A Review of Multi-gradient Composite Compatibility Requirements of Mepc Food System for Product Design

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Abstract

Microenvironment power cycle is a systematic framework for food design established for targeted nutritional therapy (including psychological well-being) purposes, employing multi-gradient matching approaches for populations with specific constitutions or specific requirements. Through food design intervention in regional environments, the involved nutrients can be maximally digested, absorbed, and delivered into the required regional scope, thereby forming a food nutrition-driven dynamic. Concurrently, it maintains favorable metabolic pathways that enable effective elimination of metabolic products.

Full Text

Review of Composite Multi-Gradient Fit Requirements for MEPC Food System Product Design*

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Abstract

The Microenvironment Power Cycle (MEPC) is a food design framework that employs multi-gradient fitting techniques to address specific physiological constitutions or requirements for targeted nutritional therapy (including psychological well-being). Through deliberate food design intervention, nutrients can be maximally digested, absorbed, and delivered to targeted regions within the body, thereby generating "food nutrition power." Simultaneously, the system establishes effective metabolic pathways for the efficient excretion of metabolic byproducts.

[**Objective**] To achieve targeted nutritional therapy (including psychological well-being) for diverse populations.
[**Methods**] Establish a food design system employing multi-gradient fitting techniques tailored to specific physiological constitutions or requirements.
[**Results**] The MEPCF food system is proposed, which ensures food nutrition power while providing effective metabolic channels for byproduct excretion. MEPCF utilizes multi-gradient fitting methods for food design, offering a novel approach to scientific food formulation.
[**Limitations**] The discussion focuses on the influence of various factors in food design without exploring their underlying mechanisms in detail.
[**Conclusions**] The MEPCF food system is proposed, with detailed elaboration of factors to be considered in food design.

Keywords: microenvironment; power; cycle
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1. Introduction

In food ecology, the microenvironment refers to localized environmental conditions created when food design interventions cause subtle changes in one or more ecological spheres, resulting in environmental differences at the receptor level. For example, during the synthesis of human pancreatic β-cells, factors such as pH conditions, nutritional environment, various intervening factors, blood glucose curve generation, and stem cell induction affect surrounding structures and components, ultimately determining the quantity and quality of β-cell synthesis—where food nutrition intervention represents the outcome of microenvironmental effects.

"Power" and "cycle" in food ecology denote that nutrients can be maximally digested, absorbed, and delivered to required regions, forming "food nutrition power," while simultaneously establishing effective metabolic channels for byproduct excretion. The three critical nodal factors—microenvironment, power, and cycle—must be monitorable, evaluable, traceable, and evidence-based within the design framework.

2. Microenvironment

2.1 Human Microenvironment

The human microenvironment encompasses both the digestive absorption microenvironment and the target organ/tissue microenvironment. Proper evaluation requires assessing the absorption efficiency, absorption modality, absorption load, physiological and pathological states of digestive organs, and tolerance levels of designed foods within the human body.

The target organ/tissue microenvironment must be objectively and effectively evaluated through existing medical and physiological detection equipment. Even peripheral data that may significantly influence target organs should be thoroughly measured and prepared. Only through extensive accurate data can the target organ microenvironment be properly understood. Comprehensive evaluation can be conducted across the entire digestive tract, including liver function, pancreatic function, oral cavity function, esophageal function, gastric function, duodenal function, jejunal function, ileal function, and colonic function. The assessment can also be expanded to include brain function, pulmonary function, renal function, splenic function, cardiac function, thyroid function, adrenal function, bladder function, sexual function, muscular function, immune function, coagulation function, skin function, basal metabolic rate, and more. Following the establishment of comprehensive, effective, and accurate data, simplified designs can be developed for specific populations under shared conditions.

2.2 Microbial Microenvironment

This refers to probiotics, pathogenic bacteria, conditional pathogens, and objectively present non-significant bacterial flora within the essential human microbiota. As this is not a specialized medical discussion, pathogenic and conditional pathogenic bacteria include mycoplasma, chlamydia, and fungi. Microbial microenvironments must be carefully considered during MEPC food design to maintain them in an optimal responsive state.

