zooca®
The Calanus® Company

Zooca® Calanus® Oil



Whitepaper

Fueling Human Performance: Energy, Adaptation, and Recovery

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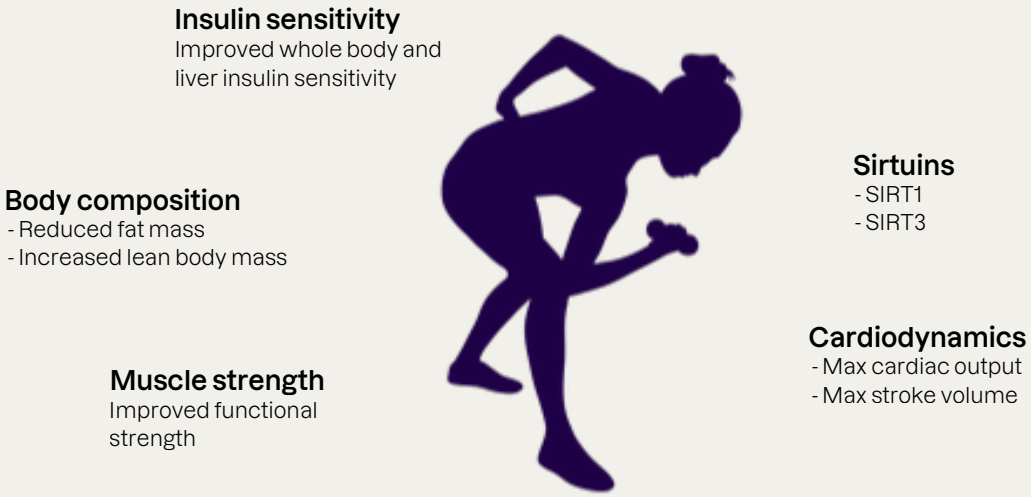


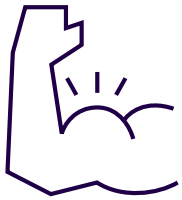
Figure 1: Summary of clinically observed changes associated with Zooca® Calanus® Oil supplementation in human intervention studies, spanning metabolic regulation, body composition, muscular function, cardiovascular physiology, lipid incorporation, and cellular energy regulation.

Performance Begins with Physiology

Human performance begins long before movement is visible. It depends on the body's ability to generate energy, deliver oxygen and nutrients, regulate metabolism, and adapt to repeated physiological demands.

In daily life as well as during structured exercise, physical capacity emerges from the coordinated interaction of metabolic, muscular, cardiovascular, and adaptive systems. These systems regulate energy mobilization and utilization, muscular function, oxygen delivery, and processes related to recovery following physical exertion (1-3).

Metabolic health is an important foundation for this process. Efficient regulation of glucose and lipid metabolism supports energy availability, functional capacity, and the body's ability to respond to physical challenges. When metabolic regulation is disturbed, the utilization of energy substrates as fuel could become less efficient, physiological flexibility could be reduced, and the body's ability to meet changing energetic demands could be compromised (3-5).





The ability to adjust fuel utilization according to changing physiological conditions is often referred to as metabolic flexibility. During rest, activity, and recovery, this flexibility could help maintain energy availability and support the body's capacity to respond to physical stress (6,7).

Modern lifestyles, often characterized by reduced physical activity, irregular energy intake, and increased metabolic stress, place considerable pressure on these regulatory systems. This has driven interest in nutritional strategies that support the biological systems underlying physical function and human performance (8-10).



This whitepaper explores the science behind Zooca® Calanus® oil and its relevance to the interconnected physiological systems that support energy metabolism, physical function, adaptation, and recovery.

