

ATRI

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Research Brief

Inaugural Issue 

Agricultural Technology is Reshaping

Non-Synthetic Amino Acids

Unlock New Nutraceutical Potentials



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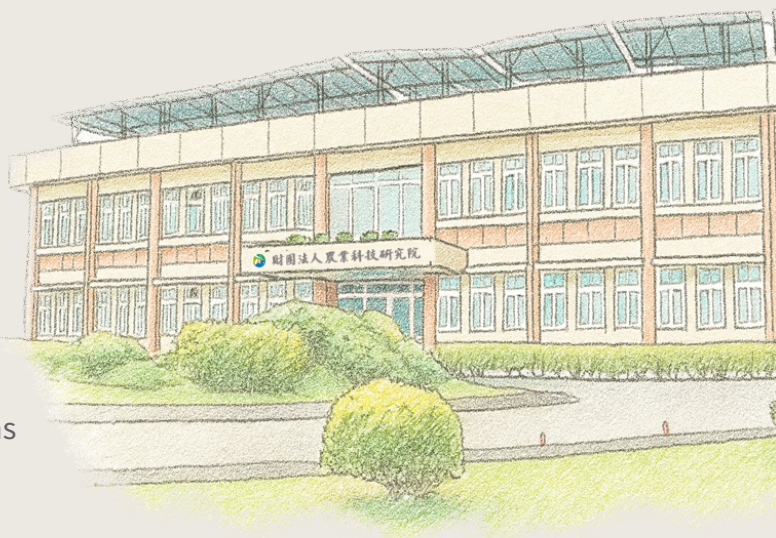


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A Cell-Based Efficacy Screening
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ABOUT ATRI

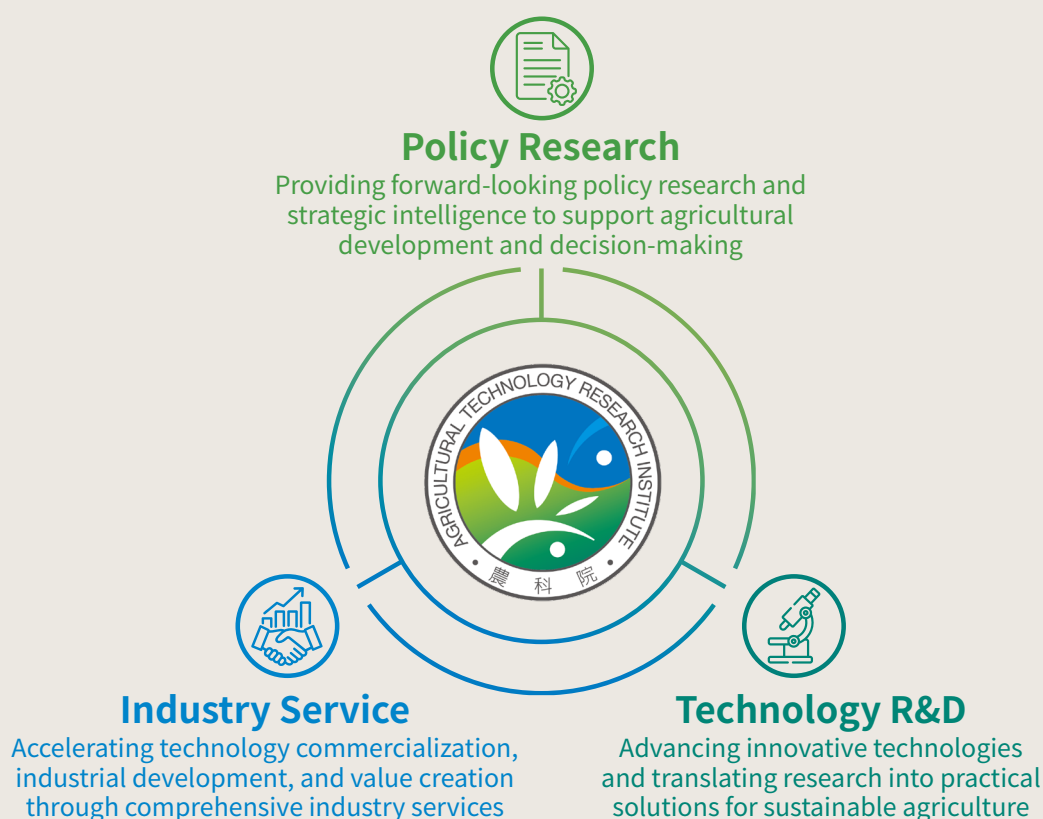
Established in 2014 with fiscal support from the Ministry of Agriculture, the Agricultural Technology Research Institute (ATRI) is Taiwan's leading agricultural research institute, dedicated to integrating policy research, technology R&D, and industry services. Guided by industry demand, ATRI bridges scientific research and practical applications to accelerate agricultural innovation and transform it into techno-entrepreneurship through business incubation.