2.3 Nutritional Microenvironment

Nutrient supplementation represents the core of MEPC food design. This requires detailed analysis of raw materials, ranging from inorganic electrolytes to various complex organic compounds. Formulations must adjust the ratios of carbon-based (C-based) and nitrogen-based (N-based) foods, with clear understanding of lipid-soluble and water-soluble foods. Comprehensive knowledge of plant-based, animal-based, and edible fungal food nutrients—and their cleavage products—is essential.

For nutritional additives, including preservatives, antioxidants, expanders, emulsifiers, thickeners, dispersants, color protectants, colloidal synthesis agents, and coating agents, appropriate range intervals must be established.

2.4 Other Microenvironments

Beyond the aforementioned categories, numerous other microenvironments influence MEPC food systems:

1. **Human Organ Function Microenvironment:** The microenvironment where various human organs absorb and utilize food nutrients while being affected themselves.
2. **Color-Taste-Olfactory Sensory Microenvironment:** The microenvironment where visual appearance, taste, and smell of food influence subjective brain factors and generate perceptual judgments about the food.

3. **Food Preservation Gas Microenvironment:** The gas composition during food storage, chemical reactions between gases and food, and the growth environment for surrounding microbial flora.
4. **Optical Microenvironment:** The influence of light exposure, spectral wavelengths, and radiant flux on food and its surrounding microbial environment.
5. **Chemical Microenvironment:** Microenvironmental factors beyond the food itself that can chemically react with it.
6. **Radiation Microenvironment:** The effects of particle wave impacts and radiation flux on food and surrounding microbial environments.
7. **Enzyme Microenvironment:** Enzymes inherent in food and those present in the environment that can induce biochemical reactions.
8. **Temperature Microenvironment:** How temperature and temperature variation curves affect biochemical reactions, enzymatic reactions, and microbial growth in food.
9. **Humidity Microenvironment:** How humidity and humidity variation curves affect biochemical reactions, enzymatic reactions, and microbial growth in food.
10. **Acid-Base Microenvironment:** How pH and pH variation curves affect biochemical reactions, enzymatic reactions, and microbial growth in food.
11. **Salt Osmotic Pressure Microenvironment:** How salt osmotic pressure and its variation curves affect biochemical reactions, enzymatic reactions, and microbial growth in food.
12. **Sugar Osmotic Pressure Microenvironment:** How sugar osmotic pressure and its variation curves affect biochemical reactions, enzymatic reactions, and microbial growth in food.
13. **Lipid Osmotic Pressure Microenvironment:** How lipid osmotic pressure and its variation curves affect biochemical reactions, enzymatic reactions, and microbial growth in food.
14. **Nanobubble Microenvironment:** The influence of nanobubbles within food on volume, shape, and biochemical reactions.
15. **Trace Element Microenvironment:** How trace elements affect food nutritional structure and biochemical reactions, either promoting or inhibiting them.
16. **Alcoholic Microenvironment:** How alcohol affects food nutritional structure and biochemical reactions, either promoting or inhibiting them.
17. **Spice Microenvironment:** How spices affect food nutritional structure and biochemical reactions, either promoting or inhibiting them.

18. **Hardness Microenvironment:** How different hardness levels affect food surface structure tension and alter contact areas between hierarchical structures.

3. Power

3.1 In Vivo Absorption Power

Carbohydrates, fats, proteins, vitamins, electrolytes, trace elements, coenzymes, and specially formulated nutrients undergo degradation into absorbable states within the gastrointestinal tract through the action of pepsin, pancreatic amylase, trypsin, intestinal peptidases, and bile. This degradation process constitutes the absorption power within foods.

3.2 Ex Vivo Ratio Absorption Power

This involves the external addition of various enzymes, including human-derived enzymes (e.g., human pepsin), animal-derived enzymes (e.g., bovine intestinal peptidase), and plant-derived enzymes (e.g., papain).

3.3 Artificially Created Degradable Acid-Base Force Field

Unlike the acid-base microenvironment that stabilizes food pH structure, the acid-base environment required for power directly degrades food components.

3.4 Power Formed by Osmotic Pressure

This refers to the process where nutrients permeate between internal and external human environments due to osmotic pressure gradients created by high-salt, high-sugar, and high-fat conditions.

