MiAlgae

Whitepaper

Rethinking Omega-3 sources in pet nutrition:

Supply resilience, and the case for traceable DHA



Executive Summary

Omega-3 fatty acids, and DHA in particular, have become a cornerstone of modern pet nutrition, associated with benefits including cognitive function, skin and coat health, joint mobility, inflammation management, cardiovascular support, retinal development, and longevity. The traditional source of Omega-3s has been fish oil – but there are significant growing challenges behind its continuing widespread use.

Pet food manufacturers, veterinarians, and consumers increasingly expect precision nutrition, traceable supply chains, and sustainable ingredient sourcing. Traditional fish oil systems are struggling to meet these expectations due to oxidative instability, variable Omega-3 levels, supply chains constrained by overfishing, climate disruptions, and limited transparency.

At the same time, the industry is moving towards new, functional ingredients that are nutritionally equivalent but superior in many ways. For example MiAlgae offers a new type of functional Omega-3 product; a sustainable, traceable, organic microalgae powder that bypasses the inefficiencies and variability of marine extraction - delivering consistent, price predictable, consistent DHA-rich ingredient designed for modern pet food formulation.

This whitepaper explores:

- **Omega-3s are not created equally:** There is still some limited understanding of the types of Omega-3s needed in pet nutrition
- **Why DHA Matters:** Understanding the unique biological role of DHA in pet health
- **The Evolving Omega-3 Market:** Growing demand, changing supply dynamics and the shift towards premium functional nutrition
- **The Hidden Challenges of Fish Oil:** Oxidation, price volatility, supply constraints and formulation complexity
- **A New Generation of DHA:** Why traceable, microalgae-derived DHA offers a more sustainable and resilient alternative
- **MiAlgae: Scaling the Future of DHA:** Delivering traceable, sustainable DHA for the next generation of pet nutrition

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1 Omega-3s Matter But Understanding Remains Inconsistent

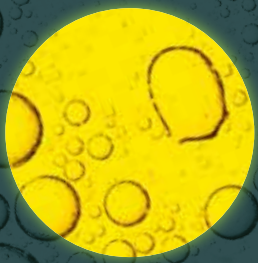
Omega-3 fatty acids are now firmly embedded in premium pet nutrition strategies. They are commonly associated with support for:

- Brain and cognitive development
- Joint mobility
- Immune modulation
- Skin and coat condition
- Cardiovascular health
- Retinal function
- Healthy inflammatory responses

However, while Omega-3 inclusion has become widespread, understanding Omega-3 functionality remains inconsistent across the industry.

Many pet food labels list total Omega-3 levels without distinguishing between the different fatty acids. This creates a disconnect between label claims and functional outcomes.

The reality is that not all Omega-3 fatty acids are equal.

