Operation Guidelines for Addition Methods of White Kidney Bean Extract in Application Fields

I. Preface

Based on the physicochemical properties, stability rules and application scenarios of white kidney bean extract (with α-amylase inhibitor, phaseolin, dietary fiber and other core active ingredients), this guideline standardizes the addition principles, processes, dosages, operation points and quality control in six major fields including food, feed, pharmaceutical and health care products, cosmetics, agriculture and industry, providing standardized operational basis for large-scale production.

1.1 Basic Characteristics of White Kidney Bean Extract

- **Form**: White to pale yellow fine powder (conventional extract), microencapsulated dosage form (stabilized modification), water-soluble concentrate (liquid extract).
- **Solubility**: Conventional powder is easily soluble in warm water, slightly soluble in cold water, and insoluble in organic solvents such as grease, ethanol and ether; microencapsulated dosage form dissolves rapidly in cold water, suitable for various aqueous systems; concentrate can be directly dissolved in aqueous phase without additional solubilization.
- **Stability**: Sensitive to high temperature (easy inactivation by prolonged heating >90℃) and strong acid/alkali, with the most stable activity at pH 5.0-7.5; microencapsulation can significantly improve heat, acid and alkali resistance and reduce the loss of α-amylase inhibitor; avoid long-term contact with strong oxidants and metal ions.
- **Core Activities**: Block starch decomposition, inhibit sugar absorption, assist in glycemic and weight control, regulate intestinal flora, mild antioxidant activity, no obvious peculiar smell and excellent palatability.

1.2 General Addition Principles

1. **Dosage Form Matching**

For water-soluble systems (beverages, oral liquids, aqueous phases of skin care products), microencapsulated powder or concentrate is preferred; for solid

systems (baking, powders, feed), conventional powder or microcapsules are selected to ensure uniform dispersion without caking or delamination.

2. **Temperature Control**

Conventional addition temperature ≤70℃. For high-temperature processes (frying, baking, high-temperature sterilization), microencapsulated dosage form is preferred or low-temperature supplementation is adopted at the later stage of the process to retain α-amylase inhibitor activity to the maximum extent and prevent efficacy loss.

3. **pH Adaptation**

Addition in neutral systems with pH 5.0-7.5 is preferred; stability pre-experiments shall be carried out in advance for strong acid (pH<4.0) and strong alkali (pH>8.0) systems, and buffers shall be added to adjust pH if necessary to maintain the stability of active ingredients.

4. **Compatibility Contraindications**

Avoid direct mixing with strong oxidants (hydrogen peroxide, potassium permanganate) and high-concentration alkaline substances; discoloration and inactivation are prone to occur when contacting metal ions such as iron and copper, so stainless steel or food-grade plastic equipment shall be used.

5. **Uniformity Control**

Powdered extract shall be sieved and premixed step by step, and direct large-scale feeding is prohibited to prevent excessive local concentration from affecting product taste, appearance and efficacy uniformity.

6. **Quality Traceability**

Use extracts conforming to GB 2760 (food grade), *Catalogue of Feed Additive Varieties* (feed grade), pharmacopoeia and health food specifications (pharmaceutical grade), *Safety Technical Specifications for Cosmetics* (cosmetic grade) and other standards, and retain batch inspection reports (α-amylase inhibitor activity, moisture, microorganisms, heavy metals).

II. Operation Guidelines for Addition in Food Field

2.1 Applicable Categories and Core Functions

- **Functional beverages (solid beverages, fruit and vegetable drinks, meal replacement drinks, glycemic control beverages)**: Block

starch absorption, stabilize postprandial blood glucose, focusing on weight and glycemic control health concepts, suitable for weight loss, glycemic control and sub-health populations.

