



The quality of the temephos sand granules which produced and sold in Thailand and the relationship to mosquito larvae control efficacy : quality trends, gaps, and approaches to developing inspection and monitoring process to protect consumers in Thailand.

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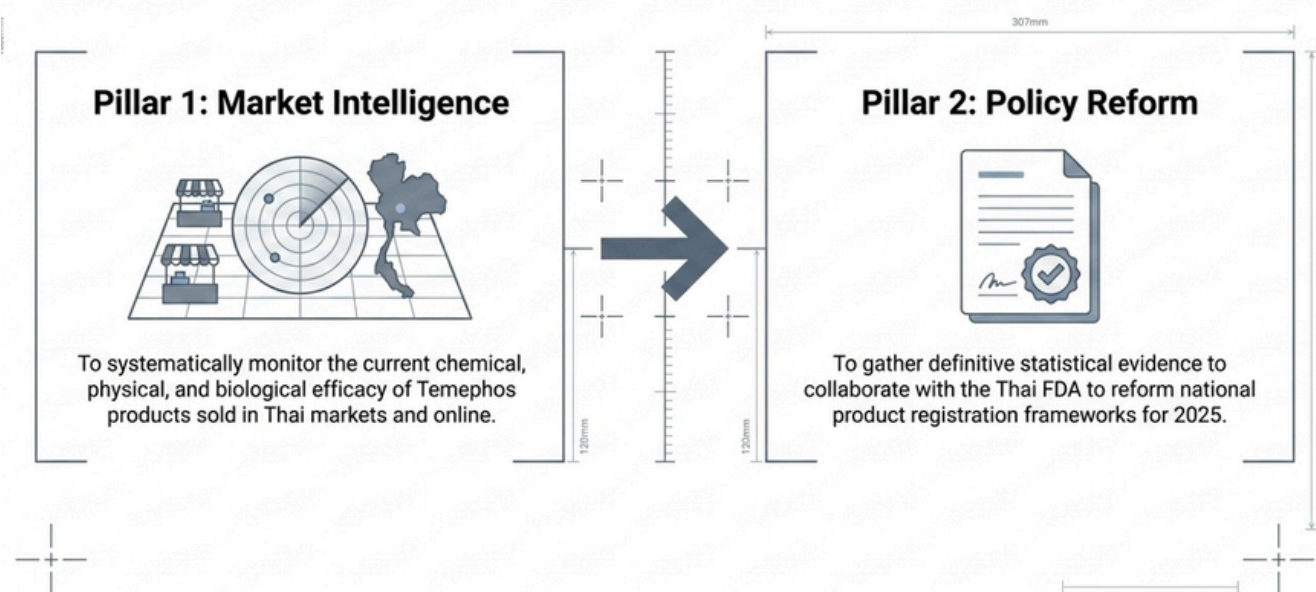
Introduction

- Public Health Context** : Dengue fever remains a persistent and escalating public health threat in Thailand. Epidemiological data from the Department of Disease Control reveals a critical surge in transmission; cumulative cases in July 2023 were 2.7 times higher than those recorded in 2022. This trajectory intensified into 2024, with 32,140 cases reported between January 1 and June 12—a 1.3-fold increase over the same period in the previous year—resulting in 38 confirmed fatalities.
- The Role of Temephos** : Temephos sand granules (commonly known as Abate) serve as the primary chemical intervention for larval control by both Thai health agencies and the general public. These products typically utilize a 1%–2% w/w active ingredient formulation. The World Health Organization (WHO) specifies that a 1% formulation, when applied to water, must achieve a concentration of 1 ppm (1 mg/L) to maintain effective larval suppression for up to three months.
- Chemical Properties and Epidemiological Risks** : Temephos is a synthetic organophosphate. While characterized by low mammalian toxicity, it is highly potent against various Diptera larvae. However, the compound is chemically unstable, being highly sensitive to light and high temperatures, which can lead to rapid degradation. Human exposure risks include respiratory irritation, cephalalgia, and nausea; severe ingestion may result in hypotension and loss of consciousness. Critically, the proliferation of sub-standard products—defined by insufficient active ingredient concentration or poor physical integrity—facilitates the development of larval resistance. Significant resistance has already been documented in several Thai provinces, including Chanthaburi, Nakhon Pathom, Kanchanaburi, and Phitsanulok.

