



The Microbial Oil Imperative:

Why Fermentation-Derived Lipids Represent the Next Frontier in Food, Feed, and Energy Security

MAY 2026

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Executive Summary



The 2026 closure of the Strait of Hormuz, described by the International Energy Agency (IEA) as the "greatest global energy security challenge in history," has exposed, with unprecedented severity, the structural fragility of a global lipid economy still anchored to petroleum and a narrow set of vegetable oil monocultures. Against this backdrop, microbial oils derived from oleaginous fungi and yeasts are graduating from laboratory curiosity to an investable industrial platform.

With the broader advanced alternative lipids and biofuel feedstock market (of which single-cell oils are rapidly capturing share) projected to expand from USD 156.6 billion in 2025 to USD 200.6 billion in 2026 at a 28.1% CAGR, and Asia-Pacific commanding the largest regional share, the thesis is clear: fermentation-derived lipids are a strategic substitute layer across food, aquafeed, and biofuel value chains. Malaysia, with its underutilised biodiesel infrastructure, agricultural side-streams, and bioeconomy policy stack, is uniquely positioned to capture disproportionate value.

Fungal oil, a form of single-cell oil produced by oleaginous fungi through fermentation, offers a compelling bioeconomy thesis. It can be produced in controlled bioreactors, tuned for specific fatty-acid profiles, and potentially grown on agricultural residues, food-processing by-products, or other low-value carbon streams. The investment case is not that fungal oil will immediately replace palm, soybean, or petroleum-derived fuels at commodity scale. Rather, the near-term opportunity lies in high-value specialty lipids, aquaculture feed, infant nutrition, functional foods, cosmetics, and biomanufacturing infrastructure, with biofuels as a longer-horizon upside if cost curves improve.

For Malaysia and ASEAN, this is strategically relevant. Malaysia already has deep palm oil, fermentation, biotechnology, halal, and biomass value-chain capabilities. The National Biotechnology Policy 2.0 identifies agriculture and food security, healthcare and wellbeing, and industrial biotechnology and circular economy as core thrusts toward 2030, while the National Biomass Action Plan 2023–2030 targets RM17 billion in incremental economic value and about 33,000 jobs by 2030. Fungal oil should therefore be viewed not as a threat to Malaysia's palm ecosystem, but as a strategic enabler for higher-value biomass valorisation, feed security, and next-generation biomanufacturing.

Introduction

A Twin Shock to the Global Lipid Economy

The world's oil challenge is broader than crude. Edible oils, fish oils, palm derivatives, oleochemicals, and biofuel feedstocks are all being pulled by overlapping demand centers. Food manufacturers need stable and traceable fats. Aquaculture producers need omega-rich feed ingredients without increasing pressure on wild fisheries. Energy systems need low-carbon liquid fuels for hard-to-electrify sectors. Meanwhile, supply chains are being tested by geopolitics, sustainability regulation, and climate-related production risk.

On the petroleum side, the Iran conflict that began in late February 2026 triggered the closure of the Strait of Hormuz, through which approximately 20% of global seaborne crude and significant LNG volumes transit. Brent crude breached USD 100 per barrel on 8 March 2026, the first time in four years, peaking at USD 126, with prices still hovering around USD 100 per barrel in early May 2026. The downstream effect in Malaysia has been acute: diesel prices in Peninsular Malaysia surged from RM2.99 per litre in February 2026 to RM6.72 per litre by 9 April 2026.

On the vegetable oil side, palm oil, long Malaysia's anchor commodity, faces structural headwinds. Roughly 30% of Malaysia's planted oil palm area is now 19 years or older, projected to rise to 35% by 2027, with replanting persistently deferred. Planted area has stagnated at around 5.6 million hectares, and high foreign-labour dependence is constraining further output. Layered on top is the EU Deforestation Regulation (EUDR), postponed for a second time to December 2026, which is reshaping compliance economics across the supply chain.