- **Baked foods (pastries, biscuits, bread, meal replacement bars, whole-grain staple foods)**: Reduce GI value of staple foods, delay starch digestion, enhance glycemic and weight control efficacy, and extend product shelf life.
- **Rice and flour products (noodles, rice noodles, dumpling wrappers, premixed flour)**: Improve digestive properties, reduce calorie absorption, and create low-GI healthy staple foods.
- **Leisure snacks/dairy products (jelly, gummies, yogurt, milk powder)**: Strengthen functions, improve product health attributes, balance taste and efficacy, replace ordinary snacks, suitable for weight control populations.

2.2 Dosage Form Selection and Addition Methods

(1) **Conventional White Kidney Bean Extract Powder (α-amylase inhibitor activity ≥10000U/g)**

Applicable to baked foods, rice and flour products, solid beverages, dairy products, suitable for medium and low functional demand scenarios with controllable cost.

Addition Methods:

- **Solid systems (baking, milk powder, solid beverages)**: Premix with flour, maltodextrin, whey protein and other powder raw materials (sieved through 80-120 mesh) to ensure no caking, then add to the formula and stir evenly to guarantee dispersibility.
- **Liquid systems (yogurt, sauces, drinks)**: Dissolve with warm water at 50-70℃ at a material-liquid ratio of 1:5-1:10, stir for 20-30 minutes until completely dispersed, filter to remove impurities, then slowly add to the system and stir continuously for 10-15 minutes until uniform.
- **Process Nodes**: Dough mixing stage for baking, before yogurt fermentation, later stage of beverage blending; avoid prolonged high-temperature baking, baking temperature ≤220℃, duration ≤25 minutes.

Reference Dosages: Baked foods 0.05%-0.5%; Rice and flour products 0.08%-0.6%; Dairy products 0.1%-0.8%; Solid beverages 0.8%-5%.

(2) **Microencapsulated White Kidney Bean Extract (Embedding rate ≥90%)**

Applicable to high-temperature process foods (frying, high-temperature sterilized beverages), instant drinks, quick-frozen foods, scenarios requiring improved

stability and dispersibility of active ingredients, suitable for high-end functional foods.

Addition Methods:

- **Beverages/oral liquids**: Directly add to aqueous phase, stir for 10-15 minutes without additional solubilization, resistant to short-term sterilization at 85-100℃ (≤15 minutes), active ingredient retention rate ≥85%.
- **Fried/quick-frozen foods**: Premix with powder (temperature ≤60℃), or spray at the cooling stage after frying (spray temperature ≤50℃) to reduce high-temperature damage to α-amylase inhibitor.
- **Process Nodes**: Beverage blending stage, frying cooling stage, before quick-frozen food forming, temperature controlled ≤70℃ throughout the process.

Reference Dosages: Functional beverages 0.1%-0.8%; Fried foods 0.05%-0.15%; Quick-frozen foods 0.06%-0.3%, dosage can be reduced by 10%-20% compared with conventional powder.

(3) **White Kidney Bean Extract Concentrate (α-amylase inhibitor activity ≥5000U/g)**

Applicable to liquid beverages, oral liquids, sauces, scenarios requiring rapid dissolution and simplified processes, suitable for large-scale production.

Addition Methods: Directly add to aqueous phase or sauce system, stir for 10-15 minutes until uniform, can be added synchronously with sweeteners and acidity regulators, adjust pH to 5.0-7.0 to improve stability.

Reference Dosages: Beverages 0.2%-1.5%; Oral liquids 0.5%-3%; Sauces 0.1%-0.7%.

2.3 Operation Points and Quality Control

1. **Temperature Control**: Conventional addition temperature ≤70℃, microencapsulated dosage form is preferred for high-temperature processes; avoid prolonged high-temperature cooking and frying to prevent α-amylase inhibitor inactivation.
2. **Uniformity**: Powder shall be sieved and premixed, liquid systems shall be fully stirred to avoid excessive local concentration and ensure consistent efficacy of each product.
3. **Compound Synergy**: Compound with dietary fiber, probiotics and chromium yeast to enhance glycemic and weight control effects and improve product added value.