Objective

In fiscal year 2024, the Bureau of Cosmetics and Hazardous Substances (BCHS), in collaboration with, the National Institute of Health (NIH), Department of Medical Sciences (DMSc), conducted a project to survey the quality and efficacy of temephos-based larvicide sand sold in Thailand. The aim was to monitor and evaluate the quality and efficacy of these products in controlling mosquito larvae, and to assess the consistency between chemical and physical quality test results and larvicide efficacy test results. This information will be used to inform the development of guidelines for regulating, monitoring, and supervising the quality and efficacy of temephos-based larvicide sand products both before and after sale, in order to protect consumers.

The 2024 Surveillance Mission



Conclusion & Discussion

Quality Trends

- Historical data reveals a precipitous decline in product quality. In FY 2017 and 2019, the pass rate was 100%. This dropped to 60% in 2022 and reached a record low of 46% in 2024.
- Statistical analysis using a t-Test (Paired Two Sample for Means) confirms that evaluating products using combined chemical and physical parameters is significantly more accurate for predicting biological efficacy than chemical testing alone (**t Stat 3.93 > t Critical 1.67**; $p < 0.05$).

Identified Gaps

- Physical Quality Drivers**: A critical synthesis of the data shows that physical failures (specifically sieving and density issues) lead to uneven distribution and clumping. This prevents the chemical from reaching the necessary 1 ppm concentration in the water column, even if the active ingredient content is theoretically sufficient.
- Biological Resistance Indicators**: The finding that 7 samples passed all physical-chemical tests yet failed to kill $\geq 90\%$ of larvae is a high-impact outlier. This suggests emerging larval resistance or the need for more rigorous biological assay protocols beyond simple chemical verification.
- Market Vulnerabilities**: The prevalence of sub-standard products in online marketplaces is exacerbated by poor storage conditions. Temephos is highly sensitive to light and high temperatures; online sellers often lack the specialized knowledge required for proper climate-controlled storage.