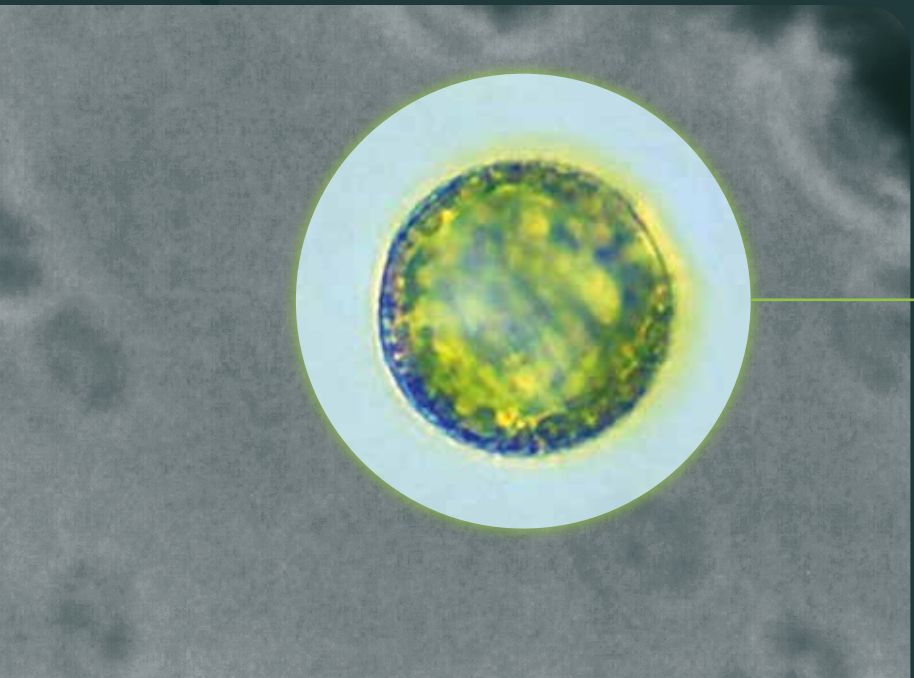


2 Total Omega-3 Does Not Always Equal Functional Omega-3s

There are three types of Omega-3 fatty acids:

- **ALA** (Alpha-linolenic Acid)
- **EPA** (Eicosapentaenoic Acid)
- **DHA** (Docosahexaenoic Acid)

ALA (found in plant oils such as flaxseed and canola) is often included as the 'plant-based' form of essential Omega-3s in pet food but the truth is, it is not functional unless it is converted to longer DHA and EPA Omega-3s. Dogs and cats cannot adequately convert ALA to DHA to provide the physiological benefits typically associated with functional Omega-3 nutrition The key functional fatty acids are EPA and DHA.



In dogs:

- ALA to EPA conversion is typically below **10%**
- ALA to DHA conversion is often below **1–2%**

In cats:
Conversion is almost non-existent.

For formulators, this means:

- Total Omega-3 **values can be misleading**
- Biological efficacy **depends on fatty acid profile**
- **Precision DHA** delivery matters more than headline Omega-3 percentages

The industry is increasingly recognising that formulation success depends on delivering functional Omega-3s consistently and predictably.

3 Why DHA is non-negotiable in pet nutrition

Omega-3 polyunsaturated fatty acids (PUFAs) are essential nutrients that pets must obtain through diet. The most biologically active and valuable forms for pets are the long-chain Omega-3s Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA).

DHA is of particular importance in pet nutrition for a number of reasons:

- It is much harder to convert from shorter chain Omega-3 fatty acids, only **1-2%** from ALA in dogs and negligible conversion in cats.
- It constitutes approximately **40%** of the fatty acids in the brain and **60%** of those in the retina, making it critical for neurological and visual development in puppies and kittens.
- It plays a central anti-inflammatory role, helping to manage chronic conditions including osteoarthritis. Supplementation has demonstrated measurable mobility **improvement in dogs within just 6 weeks**.
- It supports cardiovascular function, immune modulation, kidney health **in cats with chronic renal disease, and skin and coat quality**.
- It underpins **cognitive development in neonatal and juvenile animals**, and **mental acuity in aging pets**.

DHA is not a formulation luxury, it's a nutritional necessity for any product aspiring to genuine, substantiated health outcomes.



4 The Market Context

The global pet population now exceeds 1.5 billion animals – approximately 900 million dogs and 600 million cats. Premium and functional pet nutrition is one of the fastest growing segments of the consumer good market, driven by owners who approach pet health with the same vigour they apply to their own wellness.

Research shows:



Nearly **75%** of cat owners look for food that helps address specific health challenges for their cats



70% of pet owners now prioritise sustainability in their food choices



60% are willing to pay a premium for verified eco-friendly products

The global Omega-3 market for pet food is expanding, with fish oil demand from this sector more than doubling since 2013.

For consumers, they are increasingly viewing their pets as family members and expect human-grade ingredient standards, scientifically-supported claims, transparency around sourcing, and functional benefits. This shift is elevating scrutiny around ingredient integrity and efficacy.

For pet food manufacturers, Omega-3 content has become a key commercial differentiator – cited in health claims, featured on front-of-pack labels, and scrutinised by vets, nutritionists and consumer groups alike. This raises the stakes considerably for ingredient quality and integrity. When the ingredient at the centre of those claims carries structural quality and supply risks, the exposure extends beyond animal health and to brand credibility, regulatory compliance and procurement resilience.



5 The Fish Oil Problem: An industry under pressure

Fish oil has historically been the dominant source of marine Omega-3s in pet nutrition. However, the traditional marine supply chain presents significant problems.