The convergence of these shocks is not cyclical, it is structural. Investors should treat it as a permanent re-pricing of risk in conventional lipid value chains.

Understanding the Technology

Oleaginous Fungi as Cellular Oil Refineries

Microbial oils also called single-cell Oils (SCO), are lipids produced inside the cells of microorganisms, including specific fungi and yeasts classified as oleaginous (oil-accumulating). These organisms can store more than 20% of their dry biomass as triacylglycerols, with the most efficient strains exceeding 60–80%.

The production logic is simple:

| Stage | What Happens | Why It Matters Commercially |
|----------------------------------|--|--|
| Strain selection | High-lipid fungi (e.g., <i>Mortierella</i> , <i>Yarrowia lipolytica</i> , <i>Aspergillus</i> , <i>Cutaneotrichosporon</i>) are chosen or engineered | Determines yield, fatty-acid profile, and price point |
| Fermentation | Cultivated in bioreactors using sugars, agricultural residues, or industrial side-streams | Decouples production from arable land, climate, and geopolitics |
| Extraction & refining | Cells are disrupted; oil is recovered via solvent, supercritical CO ₂ , or pressurised liquid extraction | Modular footprint; can be co-located with feedstock sources |
| Application | Tailored for specialty nutrition, aquafeed, or biofuel | Same platform, three end-markets, a rare TAM expansion mechanism |



The strategic distinction versus algae or bacteria is operational: fungi grow rapidly in standard stirred-tank bioreactors, do not require photobioreactors, and tolerate complex waste-stream feedstocks. This translates to a lower capex burden which is a critical determinant of cost parity at scale.

Recent research has further established that strains such as *Yarrowia lipolytica* and *Cutaneotrichosporon oleaginosus* can be engineered to produce fatty-acid profiles closely mimicking human milk fat, a high-margin entry point into the regulated infant formula category.

Market Sizing and Growth Dynamics

The most disciplined way to size fungal oil is by application, not by a single headline TAM. The total global fats and oils market provides the broad ceiling, with one commercial estimate placing it at about USD320.9 billion in 2024 and projecting USD431.2 billion by 2032, a 3.76% CAGR, according to Credence Research. The emerging single-cell oil segment is much smaller but faster growing.

Market estimates vary widely because some reports define the category narrowly around microbial specialty oils, while others include broader bio-based oils. Statistics MRC estimates the global single-cell oil market at USD68.55 million in 2024, reaching USD208.40 million by 2030 at a 20.36% CAGR, while Strategic Market Research estimates a broader category at USD1.8 billion in 2024, reaching USD3.8 billion by 2030 at about 8.5% CAGR.



The more investable near-term markets are specialty and performance-driven. The aquafeed market is forecast at roughly USD68.5 billion in 2024, growing to about USD97.5 billion by 2030, creating a significant channel for fish-oil substitutes and immune-supportive lipids.

The omega-3 ingredients market also provides a high-value benchmark: GOED's 2024 report placed global EPA and DHA omega-3 ingredient volume at 124,480 tonnes in 2023, with value rising 22.5% to USD2.09 billion.



Biofuels represent a larger but more difficult prize. IEA expects sustainable aviation fuel consumption to rise from 1 billion litres in 2024 to 9 billion litres by 2030, meeting about 2% of aviation fuel demand in its main case.

Fungal oil could eventually become part of the renewable lipid feedstock mix, but only if production costs fall substantially and feedstock logistics are optimised.

The Catalysts

Why Now?

Four converging tailwinds explain the inflection:

Energy security re-pricing

The Hormuz disruption has reset what governments and corporates will pay for supply chains that are independent of geopolitical chokepoints. Asian countries including China, India, Japan, and South Korea account for 75% of oil and 59% of LNG export volumes through the strait, leaving the region structurally exposed.

