Standardizing Pesticide Formulation Types and Coding Systems in China: Current Status and Prospects

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Abstract: As of the end of 2024, China has established a comprehensive system of pesticide formulations applicable to various settings, including farmland, forestry, non-cultivated areas, public health (indoor and outdoor), and specialized uses (such as pheromones, wood preservatives, warehousing, and personal protection). This paper provides an overview of the definitions, categories, coding principles, unique domestic formulations, and regulatory issues related to pesticide formulations in China. It also highlights the alignment with international standards, identifies the need for revisions in response to evolving technologies and application methods, and offers recommendations for future development.

Since the 1980s, when China implemented a pesticide registration management system, the country has gradually developed a relatively comprehensive system for managing pesticide formulation types. In 2003, the national standard *Pesticide Formulations and Codes* was issued, establishing unified regulations for pesticide registration formulations. This standard was revised in 2017, aligning China's pesticide formulation types with international standards while also meeting the country's specific needs.

At present, China had established a diverse range of pesticide formulations applicable to agriculture, forestry, public health (both indoor and outdoor), and specialized domains such as semiochemicals, wood preservation, warehousing, and personal protection. China is now one of the countries with a rich variety of pesticide formulation types, with a wide range of products registered under each type. This paper provides an overview of the formulation types and coding system for pesticides in China, offering insights for reference and further study.

1. Definition and Scope of Formulation Types

Pesticide formulation types are defined as formulated products that possess specific physical forms, characteristics, and application methods. Formulation research and development necessitates consideration of product stability, efficacy, safety, and production feasibility. These multidimensional considerations are reflected in the FAO/WHO Manual on Development and Use of FAO and WHO Specifications for Chemical Pesticides (Second Edition, hereafter referred to as the "Manual"), which emphasizes their impacts on efficacy, human and environmental safety.

2. Current Status of Pesticide Formulation Types in China

China issued its first national standard on pesticide formulation type names and codes in 2003. The current version, GB/T 19378-2017, defines 61 pesticide formulation types and their codes. Approximately 85% of these are based on or aligned with internationally recognized formulation types listed in Appendix 4 of the "Manual" (CropLife International, 2017, Technical Monograph No. 2), while the remaining 15% are innovative domestic formulation types.

In GB/T 19378-2017, pesticide formulations are classified into 5 major categories, including technical material (TC) and technical concentrates (TK), solid formulations (direct-use, dispersible, and soluble solids), liquid formulations (solutions, dispersions, emulsions, suspensions, multiphase liquids), seed treatment (solid and liquid), and other types (e.g., formulations with applicators, volatiles, fumigants, space repellents, topicals, and use-specific forms).

3. Principles and Considerations for the Nomenclature of Pesticide Formulation Types in China

The naming of pesticide formulation types in China follows a structured set of principles designed to ensure clarity, scientific validity, and practical relevance:

3.1 Physical State and Functional Description. Nomenclature should be based on the product's physical state—such as solids (e.g., powders, granules, tablets), liquids (e.g., solutions, suspensions), or other forms—and may be supplemented by descriptors indicating functionality (e.g., mosquito repellent) or intended use (e.g., seed treatment).

3.2 Language Conciseness and Distinction. Formulation type names typically consist of two to five Chinese characters. They should be concise, easy to understand, pronounce, and remember, while also distinguishing themselves from terminology used in related fields such as chemical engineering, pharmaceuticals, and cosmetics.

3.3 Scientific Justification and Technical Feasibility. Formulation classification should reflect the physical form and delivery characteristics of the active ingredient, clearly differentiating the formulation’s mechanism of action, advantages, and distinctions from similar types. Supporting this classification should be scientifically sound and technically feasible performance indicators and analytical methods, in order to demonstrate the necessity and feasibility of the formulation type.

3.4 Alignment with International Standards. Internationally recognized formulation type names, codes, and classification methodologies should be adopted whenever possible, to enhance global **compatibility** and support harmonization of standards.