4. **Taste Optimization**: Conventional extract has no obvious beany odor; a small amount of sweetener can be compounded at high addition levels to improve palatability without affecting product flavor.
5. **Compliance**: Strictly comply with GB 2760; white kidney bean extract, as a common food raw material, shall be used appropriately according to production needs; functional addition shall comply with relevant regulations of health foods, with clear labeling of active ingredient content.

III. Operation Guidelines for Addition in Feed Field

3.1 Applicable Categories and Core Functions

- **Livestock and poultry feed (pigs, chickens, ducks, geese)**: Regulate intestinal digestion and absorption, control fat accumulation, improve meat quality, enhance feed utilization rate, and reduce obesity in livestock and poultry.
- **Aquatic feed (fish, shrimp, crabs)**: Promote nutrient absorption, reduce feed coefficient, improve body shape of aquatic animals, and enhance survival rate and meat quality.
- **Pet feed (dog and cat food, snacks)**: Control pet weight, prevent obesity, protect intestinal health, suitable for adult and obese pets.

3.2 Dosage Form Selection and Addition Methods

(1) **Feed-grade White Kidney Bean Extract Powder (α-amylase inhibitor activity ≥8000U/g)**

Applicable to formula feed, premix, concentrate, pet food, suitable for conventional livestock, poultry, aquatic and pet breeding scenarios with high cost performance.

Addition Methods:

- Adopt stepwise dilution method (10×→100×→1000×), first mix with vitamin and mineral premix (premix ratio 1:5-1:10), stir evenly, then add to basic feed and mix continuously for 20-30 minutes.
- **Process Nodes**: Feed mixing stage (normal temperature, ≤35℃), avoid high-temperature granulation; if granulation is required, granulation temperature ≤75℃, post-spraying process is preferred.

Reference Dosages: Fattening pigs 0.05%-0.12%; Broilers/layers 0.06%-0.13%; Aquatic products 0.08%-0.18%; Pet feed 0.1%-0.25%.

(2) **Microencapsulated White Kidney Bean Extract (Embedding rate ≥88%)**

Applicable to high-temperature granulated feed, water-resistant aquatic feed, pet expanded feed, scenarios requiring improved high-temperature stability and active ingredient utilization rate, suitable for large-scale breeding.

Addition Methods: Directly add to mixer, or spray after granulation (spray temperature ≤50℃) to avoid high-temperature granulation damage to active ingredients and ensure effective utilization rate ≥80%.

Reference Dosages: Same as conventional powder; microcapsules have higher effective ingredient utilization rate, dosage can be reduced by 10%-20%, adjusted appropriately according to animal species and growth stage.

3.3 Operation Points and Quality Control

1. **Uniformity**: Stepwise dilution must be strictly implemented; direct addition of high-concentration extract to a large amount of feed is prohibited to prevent excessive local concentration from affecting feed intake and digestion.
2. **Temperature Control**: Granulation temperature ≤75℃, post-spraying process shall be adopted if exceeded; storage temperature ≤25℃, light-proof and sealed to prevent active ingredient inactivation.
3. **Compatibility Safety**: Used synergistically with probiotics and digestive enzymes to improve intestinal health effect and feed conversion rate; avoid direct mixing with strong alkaline additives to prevent ingredient failure.
4. **Effect Verification**: Regularly detect active ingredient residues in feed, monitor animal growth performance and body fat rate, and optimize addition dosage according to results.
5. **Compliance**: Use feed-grade extracts conforming to *Catalogue of Feed Additive Varieties*, retain manufacturer qualifications and batch inspection reports, and strictly prohibit the use of non-feed-grade raw materials as substitutes.

IV. Operation Guidelines for Addition in Pharmaceutical/Health Care Products Field

4.1 Applicable Categories and Core Functions

- **Pharmaceuticals**: Adjuvant preparations for postprandial blood glucose regulation, weight management auxiliary drugs, for adjuvant conditioning of people with impaired glucose tolerance and obesity.
- **Health care products**: Glycemic control, weight control and intestinal conditioning products (capsules, tablets, powders, oral liquids, granules), suitable for weight loss populations, high-carbohydrate diet populations, middle-aged and elderly glycemic control populations.