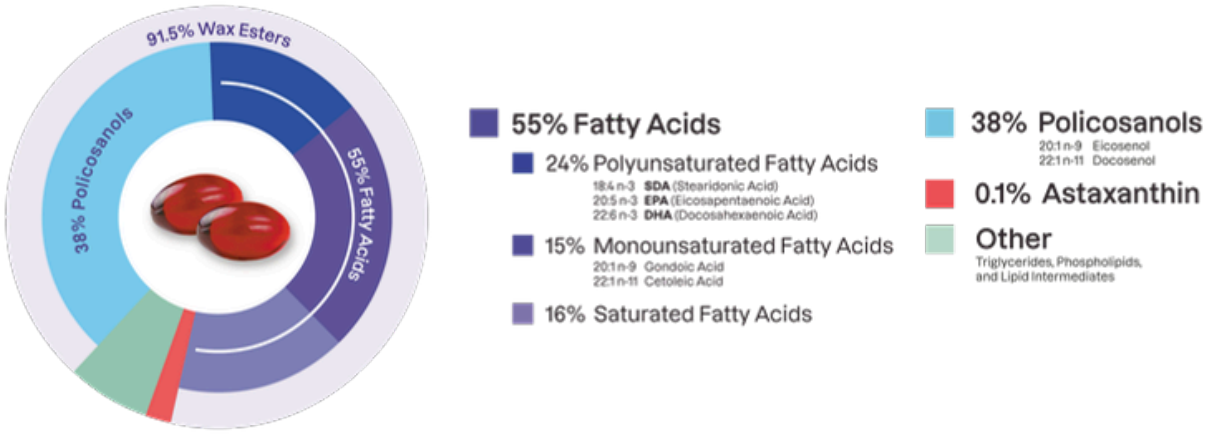


Figure 2: Composition of Zooca® Calanus® Oil, showing the predominance of wax esters and their constituent fatty acids and marine policosanols. In addition, the oil contains naturally occurring astaxanthin and minor lipid components that collectively form a unique marine lipid matrix.

Zooca® Calanus® Oil represents a distinct nutritional approach within this context. At the core of the oil is a marine wax ester matrix accompanied by a broad spectrum of fatty acids, marine policosanols, and naturally occurring astaxanthin (Figure 2). The predominance of wax esters influences digestion and absorption kinetics, contributing to a metabolic profile that differs from conventional marine oils (11,12). Research on calanus oil has shown associations with physiological processes relevant to physical capacity, including glucose homeostasis, body composition, cardiovascular function, muscular function, and adaptation to physical activity (11,13-16).

For a product also developed for active bodies, calanus oil is relevant because it connects to the biological systems that support sustained movement, adaptation to effort, and restoration after physical exertion. The physiological demands imposed by physical activity vary considerably according to exercise intensity, duration, and modality. Nevertheless, all forms of physical activity depend on the coordinated regulation of energy metabolism, cardiovascular support, muscular function, and adaptive responses.

A Marine Lipid Matrix Unlike Conventional Omega-3 Oils

Not simply another omega-3 source

Its nutritional distinctiveness lies in its naturally structured lipids. While most fish oils are dominated by triglycerides and krill oil by phospholipids, calanus oil is characterized by a high proportion of wax esters. These molecules consist of fatty acids esterified to long-chain fatty alcohols, also referred to as marine policosanols, creating a lipid structure distinct from conventional marine oils (11,12). The wax esters of calanus oil are naturally more resistant to pancreatic enzymes than conventional phospholipids or triglycerides, potentially contributing to a progressive release of fatty acids and marine policosanols during absorption (12,16)

Wax esters progress further down the intestinal tract before being fully hydrolyzed. This delayed breakdown could lead to a more gradual release of fatty acids into the circulation rather than a rapid peak. The resulting availability of these bioactive lipids could support a more sustained energetic profile and a steadier metabolic response over time, particularly during longer periods of activity when a more even supply of energy is favorable. From a physiological perspective, this supports the concept of calanus oil as a slow-release marine lipid matrix rather than a rapidly absorbed omega-3 oil. Such a release profile contributes to the scientific interest in calanus oil as a marine lipid matrix with distinct digestion and absorption characteristics.

The calanus oil also contains a naturally broad spectrum of marine lipid components, including EPA (eicosapentaenoic acid), DHA (docosahexaenoic acid), SDA (stearidonic acid), long-chain monounsaturated fatty acids such as gondoic acid and cetoleic acid, marine policosanols, and naturally occurring astaxanthin (11,12). These compounds could be relevant to biological processes involved in lipid metabolism, membrane function, cellular signaling, oxidative stress responses, and energy regulation. The biological relevance of calanus oil extends beyond isolated EPA and DHA content. Instead, calanus oil serves as a naturally integrated lipid matrix in which multiple compounds could be relevant to energy metabolism, body composition, cardiovascular function, and adaptation to physical activity.

Calanus oil is built around wax esters, the same energy-dense lipid structures that allow Calanus finmarchicus, a small copepod inhabiting the cold waters of the North Atlantic Ocean, to accumulate and store energy throughout its annual life cycle. In human nutrition, this structure gives the calanus oil a distinct digestion and absorption profile compared with conventional marine oils. These characteristics provide the physiological basis for considering the potential relevance of calanus oil to metabolic processes involved in energy availability, body composition, and physical function.