Global fish oil supply is derived almost entirely from the industrial extraction of small pelagic 'forage fish' – anchovies, herring, sardines and similar species from oceans which are already fished beyond sustainable limits. The United Nations Food and Agriculture Organisation estimates that 90% of global marine fish stocks are now fully exploited or overfished. There is no prospect of supply expansion from these wild-capture fisheries.



90%

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Meanwhile, demand for fish oil has been growing across multiple sectors simultaneously:

- **Aquaculture -** already the single largest consumer, absorbing approximately **70% of global fish oil supply, continues to expand as global protein demand rises.** Salmon farming alone accounts for more than half of global fish meal usage.
- **Human Omega-3 supplement consumption** has more than doubled since 2013, driven by health awareness in developed markets.
- **Premium pet food**, where fish oil content is marketed as a wellness differentiator, has become one of the fastest-growing demand segments, with manufacturers increasingly willing to pay premium prices that out compete aquaculture buyers.

The consequences are clear: a fixed or declining supply facing exponentially increasing demand. Industry analysts have modelled potential fish oil deficits of 20,000 tonnes or more by 2030, with supply gaps projected to persist.

5.1 Price Volatility and Procurement Risk

For pet food manufacturers, supply constraints translate directly into procurement headaches. Fish oil volatility is driven not only by catch volumes but by El Niño-linked weather patterns (which have historically decimated anchovy catches off Peru – the world's largest source of fish oil, geopolitical events and competition from higher-margin pharmaceutical grade Omega-3 producers who can absorb cost increases the pet food budgets cannot.

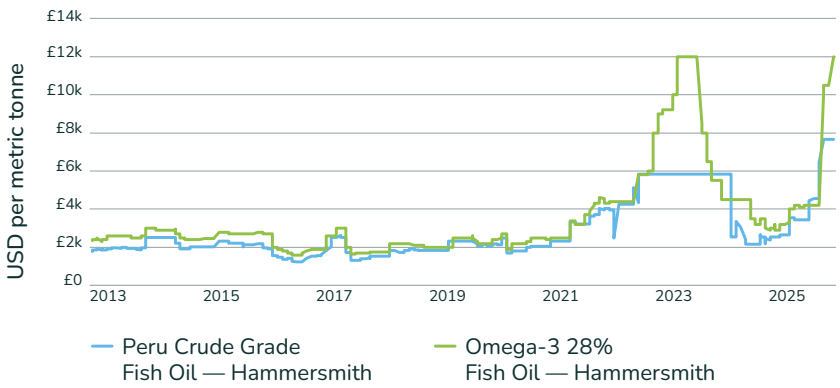
Marine ingredients are increasingly described by industry analysts as potentially "cost-prohibitive for many feed applications." A 5% commodity price movement can translate into hundreds of thousands of pounds in unplanned costs for mid-sized pet food manufacturers.

Budget accuracy, formulation consistency, and unpredictable lead times all depend on supply predictability - a guarantee fish oil cannot provide.

As premium pet nutrition increasingly depends on precise functional ingredients, this instability becomes a critical commercial challenge. This is compounded by the fact that these fish oil price fluctuations also affect salmon oil prices, as salmon oil production is closely linked to the same marine Omega-3 supply chain. Rising demand and constrained availability can therefore create cost pressure and supply uncertainty across the entire category.

> ‘5% commodity price movement can translate into hundreds of thousands of pounds in unplanned costs for mid-sized pet food manufacturers.’

Historical Fish oil Pricing — 2013-2026



In Chile, the 2026 anchovy quota is down by 44 percent to 625,000 tonnes. Super prime fishmeal FOB Peru reached USD 2,500 per tonne in May 2026, against around USD 1,400 a year earlier, while feed-grade fish oil reached USD 4,100 per tonne FOB Peru, a 64 percent year-on-year increase.
Prices have risen in anticipation of future disruption, with the US National Oceanic and Atmospheric Administration (NOAA) highlighting the significance of an El Niño event.