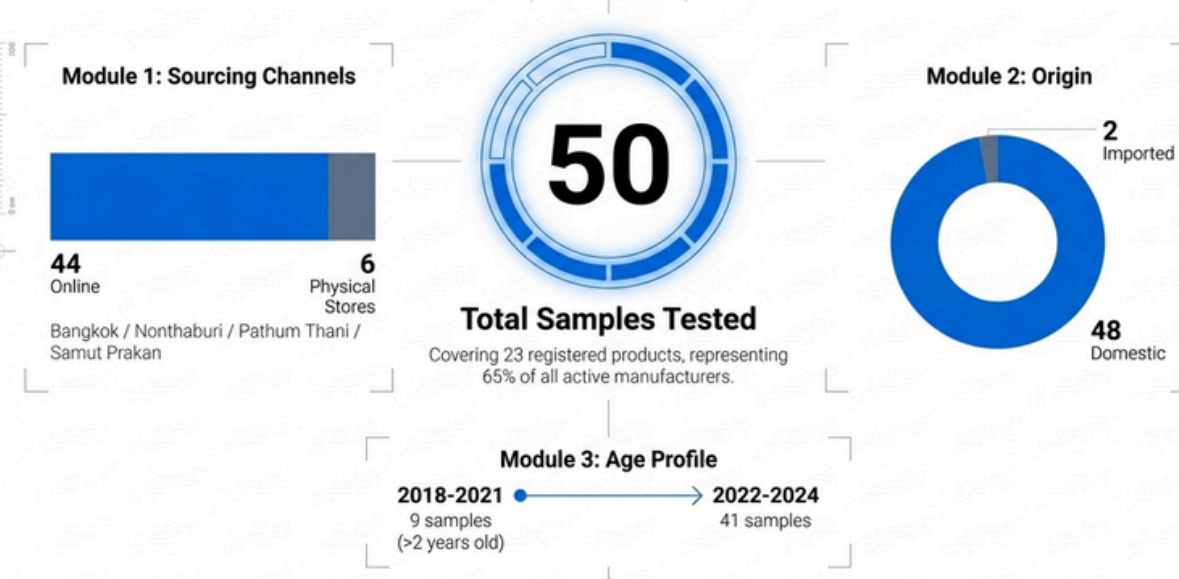
Strategic Approaches for Monitoring

- To ensure public health efficacy, three strategic pillars must be implemented:
- Regulatory Integration**: The Thai FDA should officially adopt WHO physical quality standards (sieving, density, dustiness) into the mandatory registration and post-marketing surveillance protocols for Temephos.
- Stakeholder Training**: Targeted educational programs are required for manufacturers to stabilize production quality and for online retailers to emphasize storage environments and the 2-year shelf-life limit.
- Institutional Procurement Guidance**: Specialized communication must be directed toward Subdistrict Administrative Organizations and local government agencies. As primary distributors, these agencies require procurement guidance to ensure they do not purchase sub-standard or expired batches for mass community distribution.

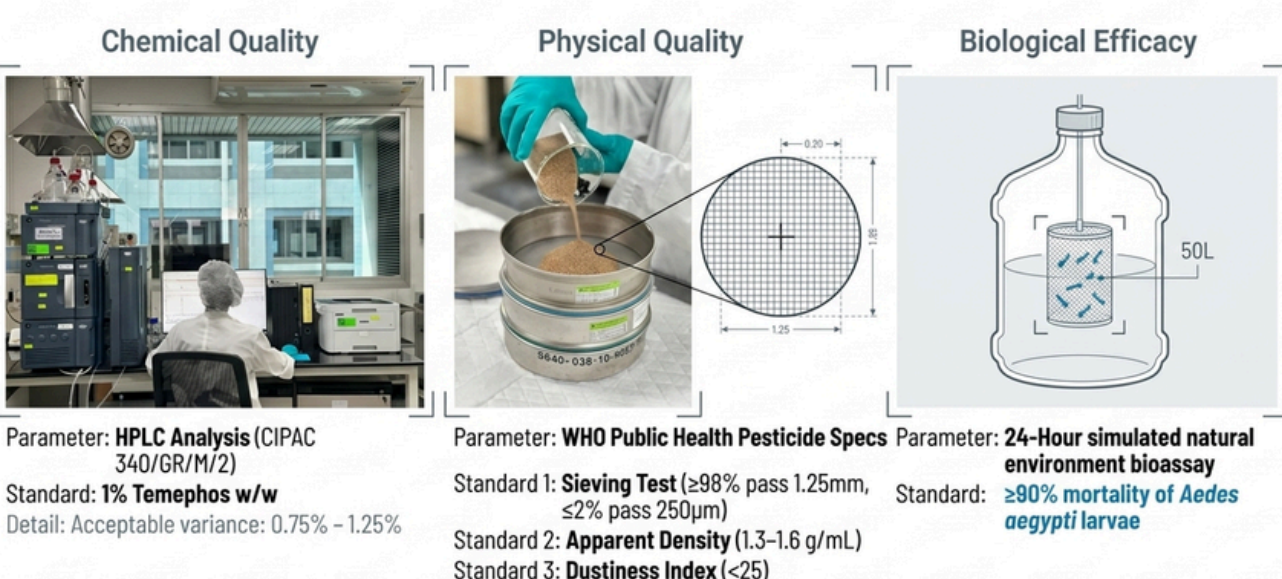
Materials and Methods

- Sampling Strategy** Between November 2023 and June 2024, 50 samples were procured, representing 23 hazardous substance registrations from 11 manufacturers and importers (representing 65% of all registered operators in Thailand). Samples were sourced from online marketplaces (44 samples) and physical retail outlets (6 samples) across the Central, Northern, Northeastern, and Southern regions.
- Quality Analysis Framework** Analyses were conducted at the Bureau of Cosmetics and Hazardous Substances based on WHO Specification of Public Health Pesticides.
- Efficacy Testing** Biological assays utilized the *Aedes aegypti* (NIH strain) in a 30-liter simulated natural environment. Larvae were exposed to a target 1 ppm concentration for 24 hours. The pass threshold was established at $\geq 90\%$ mortality at 24 hours.