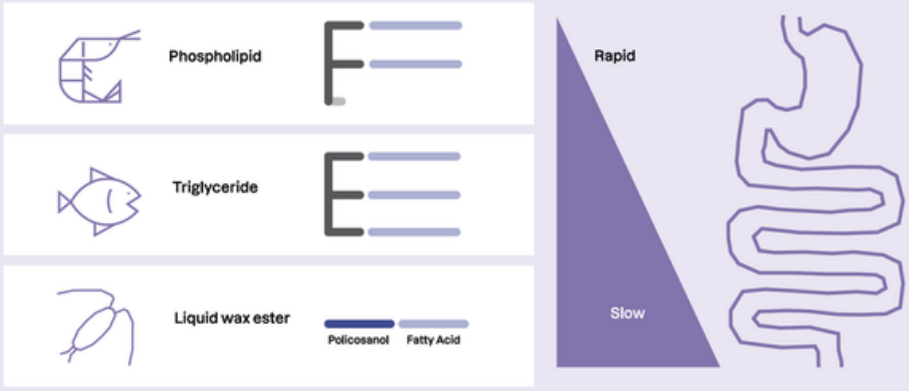


Figure 3: Structural differences between phospholipids, triglycerides, and wax esters. The wax ester matrix of calanus oil contributes to a distinct digestion and absorption profile compared with more conventional marine oils.

Energy Metabolism

Sustaining the capacity to move

Physical activity depends on the body's ability to continuously generate, distribute, and utilize energy in response to changing physiological demands. This process involves more than fuel availability. It requires coordinated regulation of glucose metabolism, insulin sensitivity, lipid utilization, and body composition. These systems govern the mobilization and utilization of energy substrates during physical activity and recovery (2,3,7).

Calanus oil is of interest in this context because its wax ester structure contributes to a gradual release of fatty acids and marine policosanols during digestion, while human intervention studies have linked supplementation to changes in glucose homeostasis, insulin sensitivity, and body composition, all of which are relevant to metabolic health and physical function (11,13,14).

Metabolic flexibility and substrate availability

The human body continuously adjusts fuel utilization according to energy demands. During activity, carbohydrates and lipids function as complementary energy sources, and efficient transitions between these substrates are characteristic of metabolic flexibility (6,7). Adipose tissue contributes to this process through lipid mobilization, hormonal signaling, and overall energy homeostasis. Efficient access to stored lipid reserves supports the body's ability to meet changing energy demands during activity and recovery (4-7).

In this context, the gradual release of lipids from the wax ester structure of calanus oil is of interest because it could support a more sustained pattern of substrate availability than, for example, conventional triglyceride-rich marine oils (12,16).

Glucose regulation and body composition

Efficient energy metabolism also depends on the body's ability to regulate glucose utilization and maintain insulin sensitivity. In obese individuals with impaired glucose regulation, supplementation with calanus oil has been linked with improvements in fasting insulin, hepatic insulin resistance, and HOMA-IR, a marker of insulin resistance, indicating promising effects on glucose homeostasis (11). In individuals with insulin resistance, calanus oil combined with lifestyle interventions has also been connected to improvements in markers of glucose regulation (13).

Furthermore, body composition is closely related to these metabolic processes. Excess fat mass is associated with impaired insulin sensitivity and chronic low-grade inflammation, while favorable body composition could support metabolic health and physical function (4,5). In exercise-based intervention studies, calanus oil supplementation has been linked to reductions in fat mass and beneficial changes in body composition (14). These observations are relevant because body composition is closely related to metabolic health and physical function (4,5). Energy availability, substrate flexibility, glucose regulation, and body composition all contribute to the physiological foundation for physical capacity.

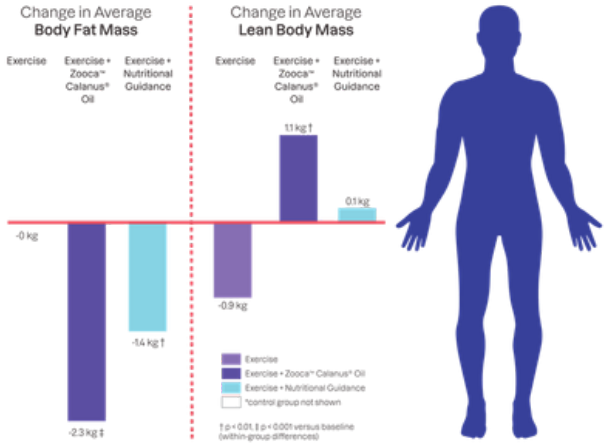


Figure 4: Changes in fat mass and lean body mass following an exercise intervention with or without calanus oil supplementation (14).