5.2 The Traceability Gap

A further dimension of supply chain risk is regulatory. Sustainability verification requirements are tightening across global markets. The EU's Farm to Fork strategy and evolving sustainability disclosure frameworks increasingly demand that ingredient claims be substantiated through verifiable documentation.

Fish oil's supply chain is long, opaque and geographically diffuse. A batch of fish oil in the UK may have been extracted from fish caught in international waters, processed in multiple countries, traded through several intermediaries, and blended with oils from different fisheries and catch dates. Meaningful end to end traceability, from vessel, fishery and catch dates is the exception, not the norm. For manufacturers seeking to substantiate 'sustainably sourced Omega-3' claims, this creates issues for credibility and compliance verification.



5.3 Composition Variability

Testing of commercially available salmon oil products revealed major inconsistencies between labelled and measured Omega-3 values.

Across sampled products:

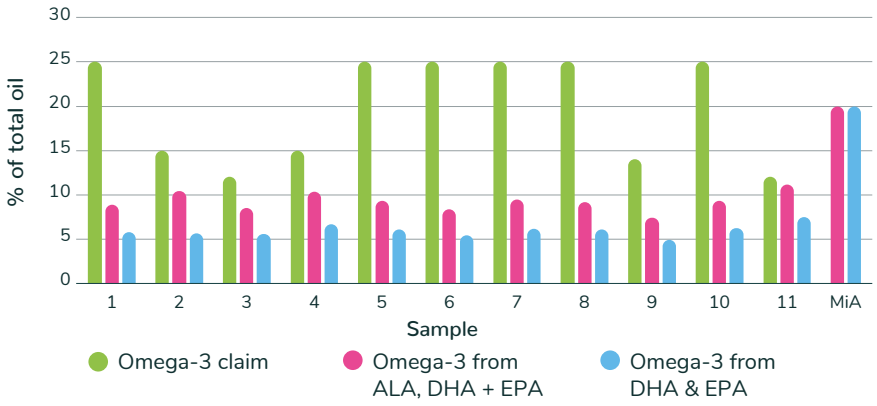
- Average Omega-3 overestimation reached approximately **48%**
- Actual DHA delivery was substantially lower than declared
- Total Omega-3 content averaged approximately **9% of product composition**
- Only around **6% represented EPA + DHA**

Claimed and analysed levels of Omega-3s in commercial salmon oils and MiAlgae Omega-3 powder.

This creates major formulation uncertainty. Manufacturers may formulate to a target inclusion rate believing they are delivering a defined functional dose, while actual delivered DHA levels may vary significantly.

For consumers, this undermines trust and for pets it may compromise intended health outcomes.

Claimed and analysed levels of Omega-3s in commercial salmon oils and MiAlgae Omega-3 powder



5.4 Oxidative Instability

Fish oil is among the most oxidatively unstable ingredients in common use. Oxidation (the chemical process by which polyunsaturated fatty acids react with oxygen) begins the moment fish oil is extracted from the fish, and accelerates through every subsequent stage: rendering, processing, storage and incorporation into finished pet food. It continues through the product's shelf life and into the bowl.

The challenge for pet food manufacturers is that these metrics are not routinely included on standard certificates of analysis, and oxidation continues, throughout the ingredient supply chain to the finished bag on the retail shelf.

Unlike the human supplement market, there is no mandatory pre-market oxidation testing requirement for fish oil in many jurisdictions. Finished pet food is tested for nutritional compliance, not ingredient freshness at point of manufacture. By the time a product reaches the consumer, months of further oxidation may have occurred.



28% of fish oil products exceeded PV limits in independent market testing



45% of Omega-3 supplements tested positive for rancidity in a 2025 peer-reviewed study



73% of OTC Omega-3 supplements exceeded peroxide safety levels in some markets



> ‘an oxidised Omega-3 ingredient may perform adequately on a certificate of analysis at point of purchase, and still deliver no meaningful DHA benefit.’

The consequences of this oxidation reach far beyond just palatability issues. Oxidised lipids generate free radicals that can possibly damage cell membranes, proteins and DNA.

In summary – an oxidised Omega-3 ingredient may perform adequately on a certificate of analysis at point of purchase, and still deliver no meaningful DHA benefit.

To compensate, many fish oil products rely heavily on synthetic phenolic antioxidants.

