JOINT NEWS RELEASE

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NTU Singapore and Temasek Polytechnic scientists replace fishmeal in aquaculture with microbial protein derived from soybean processing wastewater

Scientists from **Nanyang Technological University, Singapore (NTU Singapore)** and **Temasek Polytechnic** have successfully replaced half of the fishmeal protein in the diets of farmed Asian seabass with a 'single cell protein' cultivated from microbes in soybean processing wastewater, paving the way for more sustainable fish farming practices.

The use of a cultivated protein is new to aquaculture production, say the scientists from the **Singapore Centre for Environmental Life Sciences Engineering (SCELSE)** leading NTU's efforts in the study, and **Temasek Polytechnic's Aquaculture Innovation Centre (AIC)**.

Farmed aquaculture species rely heavily on feed made from wild-caught fish, known as fishmeal, which is not sustainable and contributes to overfishing of the seas.

Single cell protein, a sustainable alternative, can be cultivated from food processing wastewater. In particular, the wastewater from soybean processing contains organisms with probiotic potential that are essential for healthy fish growth.

Wastewaters from the food-processing industry are free of pathogens and other contaminants, make them suitable for growing microbes. Normally after processing the wastewater is discharged and flows into a wastewater reclamation plant. Its nutrients are not recovered, resulting in a lost opportunity to maximise resource use.

Co-lead author of the study, Dr Ezequiel Santillan, senior research fellow at SCELSE, said, "Our study represents a significant step forward in sustainable aquaculture practices. By harnessing microbial communities from soybean processing wastewater, we have demonstrated the feasibility of producing single cell protein as a viable alternative protein replacement in fish feed, reducing the reliance on fishmeal and contributing to the sustainability of the aquaculture industry."

The joint research team said that their waste-to-resource approach tackles food security and waste reduction, supporting the development of a circular economy with zero waste as outlined in the United Nations Paris Agreement.

The study, published in the peer-reviewed science journal *Scientific Reports*, aligns with the University's research pillar of **NTU 2025**, a five-year strategic plan that aims to leverage innovative research to mitigate human impact on the environment.

The study is also aligned with AIC's focus on enhancing food security and resilience. With the aquaculture industry aiming to meet 30 per cent of Singapore's total nutritional needs by 2030, AIC has been actively championing intensive aquaculture production with innovation and technology.

Replacing half of the usual fish feed for Asian seabass

To demonstrate their approach, the team added soybean processing wastewater from a food processing company in Singapore into bioreactors – a controlled environment for biological and chemical reactions – to cultivate single cell protein. The laboratory-scale bioreactors were operated in repeated cycles of controlled nutrient and low air supply (micro-aerobic conditions) for over four months at 30°C. These conditions suggest that the team's method can be easily reproduced at ambient temperatures in tropical regions like Singapore, further reducing the environmental footprint of fishmeal production.

After producing their single cell protein, the research team fed two groups of young Asian seabass over 24 days. One group received a conventional fishmeal diet, while the other group was fed a diet of half regular fishmeal and half single cell protein. Both diets provided the same amount of nutritional content for the young fish.

At the end of the experiment, the growth of both groups was evaluated, and researchers found that the fish had grown the same amount. Interestingly, the group of fish on the new diet showed more consistent and less variable growth than the traditional diet group.

NTU Professor Stefan Wuertz at the School of Civil and Environmental Engineering and SCELSE's Deputy Centre Director said, "The findings suggest that diets including single cell protein may help fish grow more uniformly, and exploring how this diet affects fish on a deeper level could be interesting for future research. More importantly, our study has successfully demonstrated the potential for converting soybean processing wastewater into a valuable resource for aquaculture feed, contributing to the transition to a circular bioeconomy."

Co-principal investigator of the study, Dr Diana Chan, Head, Aquaculture Innovation Centre at Temasek Polytechnic said: "The results of our fish feeding

performance trials are promising for the aquaculture industry, offering an alternative protein source to meet the increasing need to replace fishmeal which has become very costly and unsustainable in supply."

For their next steps, the research team will conduct trials over longer growth periods with higher fishmeal replacement levels. Researchers will also expand the study to include additional aquaculture species and different types of food processing wastewater.

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Notes to Editor:

Paper titled "Microbial community-based protein from soybean-processing wastewater as a sustainable alternative fish feed ingredient" published in *Scientific Reports*, 31 January 2024
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About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Medicine, Humanities, Arts, & Social Sciences, and Graduate colleges.

NTU is also home to world-renowned autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such

as the Earth Observatory of Singapore, Nanyang Environment & Water Research Institute and Energy Research Institute @ NTU (ERI@N).

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources.

Ranked amongst the world's top universities, the University's main campus is also frequently listed among the world's most beautiful. Known for its sustainability, NTU has achieved 100% Green Mark Platinum certification for all its eligible building projects. Apart from its main campus, NTU also has a medical campus in Novena, Singapore's healthcare district.

For more information, visit www.ntu.edu.sg

About Singapore Centre for Environmental Life Sciences Engineering

Singapore Centre for Environmental Life Sciences Engineering (SCELSE) is a Research Centre of Excellence in Singapore, breaking new ground in understanding, harnessing and controlling microbial biofilm communities and microbiomes in environmental, industrial and public health settings.

SCELSE's interdisciplinary research focuses on overall community structure, function and performance of microbial biofilms and microbiomes, as well as the mechanisms of their micro-ecological and host-organism interactions by using emerging technologies in diverse disciplines across science and engineering.

SCELSE is harnessing biofilms and microbiomes to meet the crucial challenges of securing sustainable environments in natural, engineered and public health settings. SCELSE is funded by National Research Foundation, Singapore Ministry of Education, Nanyang Technological University, Singapore (NTU Singapore) and National University of Singapore (NUS), and hosted by NTU in partnership with NUS.

About Temasek Polytechnic (TP)

Established in 1990, TP is one of the leading institutions of higher learning in Singapore. Currently it offers 36 full-time diploma courses in the areas of applied science, business, design, engineering, humanities & social sciences and informatics & IT. It also offers over 40 part-time courses, up to advanced diploma level. TP students undergo a holistic learning system that combines hands-on experience, character education and relevant life skills, in an enriching learning environment. The Polytechnic has also infused global realities into its programmes and developed a mindset on campus that embraces socio-cultural diversity. Believing in the possibilities

of tomorrow, Temasek Polytechnic is committed to co-creating a better world with its stakeholders by nurturing the next generation of values-centred leaders, lifelong learners and future-oriented creators. For more information, please visit www.tp.edu.sg

About Aquaculture Innovation Centre (AIC)

Aquaculture Innovation Centre (AIC) established on 1 July 2019, serves as the national innovation centre dedicated to supporting the aquaculture industry, with funding from Enterprise Singapore and hosted by Temasek Polytechnic. Guided by the mission and vision of "Closing the Loop in Sustainable Super Intensive Aquaculture to Enhance Food Security & Resilience", AIC employs a comprehensive four-pronged approach to bolster the aquaculture sector in Singapore.

1. Service & Consultancy
2. Research & Development
3. Education & Training
4. Start-up & Entrepreneurship