Muscle Function

The engine of physical capacity

Physical function depends on the ability of skeletal muscles to generate force, sustain movement, and adapt to changing physiological demands. Skeletal muscles are also major sites of glucose disposal and important contributors to overall energy metabolism, linking muscular function closely to metabolic health and energy balance (17,18).

Muscle tissue adapts continuously to physical activity. These adaptations influence functional capacity, healthy aging, and long-term metabolic regulation (18,19). Within this physiological context, clinical studies combining calanus oil supplementation with structured exercise have reported changes in functional strength, lean tissue mass, and body composition (Figure 4), suggesting relevance for the biological processes that support muscular function and adaptation (15,20).

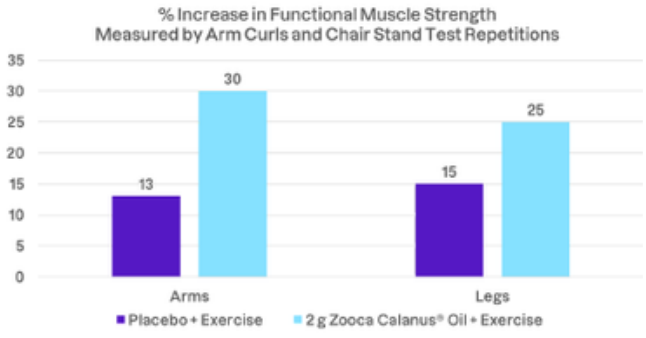


Figure 5: Calanus oil supplementation combined with exercise training was associated with greater improvements in functional muscle strength, assessed by arm curl and chair stand tests, compared with exercise and placebo (20).

Functional strength and physical independence

The capacity to perform everyday physical tasks depends on functional strength, which supports mobility, balance, and physical independence. Participants receiving calanus oil in combination with exercise training demonstrated greater improvements in functional muscle strength, assessed by arm curl and chair stand tests (Figure 5), than those receiving exercise and placebo in a randomized intervention study (20). Improvements in functional fitness were observed across the intervention groups, reflecting the adaptive benefits of regular physical activity during aging (20). Because muscular function contributes directly to mobility and long-term physical function, these observations are relevant within a broader physiological context encompassing healthy aging, metabolic regulation, and adaptation to physical activity (18,19,21).

Physical capacity begins with function. Functional strength supports movement, mobility, and the physiological resilience needed to remain active over time. It forms the foundation for physical independence and connects muscular performance with healthy aging, metabolic health, and long-term physical function.

Lean tissue and body composition

Healthy muscle tissue contributes to metabolic regulation, functional capacity, and physical resilience. With aging, reductions in muscle mass and muscle quality could influence glucose homeostasis, energy metabolism, and long-term physical function (18,19).

In an exercise-based study including calanus oil supplementation, lean mass increased across exercise groups, while the calanus oil group showed changes in body composition and regional fat distribution (15). These observations are relevant because skeletal muscle and adipose tissue are integrated in the regulation of energy metabolism, body composition, and metabolic health. Preservation of lean mass, together with improved body composition, could contribute to metabolic health, healthy aging, and the maintenance of physical function over time (18,19,21). For the calanus oil, this creates a relevant bridge between activity, body composition, and the metabolic systems that support physical capacity.

Cardiovascular Function

Delivering energy where it is needed

Physical capacity depends on the ability of the cardiovascular system to deliver oxygen, nutrients, and metabolic substrates to working tissues. During physical activity, sustained function depends on the coordinated interaction between energy production within muscle and the ability of the heart and vascular system to meet changing physiological demands. Exercise capacity and the physiological adaptations associated with regular physical activity are related to cardiovascular function (22). Efficient cardiovascular function supports the delivery of oxygen and nutrients required to sustain physical activity. Exercise-based clinical studies have linked calanus oil supplementation to changes in cardiac function, circulatory dynamics, and cardiovascular efficiency, placing the oil within a broader physiological context related to physical capacity (15,23).



Cardiodynamic adaptations

In a randomized intervention study combining calanus oil supplementation with structured exercise training, participants receiving calanus oil demonstrated increases in maximal cardiac output together with changes in stroke volume (Figure 6), peripheral oxygen extraction, and systemic vascular resistance (15). These observations are consistent with adaptations involving both central and peripheral cardiodynamic mechanisms and suggest relevance for physiological systems that support physical function and sustained activity (15,18,22).