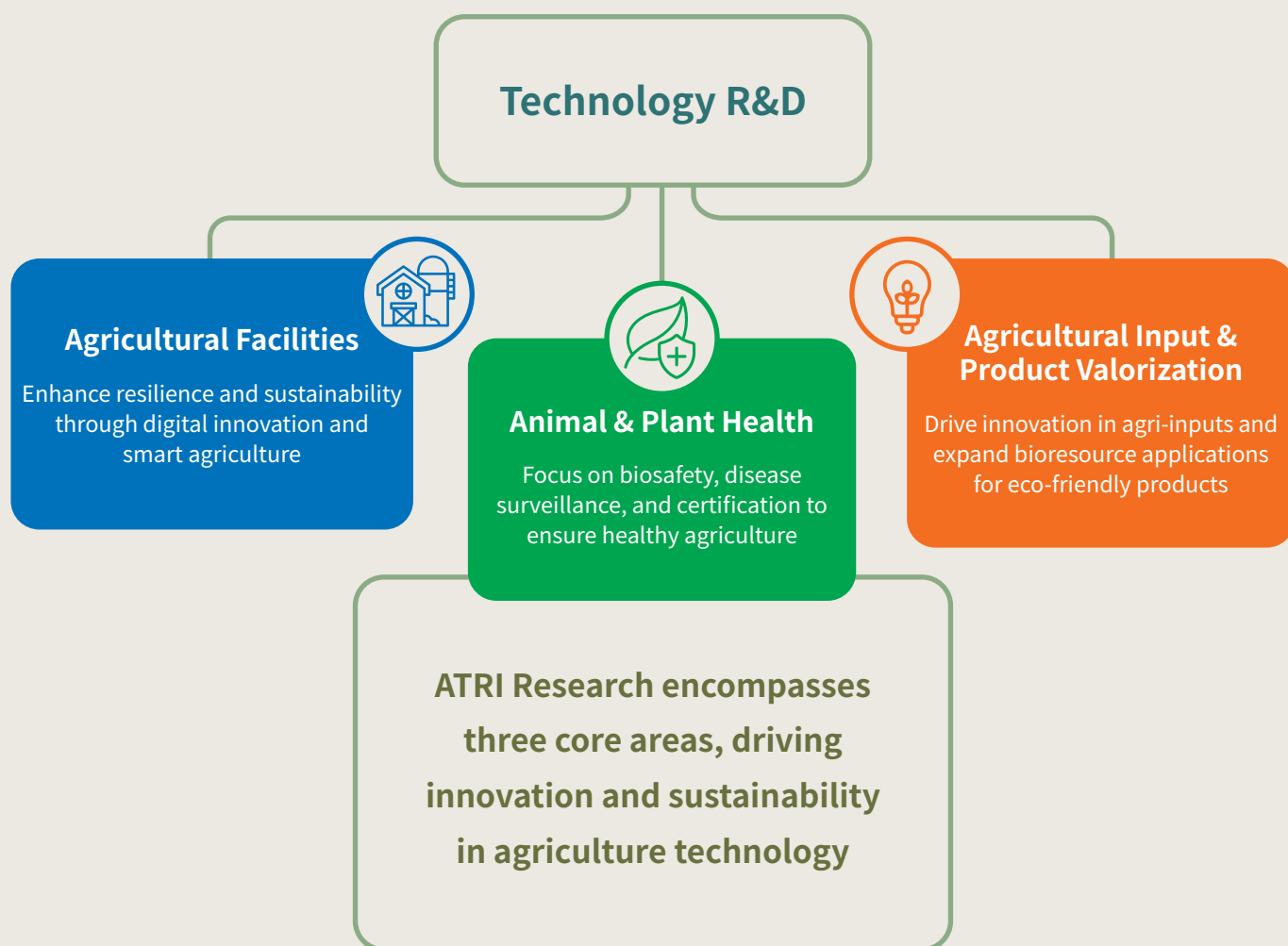


The institute works closely with enterprises, farmers' organizations, producers, and government agencies to facilitate technology transfer, industrial development, investment promotion, and international market expansion. In collaboration with agricultural research and extension institutions under the Ministry of Agriculture, ATRI serves as a platform for knowledge valorization. The mechanism is designed to generate additional value and promote prosperity and sustainability among stakeholders through ESG (Environmental, Social, and Governance) engagement.

Through the ATRI Research Brief, published quarterly, we share our latest research achievements, technological innovations, and industry insights with the international community. We also seek opportunities to collaborate with research institutions, academia, and industry partners worldwide to foster knowledge exchange and advance sustainable agriculture.

ATRI Research encompasses three core areas to advance productive, resilient, and society-enabled agriculture in the 5.0 era.





Fermentation-Derived Ornithine and Citrulline

*A Novel *Lactobacillus* Platform for Functional Amino Acid Production*

Ornithine and citrulline are functional amino acids that are attracting growing interest for use in health supplements, sports nutrition, functional beverages, cosmetics, biomedical research, and animal nutrition. Their physiological roles involve nitrogen metabolism, arginine-related pathways, and nitric oxide-mediated regulation. When formulated as food ingredients, they support metabolism, exercise performance, vascular function, and immune modulation, and can also be incorporated into skin-care formulations.

To meet growing global demand for natural, high-value functional ingredients, the ATRI has developed a *Lactobacillus* fermentation-based production platform that simultaneously produces ornithine and citrulline. This platform encompasses microbial strain screening, fermentation process optimization, product stabilization, and powder production, providing a practical bioprocess solution for the next generation of functional amino acid production.

Technology Overview

The research team has screened 115 lactic acid bacterial isolates and identified a high-performing strain capable of producing ornithine and citrulline through microbial fermentation. The process was optimized by adjusting the medium formulation, culture strategy, and fermentation conditions, and has since been validated in a 5 L fermentation system.