4.2 Dosage Form Selection and Addition Methods

(1) **Pharmaceutical-grade White Kidney Bean Extract Powder (α-amylase inhibitor activity ≥20000U/g, purity ≥98%)**

Applicable to capsules, tablets, granules, suitable for pharmaceutical preparations and high-end health care products with high purity and stable activity.

Addition Methods:

- **Capsules/tablets**: Mix with microcrystalline cellulose, lactose, magnesium stearate, dry/wet granulation (granulation temperature ≤50℃), tableting or capsule filling, mixing uniformity conforming to GMP specifications.
- **Process Nodes**: Preparation mixing stage, avoid high temperature and strong light, operate in a clean environment throughout the process to prevent contamination.

Reference Dosages: 500-1500mg extract per capsule; 300-1000mg extract per tablet; total daily intake ≤10g.

(2) **Health Care Product-grade White Kidney Bean Extract Concentrate (α-amylase inhibitor activity ≥10000U/g)**

Applicable to oral liquids and drinks, scenarios requiring rapid dissolution and high activity, suitable for liquid dosage form health care products.

Addition Methods: Dissolve in warm water at 40-50℃, add sweeteners and stabilizers, adjust pH to 5.0-7.0, sterile filter and fill to ensure sterility.

Reference Dosages: Daily intake of oral liquid 10-30mL, convert addition dosage according to product specifications.

(3) **Stabilized White Kidney Bean Extract (Embedded and Modified)**

Applicable to long-term health care products and high-temperature sterilized preparations, with excellent stability and high bioavailability.

Addition Methods: Same as water-soluble powder, resistant to short-term sterilization at 90℃ (≤15 minutes), can be directly mixed with other raw materials.

Reference Dosages: Daily extract intake 600-1500mg, accurately converted according to product specifications.

4.3 Operation Points and Quality Control

1. **GMP Specifications**: Production environment cleanliness Grade D or above, special equipment to avoid cross-contamination; operators strictly implement aseptic operation.
2. **Stability**: High-purity extracts shall be stored in light-proof, sealed and cool conditions; stabilized dosage forms can be stored at room temperature with shelf life ≥24 months.
3. **Content Control**: Detect α-amylase inhibitor activity per batch with deviation ≤±5%; detect heavy metals, microorganisms and solvent residues, conforming to pharmacopoeia and health care product standards.
4. **Safety**: Clearly define inappropriate populations (pregnant women, lactating women, children, legume allergic persons); diabetic patients shall take medicine under doctor's advice, and excessive consumption is strictly prohibited.
5. **Efficacy Verification**: Health care products shall complete animal experiments and human food trials to ensure glycemic and weight control efficacy meet standards; pharmaceuticals shall conform to pharmacopoeia standards and complete clinical verification.

V. Operation Guidelines for Addition in Cosmetics Field

5.1 Applicable Categories and Core Functions

- **Skin care products**: Soothe skin, resist oxidation, improve skin dullness, repair skin barrier (creams, essences, facial masks, toners, emulsions), suitable for all skin types, especially sensitive skin.
- **Washing and care products**: Mild cleaning, protect scalp, nourish hair (shampoo, hair conditioner, body wash), improve skin and hair moisture.

5.2 Dosage Form Selection and Addition Methods

(1) **Cosmetic-grade White Kidney Bean Extract Powder (Hypoallergenic Refined Type)**

Applicable to creams, emulsions, shampoos, body washes, suitable for medium and low-end skin care and washing products with controllable cost and high safety.

Addition Methods:

- **Oil phase systems (creams, emulsions)**: After oil phase preparation, cool to 40-45℃, add extract dissolved in aqueous phase, homogenize for 3-5 minutes (rotating speed 2000-3000r/min) to ensure uniform dispersion.
- **Aqueous phase systems (shampoos, toners)**: Pre-dissolve with glycerin and propylene glycol, add to aqueous phase (≤40℃), stir for 20-30 minutes until uniform.
- **Process Nodes**: Later emulsification stage, batching stage, avoid high temperature (>50℃) causing active ingredient inactivation.