3.5 Power of Active Transport

This driving force originates from the active transport absorption environment mediated by various transmitters and receptors on human cell membranes. Active transport is the energy-consuming process where specific substances are transported from low-concentration to high-concentration sides via special carrier proteins. Examples include ion pumps transporting electrolytes against concentration gradients (e.g., sodium-potassium pump), glucose absorption by intestinal epithelial cells via glucose pumps, and glucose reabsorption by renal tubular epithelial cells. These processes utilize ATP hydrolysis by membrane sodium pumps for energy. Active transport comprises primary and secondary types.

During active transport, the sodium pump exports sodium ions and imports potassium ions, maintaining uneven ion distribution (high intracellular potassium, high extracellular sodium). Its roles in absorption include: maintaining high intracellular potassium as a necessary condition for many metabolic reactions, preventing cellular edema, and storing potential energy.

3.6 Mainstream Flora Power

This refers to the degradation—both normal and abnormal—of food by various enzymes and factors secreted by microbial flora.

3.7 Secondary Flora Power

Secondary flora are small colonies that develop from primary colonies. Their presence leads to degradation—both normal and abnormal—of secondary metabolites under the influence of mainstream flora.

3.8 Other Powers

Beyond the aforementioned powers, others include inorganic salt power, special element power, human pathological power, colloid-to-crystal ratio power, sugar-salt ratio power, human subjective demand power, human excitatory demand power, and hormone power.

4. Cycle

Numerous regular, repetitive processes occur during human food digestion, requiring repeated execution of inherent biochemical reactions. The repeated execution of biochemical reactions is termed a cycle. As historical texts note: "This must make its words like cycles, and military deployment like embroidery" (*Strategies of the Warring States・Yan Ce II*); "The ways of the Three Kings are like cycles, ending and beginning again" (*Records of the Grand Historian・Basic Annals of Emperor Gaozu*); "Cold and heat succeed each other, rise and fall follow cyclical principles" (Ming Dynasty Zhang Jing, *Feiwan Ji・Lvdi Chumo*); "Flowers wither and bloom, moons wax and wane—all are endless cycles, which is natural" (Ba Jin, *Autumn* 40).

4.1 Carbon-Based Cycle

The carbon-based cycle refers to the balanced absorption-excretion cycle of carbohydrates and other carbon-dominant substances after metabolic action.

4.2 Nitrogen-Based Cycle

The nitrogen-based cycle refers to the balanced absorption-excretion cycle of nitrogen-dominant substances after metabolic action.

4.3 Metal Ion-Based Cycle

The metal ion-based cycle refers to the balanced absorption-excretion cycle of metal ion-dominant substances after metabolic action.

4.4 Non-Metal Ion-Based Cycle

The non-metal ion-based cycle refers to the balanced absorption-excretion cycle of non-metal ion-dominant substances after metabolic action.

4.5 Original Form Substance-Based Cycle

The original form substance-based cycle refers to the balanced absorption-excretion cycle where substances are excreted in exactly the same state as when absorbed.

4.6 Cyclic Accumulation

During cycling, regardless of the foundational substances, accumulation processes can occur in the body—including both beneficial and harmful accumulation. This does not contradict the MEPC concept, as the excreted foundational substances are equivalent or nearly equivalent to the accumulated substances.

4.7 Other Cycles

Beyond the aforementioned cycles, others exist, including coenzyme cycles, total sugar cycles, polysaccharide cycles, oxidant cycles, and antioxidant cycles.

5. Conclusion

The Microenvironment Power Cycle (MEPC) is a food design framework that employs multi-gradient fitting techniques for specific physiological constitutions or requirements, aimed at targeted nutritional therapy (including psychological well-being).

This system integrates specific human physiological and pathological functions to conduct precise nutritional analysis of food components and their degradation structures. Through complex internal and external fitting factors, combined with subjective and objective power, it generates specific effects within the human body and enables cyclic excretion (including controlled cyclic accumulation of foundational substances).

Only through scientific food design using the MEPC framework can we achieve purposeful, rapid nutrient intake, effective metabolic byproduct excretion, and desired nutrient accumulation. Moreover, with the correct conceptual foundation, this approach will generate more effective and accurate food design algorithms, producing correct and efficient foods for the food industry.

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Note: Figure translations are in progress. See original paper for figures.