2024 Sampling Footprint

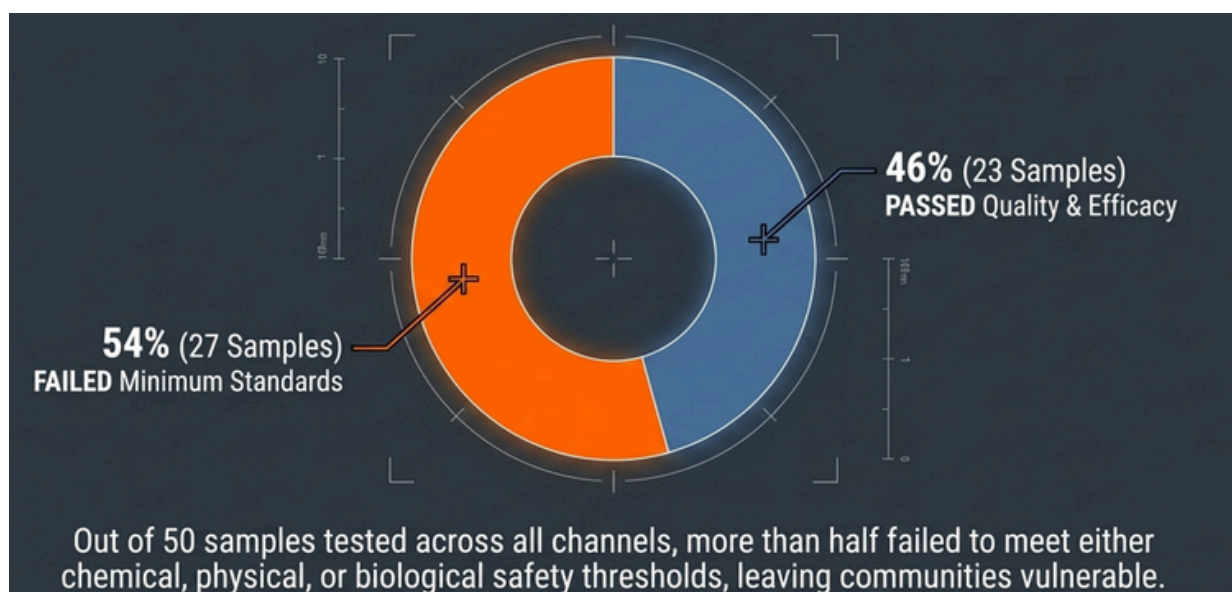


The Testing Triad: A Comprehensive Evaluation Framework



Results

- Overall Performance**: Only 46% (23/50) of samples passed the comprehensive testing battery. A majority, 54% (27/50), failed to meet either quality or efficacy standards.