Reference Dosages: Skin care products 0.2%-3%; Shampoos 0.5%-2%; Facial mask essence 0.3%-2.5%.

(2) **Water-soluble White Kidney Bean Extract Concentrate**

Applicable to essences, toners, facial masks, high-end washing and care products, easy to absorb, mild and non-irritating.

Addition Methods: Directly add to aqueous phase, stir evenly without additional solubilization; compound with hyaluronic acid and vitamin E to enhance repair effect.

Reference Dosages: Same as conventional powder; concentrate has higher utilization rate, dosage can be appropriately reduced.

5.3 Operation Points and Quality Control

1. **Irritation Control**: Select hypoallergenic refined extract, addition dosage ≤3%, ≤1% for sensitive skin products; conduct skin irritation tests in advance to ensure no irritation and allergy.
2. **Compatibility Safety**: Avoid direct mixing with high-concentration fruit acids and strong oxidants to prevent ingredient failure; compound with niacinamide and hyaluronic acid for synergistic skin repair.
3. **Stability**: Add a small amount of antioxidants, store products in light-proof and sealed conditions to prevent active ingredient inactivation and ensure

stable efficacy within shelf life.

4. **Compliance**: Conform to *Safety Technical Specifications for Cosmetics*, detect heavy metals and microorganisms, no prohibited ingredients; label ingredient names and addition dosages.

VI. Operation Guidelines for Addition in Agricultural Field

6.1 Applicable Scenarios and Core Functions

- **Fertilizer/soil treatment**: Improve soil, promote crop root growth, enhance crop stress resistance, improve crop quality and increase yield.
- **Seed treatment**: Promote seed germination, improve emergence rate, enhance seedling stress resistance, reduce seedling diseases.
- **Foliar spraying**: Supplement plant nutrition, improve crop disease and drought resistance, improve fruit taste and quality.

6.2 Dosage Form Selection and Addition Methods

(1) **Agricultural-grade White Kidney Bean Extract Powder**

Applicable to soil treatment and seed dressing, suitable for large-scale agricultural production with convenient use.

Addition Methods:

- **Seed dressing**: Mix powder and seeds at a ratio of 1:50-1:100, stir evenly and dry in shade (avoid exposure) before sowing.
- **Soil broadcasting**: Mix powder with fine soil, broadcast evenly and then tillage, dosage 1-3kg per mu.

(2) **White Kidney Bean Extract Aqueous Solution**

Applicable to foliar spraying and root irrigation, with fast effect and good absorption.

Addition Methods: Dissolve and dilute 500-1000 times with warm water, spray evenly on leaves or irrigate roots, apply once every 10-15 days, continuously apply 2-3 times.

Reference Dosages: 50-100g per mu for foliar spraying; dosage can be appropriately increased for root irrigation.

6.3 Operation Points and Quality Control

1. **Application Timing**: Avoid high-temperature and strong light periods, apply in early morning or evening to improve absorption effect.
2. **Compound Synergy**: Compound with organic fertilizers and water-soluble fertilizers to improve fertilizer efficiency and promote crop growth.
3. **Storage Protection**: Sealed and moisture-proof, placed in dry and ventilated place to avoid caking and failure.
4. **Compliance**: Use agricultural-grade extracts conforming to agricultural production specifications, strictly prohibit the use of industrial-grade and non-edible raw materials.

VII. Operation Guidelines for Addition in Industrial Field

7.1 Applicable Scenarios and Core Functions

- **Water treatment**: Inhibit microbial growth, assist in water purification, mild and non-corrosive, protect pipelines.
- **Papermaking/textile**: Prevent mildew and corrosion, extend product shelf life, improve product durability.
- **Coatings/fillers**: Natural antioxidant, delay aging, reduce the use of chemical additives.