Under optimal conditions, ornithine and citrulline can be produced simultaneously in the fermentation broth, reaching concentrations of up to 140 kg/m³ and 50 kg/m³, respectively. Sterilization and spray-drying were then applied to produce a stable, heat-inactivated *Lactobacillus* fermentation powder containing both amino acids, ensuring storage stability and readiness for subsequent formulation and diversified product development.

Core Advantages

- **Fermentation-based process**

The fermentation-derived production approach aligns with global interest in natural and biotechnology-enabled functional products and supports the development of naturally positioned, biotechnology-derived functional ingredients. Microbial fermentation also makes it easier to implement effective quality control and quality assurance during production.

- **Simultaneous dual-ingredient production**

The platform enables the co-production of ornithine and citrulline in a single fermentation process, thereby creating a unique market niche for the product.

- **Scale-up and cost management potential**

The established production protocol provides a useful reference for future industrial-scale advances, with respect to production efficiency, reproducibility, and cost management.

- **Extensive application**

The powder form can be used not only in amino acid-based formulations but also further formulated into functional additives or supplements for human and animal nutrition, cosmetic products, and biomedical research materials.



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Nutraceutical effects of Ornithine and Citrulline

Scientific evidence and Application Potential

Ornithine and citrulline are functional amino acids with known beneficial effects, supporting their use as nutraceuticals for health and wellness applications in various forms, as nutraceutical ingredients and in cosmetic formulations, including skin-care lotions.

The inactivated lactic acid bacteria powder produced, containing both ornithine and citrulline, can serve as a basic ingredient for developing functional ingredients for a wide range of commercial products. It has application potential in functional foods, beverages, dietary supplements, sports nutrition products, cosmetics, biomedical research materials, and animal nutrition.

Product Development and Collaboration Opportunities

The coexistence of ornithine and citrulline may enable products with different market positions through a multifunctional formulation. Depending on the purpose and target customers, the powder may be further combined with complementary ingredients to develop products targeting metabolic health, exercise nutrition, wellness, or other specific applications. The research team welcomes collaboration in formulation design, efficacy evaluation, quality analysis, technology licensing, and co-development of market-oriented products.



