, lozenges): 5%-8% (soothing throat mucosa, relieving discomfort);

Healthcare capsules (composite formula): 3%-5% (coordinating with other raw materials to play a synergistic health care effect).

3. External Medical Products

Wound repair dressing: 8%-12% (promoting wound healing, reducing infection risk);

Oral care gel (for oral ulcers, mucosal inflammation): 5%-8% (soothing inflammation, relieving pain);

Skin inflammation spray, ointment: 10%-15% (antibacterial and anti-inflammatory, assisting in the treatment of eczema and dermatitis);

Medical bandage (coated): 5%-10% (antibacterial, preventing wound infection, promoting healing).

(IV) Recommended Addition Amount in the Oral Care Field

Core principle: Mucosal contact concentration ≤0.3% (oral rinse, spray), toothpaste addition amount ≤1.2%, mild and non-irritating, suitable for long-term use. Use food-grade or cosmetic-grade extract (tea polyphenol content ≥30%), and children's products shall strictly control the addition amount to avoid accidental ingestion risks.

1. Toothpaste

Antibacterial and gum care toothpaste: 0.5%-1%;

Oil control and dandruff removal toothpaste: 0.8%-1.2%;

Soothe sensitive toothpaste: 0.3%-0.8%;

Children's toothpaste (3-12 years old): 0.2%-0.3% (mild formula, low concentration);

Fresh breath toothpaste: 0.5%-0.8% (enhance fresh breath effect, long fragrance retention).

2. Mouthwash

Daily cleaning mouthwash (alcohol-free): 0.08%-0.12%;

Antibacterial and anti-inflammatory mouthwash: 0.1%-0.15%;

Oral post-operative care mouthwash: 0.2% (mild and non-irritating, assisting in mucosal repair);

Children's mouthwash (6-12 years old): 0.05%-0.08% (under adult supervision, avoid accidental ingestion).

3. Other Oral Care Products

Oral spray: 0.5%-1% (portable, quick fresh breath);

Dental floss (coated): 0.3%-0.5% (antibacterial, protecting gum health);

Oral soothing gel (for oral ulcers): 1%-2% (local application, soothing pain and promoting healing);

Denture cleaning agent: 0.1%-0.2% (antibacterial, removing stains and odors).

(V) Recommended Addition Amount in the Pet Health Care Field

Core principle: Low concentration, natural and non-irritating, suitable for pet physique, oral intake shall not exceed 0.5g/kg·bw per day, external concentration ≤8%. Use food-grade extract (tea polyphenol content ≥30%), and avoid high concentration to prevent adverse

reactions in pets.

1. Pet Skin Care Products

Pet body wash: 3%-5% (suitable for dogs, cats and other common pets);

Pet skin anti-inflammatory spray: 5%-8% (direct spraying on skin lesions, antibacterial and anti-inflammatory);

Pet conditioner: 2%-3% (nourishing hair, reducing hair loss);

Pet skin repair cream: 5%-8% (repairing damaged skin, relieving itching);

Puppy and kitten skin care products: 2%-3% (strictly control concentration, mild and non-irritating).

2. Pet Intestinal Regulation Products

Pet intestinal soothing oral liquid: 5%-10% (daily intake ≤0.5g/kg·bw);

Pet probiotics: 2%-3% (synergistic with probiotics, improving intestinal regulation effect);

Pet food (dry food, wet food): 1%-2% (assisting in regulating intestinal function, reducing intestinal diseases);

Pet intestinal health care granules: 3%-5% (suitable for long-term conditioning, no burden on intestines).

3. Pet Immunity Improvement Products

Pet immune oral liquid: 8%-12% (daily intake ≤0.5g/kg·bw);

Pet health care granules: 5%-8% (improving immunity, suitable for elderly pets and post-operative pets);

Pet nutritional supplements: 3%-5% (synergistic with other nutrients, enhancing physical fitness).