Testing identified:

- BHA levels between 1000–1370 mg/kg
- BHT levels between 280–447 mg/kg

Whilst these antioxidants can slow oxidation, they can also present fundamental limitations:

- They do not reverse existing oxidation. Oil that has already reached an elevated oxidation level cannot be improved, only stabilised at a degraded state.
- Their effectiveness declines over time and under the thermal conditions of pet food processing (extrusion, retort sterilisation, spray-coating).
- Consumer demand for clean-label formulations doesn’t align with synthetic antioxidant use.
- High levels of antioxidants can interfere with the absorption of fat-soluble vitamins and nutrients.

5.5 The Environmental Cost

Forage Fish are the foundation of marine food webs. They are the primary food source for larger commercially valuable fish species, seabirds, marine mammals and entire ocean ecosystems. Their industrial extraction for reduction into fish meal and fish oil has direct and well-documented consequences for broader ocean health. As UN fisheries experts noted in June 2025: "Plenty of fish in the sea? Not anymore".

Every tonne of fish oil used in pet food represents approximately 5-6 tonnes of whole fish harvested from the ocean. For a pet food manufacturer producing at meaningful scale, this translates into a significant and growing environmental footprint – one that is becoming increasingly visible to consumers, regulators and sustainability minded retail partners.

Carbon footprint – it's not just the depletion of fish that is a problem for the planet – it's also the methods of extracting, processing and transporting this marine resource.

Fuel use for fishing vessels is usually the dominant source of greenhouse gas emissions in fisheries. A fish caught specifically for oil production carries a much higher footprint than oil recovered as a by-product from existing food fisheries.

Similarly, fish oil supply chains are often international and require refrigerated transport, shipping across continents and have multiple handling points. Recent disruption to major international shipping routes has demonstrated how geopolitical instability affecting key transport corridors can have widespread consequences for global supply chains.



90% of global marine fish stocks are now fully exploited or overfished (FAO)



"Plenty of fish in the sea? Not anymore"

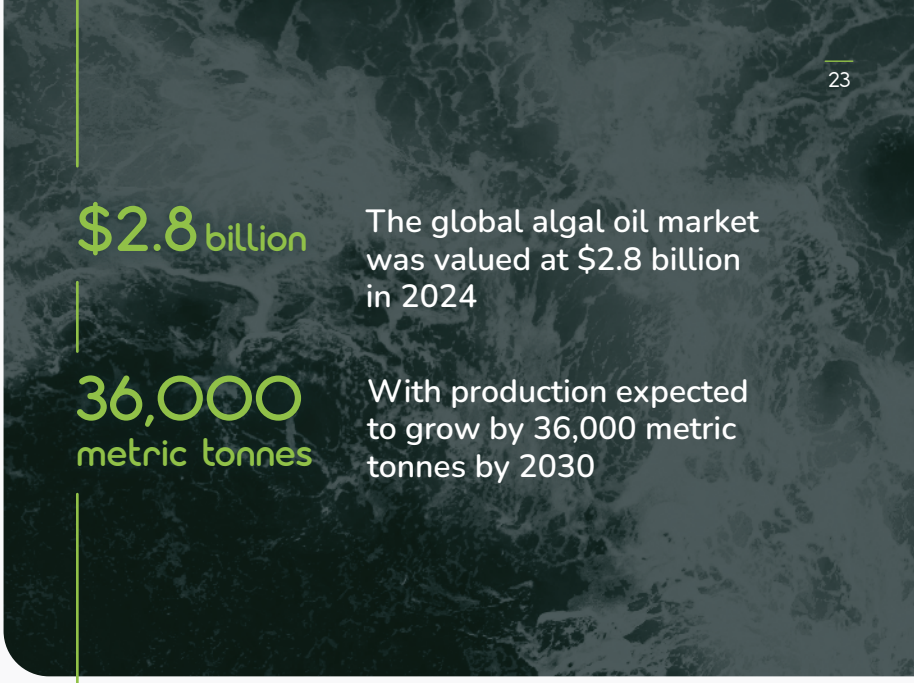
UN Fisheries expert
June 2025

6 The Algae Advantage: A Better Origin for DHA

The solution to the supply problems of fish oil is not to reformulate around it – but to return to the original source.