Regulatory pull-on conventional oils

EUDR compliance, MSPO traceability mandates, and tightening sustainability rules in the EU and US are raising the all-in cost of commodity vegetable oils, narrowing the cost-parity gap with fermentation-derived alternatives.

Aquaculture and infant-nutrition demand

With wild fisheries flat and fish-oil supply constrained, major formula manufacturers are committing to 100% algal DHA sourcing by 2030. Fungal oils offer a fermentation-platform analog with potentially lower production costs.

Capital discipline meets infrastructure maturity

Although fermentation funding for alternative proteins fell from USD 632 million in 2024 to USD 357 million in 2025, this represents a healthy shift from "promise to proof." Survivors are scaling commercial-scale facilities, including Clean Food Group's one-million-litre Knowsley site, positioned as the world's largest dedicated to yeast-derived oils and fats.



Investment Opportunities

Where Capital Should Flow

Specialty lipids for infant and clinical nutrition

Human milk fat analogs, arachidonic acid (ARA), and DHA-rich oils which are high-margin, regulation-protected, and underserved in ASEAN.

Aquafeed-grade microbial oils

Asia-Pacific's aquaculture sector is the world's largest. Fungal oils rich in DHA and ARA, are produced from local agricultural residues, represent an import-substitution play with clear policy support.

Drop-in biodiesel feedstock from non-food fermentation

With Malaysia's B12 rollout commencing in 2026 en route to B15, and B30 targeted under the 13th Malaysia Plan, and domestic biodiesel capacity utilised at only 975,207 tonnes against 2.36 million tonnes installed, fungal oil offers a non-land-competing supplement to the palm-based pipeline.

"Picks and shovels" infrastructure

Bioreactor systems, downstream processing IP, strain engineering platforms, and biorefinery-integration plays carry lower technology-binary risk than single-product startups.

Malaysia and the ASEAN Inflection Point

The strategic case for Malaysia is unusually well-aligned:

| Asset | Implication |
|---|--|
| 2.36 Mt installed biodiesel capacity, ~58% utilisation | Existing infrastructure for blending and distribution – fungal oil can plug in without greenfield capex |
| 13th Malaysia Plan (2026–2030) | Explicit prioritisation of renewable energy, bioeconomy, and high-income transformation under the MADANI framework |
| Bioeconomy Corporation + BioNexus Status | Established fiscal and tax incentive regime for qualifying biotech ventures |
| Abundant agricultural residues | Empty fruit bunches, palm kernel cake, rice husks – ideal low-cost feedstocks |
| MSPO + EUDR-ready traceability infrastructure | Sustainability-credentialled brand position transferable to bio-based exports |

For Malaysia, the opportunity is not to replace palm oil but to layer a higher-value-add microbial lipid industry on top of it, converting waste-stream economics into specialty-product margins while reducing import dependence in the diesel and aquafeed value chains.

Conclusion

The Strategic Imperative

The investment case for microbial oils rests on a simple proposition: in a world where lipid supply is increasingly held hostage to geopolitical chokepoints, climate variability, and tightening sustainability regulation, fermentation offers the only production platform that is simultaneously decoupled from arable land, fossil fuel logistics, and monocrop concentration risk.

The risks are real and must be priced in. Production costs remain above commodity oils in most categories; novel-food regulatory pathways are uneven across jurisdictions; and the 2025 funding correction is a reminder that scale-up economics, not technology validation, will determine winners. The collapse of high-profile players like Meati and Motif Foodworks has appropriately raised the bar for new capital.



But the macro signal is unambiguous. For institutional investors and policymakers in this region, microbial oil is no longer a speculative bio-frontier, it is a strategic substitute layer in the most contested commodity markets on earth. The capital deployed today will define which jurisdictions own the next generation of lipid supply chains.

For Malaysia, the strategic imperative is to move now: while the policy stack is aligned, the feedstock is abundant, and the regional capital is still pricing the opportunity at an early-stage discount.