7.2 Dosage Form Selection and Addition Methods

(1) **Industrial-grade White Kidney Bean Extract Powder**

Applicable to papermaking pulp, coating formulas, water treatment, exerting anti-corrosion and antibacterial effects.

Addition Methods: Premix with raw materials, stir evenly at room temperature to ensure dispersibility, dosage 0.1%-1%.

(2) **Water-soluble Antiseptic Solution**

Applicable to industrial circulating water, textile dyeing and finishing, assisting in antibacterial and algae removal.

Addition Methods: 30-100g per ton of water, dissolve in warm water and add to the system, supplement regularly to maintain concentration.

7.3 Operation Points and Quality Control

1. **Concentration Control**: Precisely add according to the process to avoid excessive cost increase or insufficient dosage affecting effect.
2. **Equipment Protection**: Use stainless steel and plastic equipment, avoid contact with metal ions to prevent failure.
3. **Environmental Protection Requirements**: Discharge wastewater after reaching standards, conform to environmental protection specifications.
4. **Storage**: Sealed and moisture-proof, stored in cool and dry place, shelf life ≥12 months.

VIII. Storage and Transportation Specifications

1. **Storage Conditions**

Sealed, light-proof, cool and dry place, temperature ≤25℃, humidity ≤60%; avoid high temperature, high humidity and direct strong light. Shelf life of conventional powder ≥24 months, concentrate ≥12 months.

2. **Packaging Requirements**

Powder is packed in aluminum foil bags and cardboard drums lined with polyethylene bags for moisture and leakage prevention; concentrate is packed in sealed plastic drums or aluminum cans; all packages are labeled with product name, specification, active content, batch number, production date and shelf life.

3. **Transportation Requirements**

Avoid exposure, rain and high temperature; prohibit mixed transportation with toxic and harmful substances, strong oxidants and alkaline substances, keep ventilated to prevent damage and leakage.

4. **Batch Management**

Implement the first-in first-out principle, retain usage records and inspection reports of each batch for quality traceability.

IX. Quality Inspection and Abnormality Handling

9.1 Mandatory Inspection Items

- **Activity Detection**: α-amylase inhibitor activity, detected in accordance with industry standards to ensure compliance.

- **Physicochemical Indicators**: Moisture, ash, pH, solubility, heavy metals (lead, arsenic, mercury), conforming to corresponding national standards.
- **Microbiological Indicators**: Total bacterial count, mold, yeast, pathogenic bacteria, conforming to food, pharmaceutical and cosmetic grade standards.
- **Stability**: Accelerated test to detect activity retention rate, retention rate ≥80% within shelf life.

9.2 Abnormality Handling

1. **Active Ingredient Inactivation**: Causes (high temperature, strong acid/alkali, contact with contraindicated substances); Treatments (control temperature ≤70℃, adjust pH to 5.0-7.5, replace microencapsulated dosage form, avoid contraindicated compatibility).
2. **Caking and Uneven Dispersion**: Causes (moisture absorption, unsieved, insufficient stirring); Treatments (sealed moisture-proof, sieve before addition, stepwise premixing, extend stirring time).
3. **Product Discoloration**: Causes (contact with metal ions, photo-oxidation); Treatments (switch to stainless steel equipment, light-proof storage, add antioxidants).
4. **Uneven Efficacy**: Causes (uneven feeding, insufficient mixing); Treatments (strict stepwise dilution, standardized stirring process).

X. Supplementary Provisions

1. This guideline is a standardized operation specification. Enterprises can optimize and adjust addition dosages and process parameters according to their own product characteristics, process equipment, regulatory requirements, combined with laboratory and pilot tests to ensure product quality and efficacy.
2. The optimal range of white kidney bean extract addition dosage shall be determined through laboratory tests, and large-scale production shall be carried out after verifying stability and efficacy via pilot tests to avoid batch quality problems and reduce production costs.
3. Matters not covered in this guideline shall be implemented with reference to relevant national standards, regulations and product instructions of white kidney bean extract manufacturers.