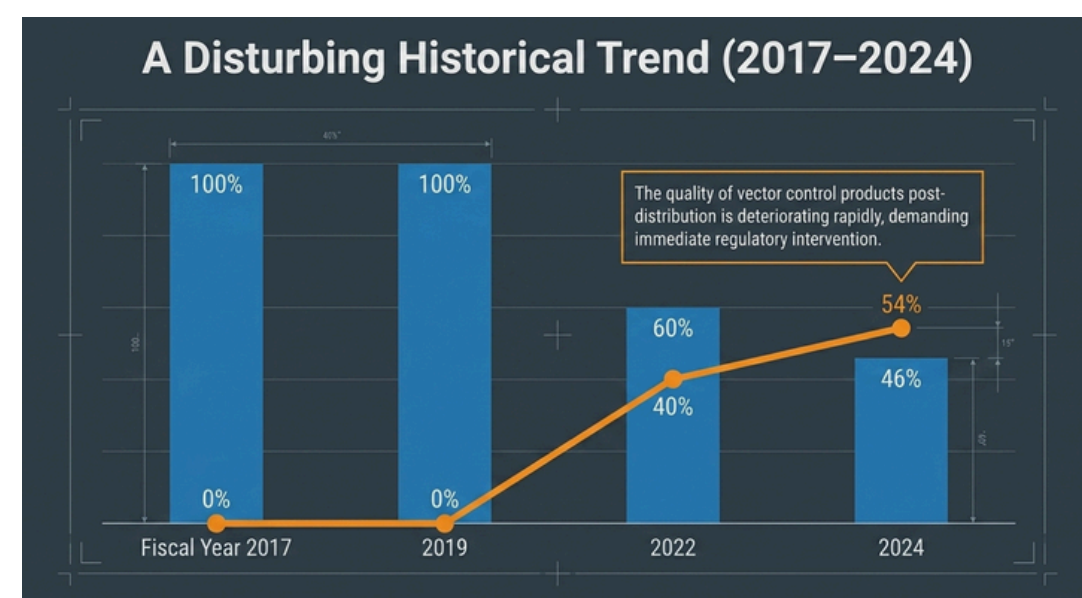
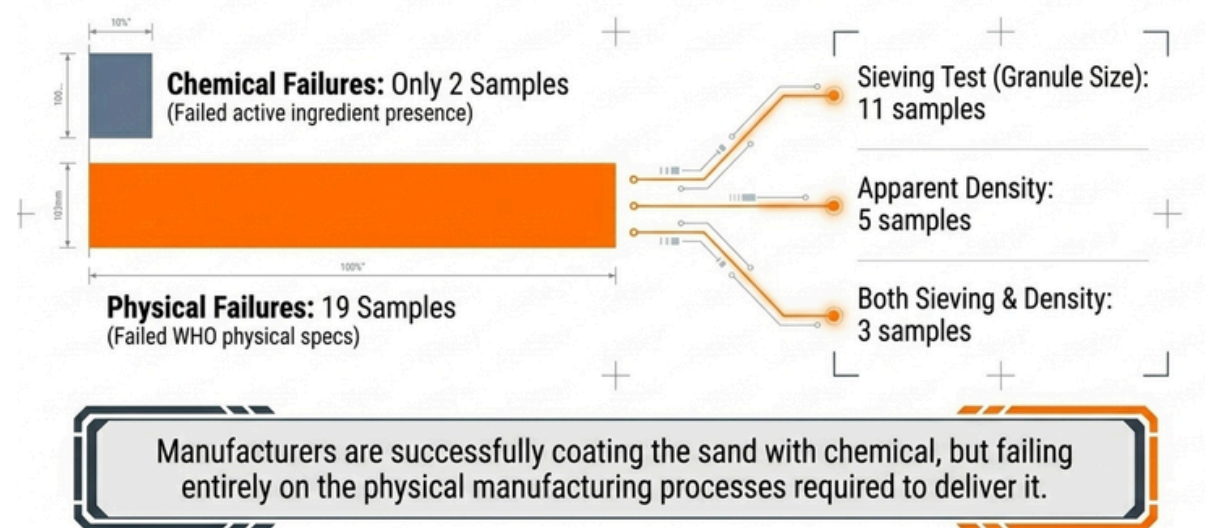
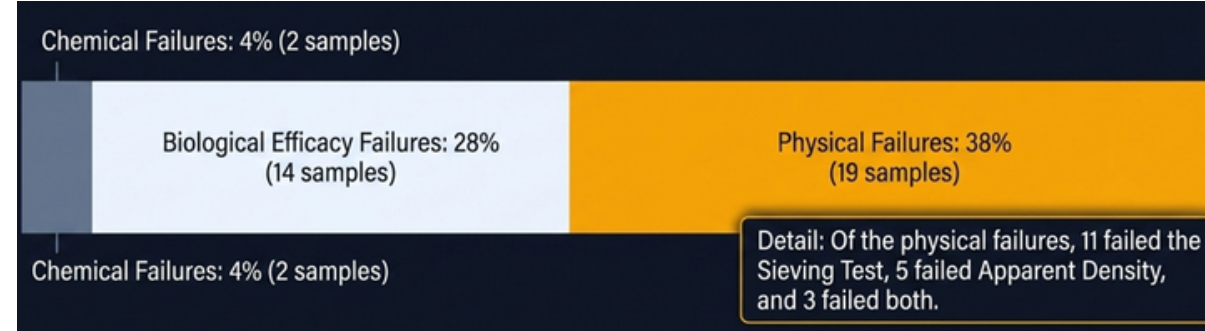
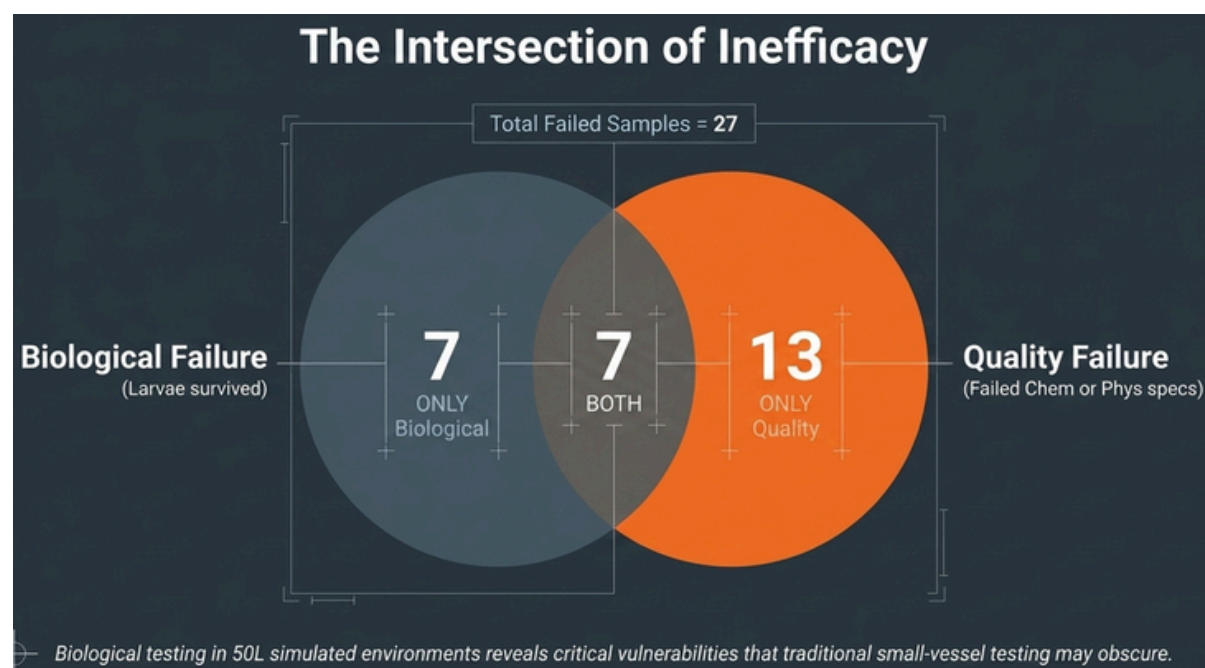