3.5 Considerations for New Formulation Types. For formulation types not included in either international or national pesticide formulation standards, the naming and coding should take into account the following factors:

- The names and definitions of formulation type and should not be overly narrow; they should exhibit general applicability, compatibility, and foresight to ensure sustainability over time.
- Existing international and domestic formulation types standards should be fully utilized. Where possible, relevant types should be adopted or appropriately modified to minimize ambiguity and avoid unnecessary additions.
- The development and adoption of green, clean, and low-carbon environmentally friendly formulation types should be encouraged, with the aim of progressively replacing outdated formulation types and improving the overall diversity and quality of registered pesticide products.

4. China-Specific Formulation Types and Codes

In addition to adopting international codes, China has introduced unique domestic formulation types to meet local needs, particularly in public health pesticide registration. These include repellents, insect-proof nets, and pheromone-based dispensers, among others. Specific codes and definitions of the formulation types are provided in the following table.

Table 1 Innovative domestic formulation types developed and registered in China for public health and semiochemical use

Code	Term	Definition
Solid formulations for direct use		
PT*	pellet	Sphere-shaped formulation containing active ingredients (generally with a diameter greater than 6mm)
Formulations prepared as devices		
PM*	proof mat	A sheet-like or granular formulation, using synthetic resin or other carriers, that allows the active ingredients to volatilize under the action of wind generated by a fan or similar device
Spatial repellent formulations		
PN*	insect-proof net	A mesh-like formulation, using synthetic resin or other carriers, that releases active ingredients
PC*	insect-proof cover	A mesh-like formulation, using non-woven fabric or other carriers, that releases active ingredients
RK*	repellent milk	A lotion formulation containing active ingredients that can be directly applied to the skin, providing repellent effects.

RQ*	repellent liquid	A clear liquid formulation with repellent effects that can be directly applied to the skin, containing active ingredients or having viscosity
RW*	repellent floral water	A clear liquid formulation, resembling floral water, with repellent effects that can be directly applied to the skin and contains active ingredients
RP*	repellent wipe	A wet non-woven fabric or other carrier formulation containing active ingredients with repellent effects that can be directly applied to the skin and contains
Volatile formulations		
DR*	dispensor	A formulation that uses carriers to release active ingredient(s) to regulate insect behavior

These products, along with those used for residual spraying (IRS), indoor and outdoor space spray, long-lasting insecticidal nets (ITN), and larvicides for mosquito control, as well as common indoor formulations such as aerosol (AE), electric mosquito-repellent mats (MV), electric liquid mosquito repellents (LV), and mosquito coils (MC), have played a vital role in vector control. Combined with improved living conditions, better sanitation, and the widespread use of public health pesticide products, malaria cases in China declined from 30 million annually in the 1940s to zero indigenous cases by 2017. In June 2021, the World Health Organization officially certified China as malaria-free.

5. Issues and Recommendations

5.1 Reevaluating Equipment-Based Formulation Types

In China's national pesticide formulation type standards, two application equipment-based formulation types are defined: ultra-low volume (ULV) liquid and thermal fogging formulations. These types are characterized by their reliance on specific application equipment. However, the current formulation type names reflect the equipment used rather than the actual characteristics of the pesticide products themselves.

In recent years, formulations specifically designed for ultra-low volume (ULV) equipment have seen rapid development in the Chinese market. These have evolved from early oil-based formulations (OL) to a variety of types including emulsion-in-water (EW),

emulsifiable concentrates (EC), microemulsions (ME), dispersible oil suspensions (OD), oil suspensions (OF), and wettable powders (WP).

From both a technical and regulatory perspective, it is recommended to discontinue defining formulation types based on application equipment. Instead, product formulations should be classified according to their actual physical and chemical properties. "Ultra-Low Volume Spraying (ULV)" and "Thermal Fogging" should be indicated as application methods rather than formulation types. According to registration practices in countries such as the United States, Mexico, Sudan, Malaysia, Thailand, and Vietnam, EW products are commonly registered and used for ULV or aerial spraying operations.