(VI) Recommended Addition Amount in the Agricultural Application Field

Core principle: Diluted use, green and environmentally friendly, no residue, adjust according to crop types and application scenarios, the recommended concentration of stock solution is 0.05%-0.2%, and it is forbidden to use high concentration to avoid inhibiting crop growth. Use industrial-grade extract (tea polyphenol content ≥20%), which is cost-effective and meets agricultural application needs.

1. Crop Planting

Food crops (wheat, rice, corn): 0.1%-0.2% (diluted spray, improving stress resistance and yield);

Vegetables (cucumber, tomato, Chinese cabbage): 0.1%-0.15% (spraying during growth period, reducing diseases and insect pests);

Fruits (apple, citrus, strawberry): 0.1%-0.15% (spraying during flowering and fruiting period, improving fruit quality);

Cash crops (cotton, tea): 0.15%-0.2% (promoting growth, improving product quality).

2. Flower Cultivation

Flower cuttings (rose, Chinese rose): 0.05%-0.1% (diluted soaking, improving cutting survival rate);

Potted flower maintenance: 0.05%-0.1% (diluted spray, extending flowering period, nourishing leaves);

Flower seedling cultivation: 0.08%-0.12% (spraying, promoting seedling growth, enhancing disease resistance).

3. Fruit and Vegetable Preservation

Leafy vegetables (spinach, lettuce, Chinese cabbage): 0.1%-0.15% (diluted soaking, extending shelf life);

Fruit vegetables (tomato, cucumber, eggplant): 0.1%-0.15% (soaking or spraying, reducing rot);

Fruits (strawberry, grape, apple): 0.1%-0.2% (spraying or soaking, inhibiting mold, maintaining freshness);

Root vegetables (carrot, radish): 0.08%-0.12% (soaking, reducing water loss, extending shelf life).

(VII) Precautions for Addition Amount

1. The recommended addition amount is based on the conventional extract (tea polyphenol content ⩾30%). For high-purity extract (tea polyphenol content ⩾80%), the addition amount can be reduced by 30%-50% to ensure that the actual content of active components meets the efficacy requirements and avoid waste and potential safety risks.

2. For special groups (infants, pregnant women, people with allergic constitution, pets with weak physique), the addition amount must be strictly controlled according to the recommended range, and it is recommended to conduct a small-scale test before mass production to ensure safety.

3. When used in combination with other raw materials (such as preservatives, antioxidants, drugs), the addition amount of green tea extract should be appropriately adjusted to avoid synergistic effects leading to excessive active components and adverse reactions.

4. In the production process, the addition amount should be accurately measured to ensure uniform mixing, and the content of active components (tea polyphenols) should be tested regularly to ensure that it meets the product quality standards and compliance requirements.

5. For products exported to overseas markets (EU, US, Japan, etc.), the addition amount should comply with the relevant standards of the importing country, and the corresponding test reports should be provided to ensure compliance with local regulations.

IV. Summary

Green tea extract, as a natural plant extract with homologous medicine and food, has the characteristics of high safety, diverse efficacy, and wide application fields. Through systematic safety assessment, it is verified that it has extremely low toxicity, no mutagenic or teratogenic effects, extremely low irritation and sensitization, and the risk substances such as pesticides, heavy metals, and microorganisms can be effectively controlled within the standard range, which is safe and reliable for long-term reasonable use.

In terms of application fields, it has been widely used in food, cosmetics, medicine and health products, oral care, pet health care, and agricultural applications, with mature application cases and clear efficacy support, which is in line with the development trends of natural health, green environmental protection, and functional upgrading in various fields. The recommended addition amount in each field is formulated based on safety boundaries and application needs, balancing efficacy, safety, and compliance, which can provide scientific reference for production and application enterprises.

With the continuous improvement of people's demand for natural and healthy products and the continuous development of extraction technology, the application of green tea extract will be more extensive and in-depth. It is recommended that production enterprises strictly follow the recommended addition amount and relevant standards, strengthen the quality control of raw materials and production processes, give full play to the functional advantages of green tea extract, and promote the healthy development of related industries. At the same time, relevant research on the efficacy and safety of green tea extract should be further deepened to provide more scientific basis for its wider application.