- Labeling and Packaging**: 100% of samples complied with legal requirements for labeling and container integrity.
- Impact of Product Age**: Data confirms a significant correlation between product expiration and standard non-compliance. For products exceeding the 2-year manufacture threshold, the failure rate was 67% (6 out of 9 samples)

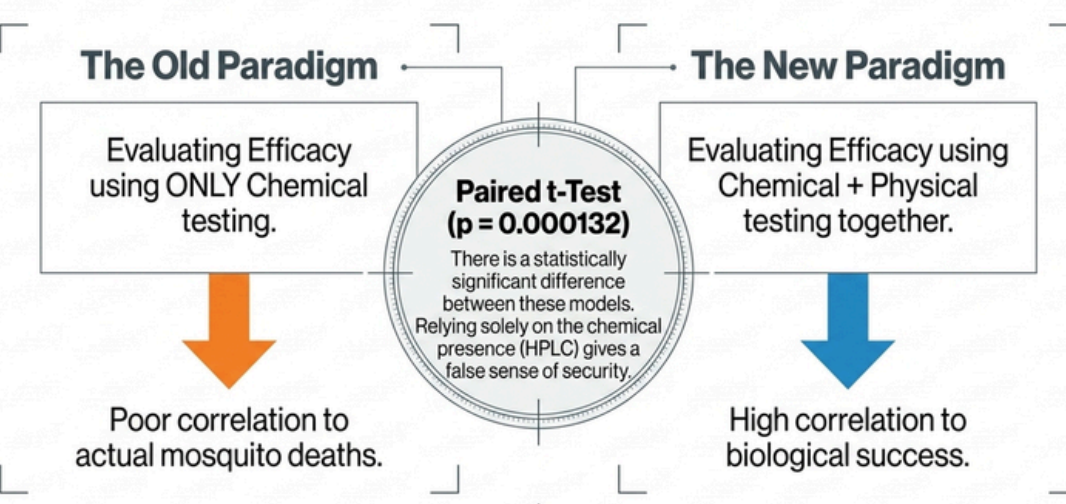
The Age Factor: Degradation Over Time



Categorized Failure Analysis:



The 'Physical' Blindspot: A Statistical Revelation



References

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