Although the current FAO/WHO *Manual on Development and Use of FAO and WHO Specifications for Chemical Pesticides* includes formulation guidelines for UL, its technical parameters are limited to active ingredient content, impurity levels, stability, and viscosity. It is therefore recommended that, in addition to these basic parameters, specifications incorporate application-specific criteria such as volatility (droplet mass loss rate), droplet diameter, and flash point—factors critical to ensuring effective performance with ULV equipment.

5.2 Recommendation on Revising the Definition of Aerosol (AE) Formulations

Aerosol formulations can be classified into three types based on their dispersion systems: solution-based aerosols (sprays), primarily used for controlling small- to medium-sized flying insects such as mosquitoes and flies; powder suspension aerosols (powder sprays), currently commonly applied in medical settings; and emulsion-based aerosols (foam sprays), which are mainly used for rodent control. These variations in the physical state of the dispensed product enable targeted control of different pests.

It is recommended that the current definition of aerosol formulations (AE) be revised to reflect this diversity by adding the phrase “or foam” to the definition (see Table 2) and explicitly specifying “foam spraying” as a method of application. Foam-based aerosol formulations are particularly effective for controlling species such as the Norway rat, the roof rat, and the house mouse. These formulations typically contain first-generation rodenticides with relatively low toxicity, as well as bittering agents to minimize accidental ingestion by non-target organisms. After application, the foam dries into a powder, retaining its biological activity for up to 12 days. This type of formulation has already been registered in over 20 countries, including Germany, France, and Spain.

Table 2: Revised Definition of AE Formulation Type

AE	aerosol dispenser	A container-held formulation which is dispersed generally by a propellant as fine droplets or particles **or foam** upon the actuation of a valve

5.3 Clarifying Status of "No-Longer-Supported" Formulation Type

The current Manual includes specification guidelines for 45 pesticide formulation types, among them soluble powders for seed treatment (SS), liquid vaporizers (LV), and vaporizing mats (MV). However, in Appendix 4 of the Manual—"Classification of Pesticide Formulations and International Codes"—these three formulation types are listed as "no longer supported."

In China's current national standard GB/T 19378—2017, the SS formulation code was removed due to the absence of corresponding registered products at the time. In contrast, LV and MV formulations remain widely used, with nearly 500 products currently holding valid registrations. These products are not only utilized domestically but are also exported to dozens of countries across the Middle East, Africa, and Southeast Asia.

Given this continued relevance, when evaluating whether to classify certain formulation type codes as "no longer supported," it is advisable to give careful consideration to their global registration status and current market applications. Particular attention should be paid to formulation codes that remain referenced in the main text of the Manual, as listing these codes as obsolete in the appendix may create confusion for users and undermine the clarity of the document.

References

1. FAO/WHO. (2016). Manual on Development and Use of FAO and WHO Specifications for Chemical Pesticides (2nd ed.). Food and Agriculture Organization of the United Nations & World Health Organization. Retrieved from: https://www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/jmps/manual/en

2. CropLife International. (2017). Technical Monograph No. 2: Classification of Pesticide Formulations and International Coding System. Brussels: CropLife International.

3. Standardization Administration of China. (2017). GB/T 19378–2017: Pesticide Formulation Names and Codes. Beijing: Standards Press of China.

4. China Certified as Malaria-Free by WHO

https://www.who.int/china/news/commentaries/detail/china-certified-as-malaria-free-by-who.

Attachment: Illustrations of Products in Table 1

1. PT*, Primarily used for moth prevention

2. PM*, Mosquito repellent product with a strap-friendly design

3. PN*, Household mosquito prevention product

4. PC*, Mainly used for mothproofing clothes

5. RK*，Outdoor personal protection product, applied to the skin to repel mosquitoes

6. RQ*，Outdoor personal protection product, applied to the skin to repel mosquitoes

7. RW*，Outdoor personal protection product, applied to the skin to repel mosquitoes

8. RP*，Outdoor personal protection product, easy to carry and applied to the skin to repel mosquitoes

9. DR*，Product used to regulate insect behavior
   Attractant type

Disorientation type