Fish do not produce DHA, they accumulate it by consuming microalgae. Microalgae are the primary producers of long-chain Omega-3 fatty acids in marine ecosystems, and the entire ocean food chain ultimately depends on them. Algae derived DHA simply removes fish as an unnecessary, and increasingly problematic, intermediate step.





$2.8 billion

The global algal oil market was valued at $2.8 billion in 2024

36,000 metric tonnes

With production expected to grow by 36,000 metric tonnes by 2030

6.1 Supply Security and Price Predictability

Algae-derived Omega-3 production is not constrained by fisheries cycles, weather events, or geopolitical disruptions. It's an indoor controlled fermentation or cultivation process that can be scaled independently of marine ecosystems. The global algal oil market was valued at $2.8 billion in 2024, with production expected to grow by 36,000 metric tonnes by 2030 – driven by demonstrated functional equivalence and the supply resilience it offers.

For procurement teams, algal DHA represents a fundamentally different risk profile: domestically or regionally produced, with predictable input costs, scalable volume, and supply relationships that can be planned with confidence rather than hedged against uncertainty.

6.2 Traceability by Design

Algae cultivation is an inherently traceable process. Inputs are known and controlled; the production facility is fixed; feedstocks are documented from intake to ingredient batch.

This is in direct contrast to the opacity of the marine fish oil supply chain. Manufacturers sourcing algal DHA can provide substantive, documented answers to questions about ingredient provenance because the information is structurally embedded in the production.

6.3 Nutritional Equivalence and Oxidative Stability

DHA from algae is chemically identical to DHA from fish oil. It is absorbed and metabolised by pets in the same way and numerous studies have demonstrated equivalent bioavailability and equivalent functional outcomes – including improvements in skin and coat condition, cognitive markers, joint mobility, and inflammatory biomarkers.

Critically, algal DHA is substantially more oxidatively stable more than fish oil. Microalgae naturally accumulate DHA within cell matrices that offer inherent protection from oxidation, controlled cultivation and extraction processes allow this stability to be maintained through processing and supply chain handling. Where fish oil requires aggressive antioxidant management to slow inevitable degradation, algal DHA formulations can achieve and maintain lower oxidation values throughout their shelf life.

6.4 A clean label ingredient

Microalgae-derived DHA carries none of the marine contaminants associated with fish oil. Ocean fish accumulate persistent organic pollutants, heavy metals (including mercury and PCBs) and, increasingly, microplastics, through their position in the food chain.

DHA produced directly from algae in a controlled cultivation environment contains none of these. For manufacturers wanting to make clean-label claims, this distinction between a fish oil or algae source can be a game-changer.



7 MiAlgae: Delivering Traceable, Sustainable, Organic DHA At Scale

We're a biotechnology company based in Scotland, founded in 2016 with a singular focus: producing a premium microalgae-derived Omega-3 ingredient at a commercial scale using a circular economy model that generates a fraction of the environmental footprint of conventional fish oil production.

A finalist of the 2024 Earthshot Prize – Prince William's globally recognised environmental awards in the 'Revive our Oceans' category, MiAlgae represents a new generation of ingredient innovation that doesn't compromise functionality whilst being more sustainability conscious.





7.1 A Circular Economy Production Model

Whisky distillation in Scotland produces large volumes of nutrient-rich by-products, principally pot ale and spent lees, that are abundant, low-cost, and otherwise present environmental disposal challenges. MiAlgae uses these by-products as the primary feedstock for microalgae cultivation in large-scale bioreactors, powered by renewable energy.