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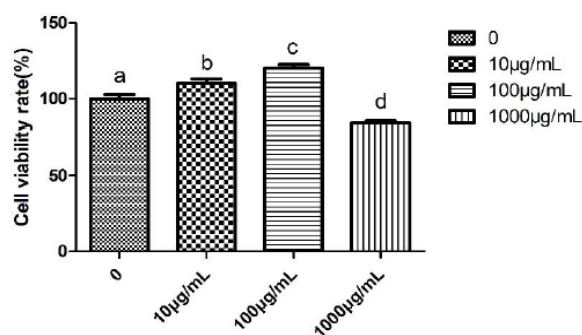
A Cell-Based Efficacy Screening Platform to Accelerate Pharmaceuticals and Nutraceuticals Development

Bringing a new pharmaceuticals or nutraceuticals to market involves several distinct tests that critically depend on the rapid and reliable identification of promising candidates. Animal testing has long been employed; however, it is constrained by time and labor demands, ethical considerations, and limitations in data translatability, reducing its suitability for preliminary screening.

In response to these challenges, a Cell-Based Efficacy Screening Platform has been developed to eliminate unsuitable candidates before costly animal studies. This efficient, precise, and cost-effective approach accelerates new compound development while saving time and research resources.

The platform is customizable and offers technical support from cytotoxicity assessment through efficacy evaluation. Initial cytotoxicity testing determines the maximum non-toxic concentration of a substance, guiding the design of subsequent functional assays to ensure experimental importance and safety.

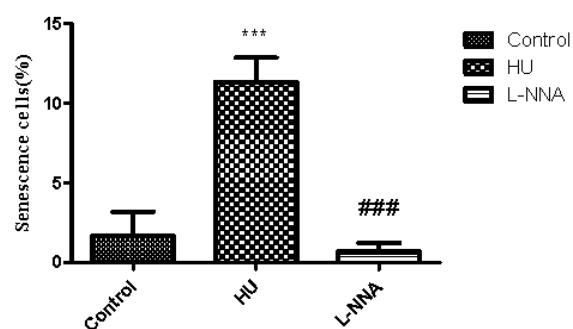
A range of <i>in vitro</i> cellular models is available, including:	
Anti-aging Evaluation	Hydroxyurea-induced aging in BHK-21 cells is applied to assess anti-aging potential through SA-β-galactosidase staining.
Metabolic Health Evaluation	3T3-L1 preadipocytes differentiated with insulin-containing induction medium form lipid droplets, enabling the assessment of whether a test substance inhibits adipogenesis.
Antioxidant Evaluation	Multiple cell-based assays assess free radical scavenging activity and cellular protective effects.



Cell Toxicity Analysis.

Cytotoxicity was observed at a concentration of 1,000 µg/mL; the maximum recommended non-toxic concentration was determined to be 100 µg/mL.

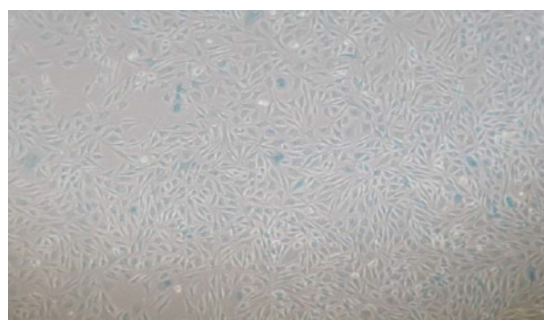
» Photo by Hung SW, ATRI 2024



Anti-aging Efficacy.

Aging was induced using HU, with L-NNA serving as a control treatment. HU significantly induced aging, whereas L-NNA delays aging.

» Photo by Hung SW, ATRI 2024



Aged Cell Staining.

Following SA-β-galactosidase staining, aged cells exhibited blue coloration.

» Photo by Hung SW, ATRI 2024

A range of in vitro cellular evaluation models is available, including anti-aging, metabolic adjustment, and antioxidant capacity.

The platform provides a reliable framework for preliminary assessment by combining academic expertise with high-throughput methodologies and systematic evaluation. This precision approach reduces potential risks and supports evidence-based decision-making in the development of pharmaceutical and nutraceutical products.



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