This circular production approach delivers multiple compounding benefits:

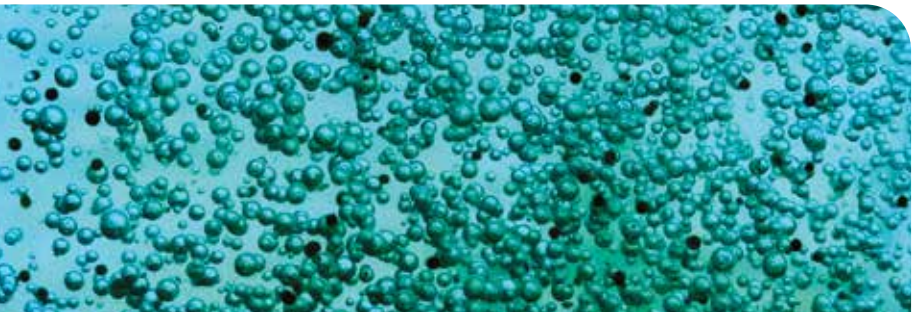
- Converts by-products into a high-value nutritional ingredient, reducing disposal costs and environmental burden for the distillery sector.
- Recycles and returns clean water to local watercourse in the process
- Anchors production to a secure, regionally available, low-cost feedstock not subject to global commodity price movements.
- Creates a fully documented, single-origin ingredient with unbroken traceability from feedstock to finished batch.

7.2 A Premium, Organic Ingredient for Pet Food Manufacturers

Our dedicated pet nutrition ingredient is a microalgal biomass naturally rich in DHA, designed for incorporation into dry kibble, wet food, treats and supplement formats.

The ingredient offers pet food manufacturers a compelling combination of premium nutritional performance and commercial advantage:

- **DHA-rich:** naturally high in Docosahexaenoic Acid, the most biologically important long-chain Omega-3 for pet health.
- **Certified Organic:** ideal for formulators wanting to swap from an organic fish oil ingredient
- **Fully traceable:** single-site, documented production from whisky by-product feedstock through to finished ingredient batch.
- **Contaminant-free:** no marine pollutants, heavy metals, or microplastics
- **Vegan and fish-free:** suitable for plant-based and allergen sensitive formulations; supports a growing segment of the market.
- **Oxidatively stable:** controlled cultivation and water-based extraction maintain ingredient integrity throughout the supply chain.
- **Low carbon footprint:** circular model powered by renewable energy
- **Locally produced:** not subject to geopolitical uncertainty



7.3 The Business Case for Change

The case for transitioning from fish oil to algae-derived DHA in pet nutrition is not simply ethical or environmental, it is commercial. Pet food manufacturers who continue to rely on fish oil as their primary Omega-3 ingredient face a multi-dimensional risk profile that is worsening over time across every dimension that matters to a procurement and formulation strategy.

Risk Dimension	Conventional Fish Oil	MiAlgae Algae DHA
Oxidation Risk	**High** - begins at extraction; compounds through processing and shelf life	**Low** - controlled cultivation; stable through supply chain
Supply Security	**Exposed** - wild fisheries at capacity; 20,000+ tonne deficits projected	**Secure** - indoor production; scalable independently of marine conditions
Price Stability	**Volatile** - driven by catch volumes, El Niño, and competing sector demand	**Predictable** - domestic feedstock; contracted supply at manageable cost
Traceability	**Opaque** - multi-country, multi-intermediary supply chain	**Transparent** - single-site, documented from feedstock to batch
Contaminant Risk	**Present** - heavy metals, PCBs, microplastics require active remediation	**Absent** - controlled cultivation; no bioaccumulation
Sustainability Claim Integrity	**Difficult** - dependent on certification of a complex, opaque chain	**Strong** - circular model, renewable energy, quantified impact metrics
Clean-Label Compatibility	**Challenged** - animal-derived; antioxidant addition often required	**Strong** - plant-based, vegan-suitable, fish-free, minimal additives

7.4 Partner with MiAlgae

MiAlgae is actively partnering with leading pet food manufacturers to integrate our Omega-3 powder into new and existing formulations. We deliver a high-quality source of DHA with year-round commercial stability and no seasonal fluctuations. Clean (no heavy metals or microplastics), highly bioavailable, and adaptable across diverse formulations, it enables new levels of precision, performance and innovation for pet food brands ready to do things differently.

Our team can support you from technical evaluation through to commercial supply at scale.

We offer:

- Product samples and full technical data sheets for formulation evaluation.
- Health claim substantiation and nutritional equivalence
- Flexible commercial supply arrangements
- FEMAS and Organic certification
- Traceability documentation for sustainability reporting and regulatory compliance.



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