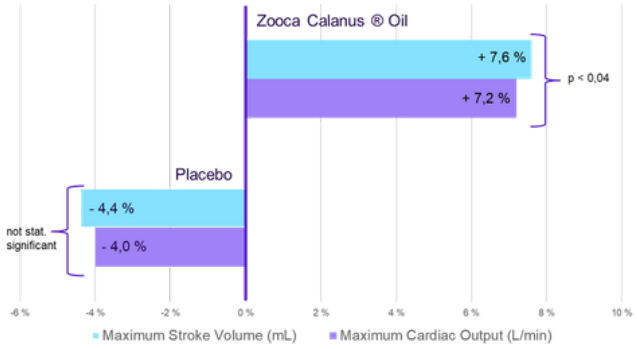


Figure 6: Improvements in maximal stroke volume and maximal cardiac output reported following calanus oil supplementation combined with exercise training (15).

Cardiometabolic function

More recent clinical research has expanded the discussion from cardiodynamics to cardiac function in metabolically challenged individuals. Recent clinical research in obese and prediabetic women has linked calanus oil supplementation to improvements in E/A ratio, an indicator of how efficiently the heart fills with blood between contractions, together with changes in diastolic blood pressure, triglycerides, and markers related to metabolic syndrome (23). These findings require confirmation in larger controlled studies, but they point to an important physiological relationship: metabolic health and cardiovascular physiology are connected. Alterations in glucose regulation, lipid metabolism, and body composition could influence processes relevant to cardiovascular performance and physical capacity, supporting a broader view of cardiovascular function as part of an integrated metabolic system (18,22,23).

Cardiovascular function is not an isolated heart health topic. It is part of the biological infrastructure that supports movement, sustained activity, and adaptation to physical effort.

Adaptation and Recovery

Building physiological resilience

Physical capacity is shaped by more than the energy available during a single bout of activity. It also depends on the body's ability to respond to repeated physiological challenges and adapt over time. Exercise induces coordinated changes across skeletal muscle, adipose tissue, the cardiovascular system, and cellular energy-regulating pathways. These adaptations support metabolic health, functional capacity, and processes relevant to physiological resilience required for sustained physical activity (18,22,24). Within this adaptive framework, calanus oil is scientifically interesting because its relevance appears to extend beyond classical omega-3 nutrition. Calanus oil could be considered within a physiological context involving inflammation, lipid signaling, insulin sensitivity, cellular energy regulation, and adaptive recovery processes (25-27).



Adipose tissue and low-grade inflammation

Adipose tissue is a metabolically and immunologically active organ that contributes to hormonal signaling, lipid metabolism, and the regulation of low-grade inflammation. These processes can be related to insulin sensitivity and overall metabolic health (24).

Exercise training in older women was accompanied by changes in markers of inflammation and oxidative stress within adipose tissue, together with alterations in immune cell populations. These responses were accompanied by associations with insulin sensitivity and cardiorespiratory fitness, reinforcing the relationship between adipose tissue function, metabolic health, and physical capacity. Although calanus oil did not provide additional effects beyond exercise on adipose tissue inflammatory characteristics, the study provides useful context for evaluating calanus oil within physiological systems involving low-grade inflammation, metabolic regulation, and adaptation to physical activity (25).

Lipid signaling and metabolic adaptation

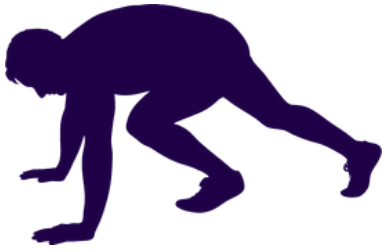
Exercise adaptation also involves changes in metabolic and lipid signaling pathways. Lipid mediators participate in the regulation of inflammation, insulin sensitivity, and communication between tissues. Moreover, PAHSAs, members of the broader FAHFA family, have attracted attention due to their insulin-sensitizing and anti-inflammatory properties, and their levels have been reported to increase following exercise training (26,28-30). These observations link exercise-induced changes in lipid signaling to pathways involved in insulin sensitivity and metabolic adaptation, extending the discussion beyond EPA and DHA alone.



Cellular energy regulation

At the cellular level, adaptation to physical activity requires coordinated regulation of energy metabolism. Exercise increases energetic demand, stimulates mitochondrial activity, supporting the cell's ability to produce energy, and activates molecular pathways involved in fuel utilization, oxidative stress responses, and cellular adaptation. Sirtuins, particularly SIRT1 and SIRT3, are progressively more recognized as regulators of cellular energy metabolism and mitochondrial function (27,31,32).

Exercise training in older overweight individuals was associated with increased activity of SIRT1 and SIRT3, two proteins involved in cellular energy regulation (Figure 7). The findings suggest that while exercise acts as the primary stimulus for these adaptive responses, dietary factors, including calanus oil supplementation, could help shape the biological environment in which they occur (27).



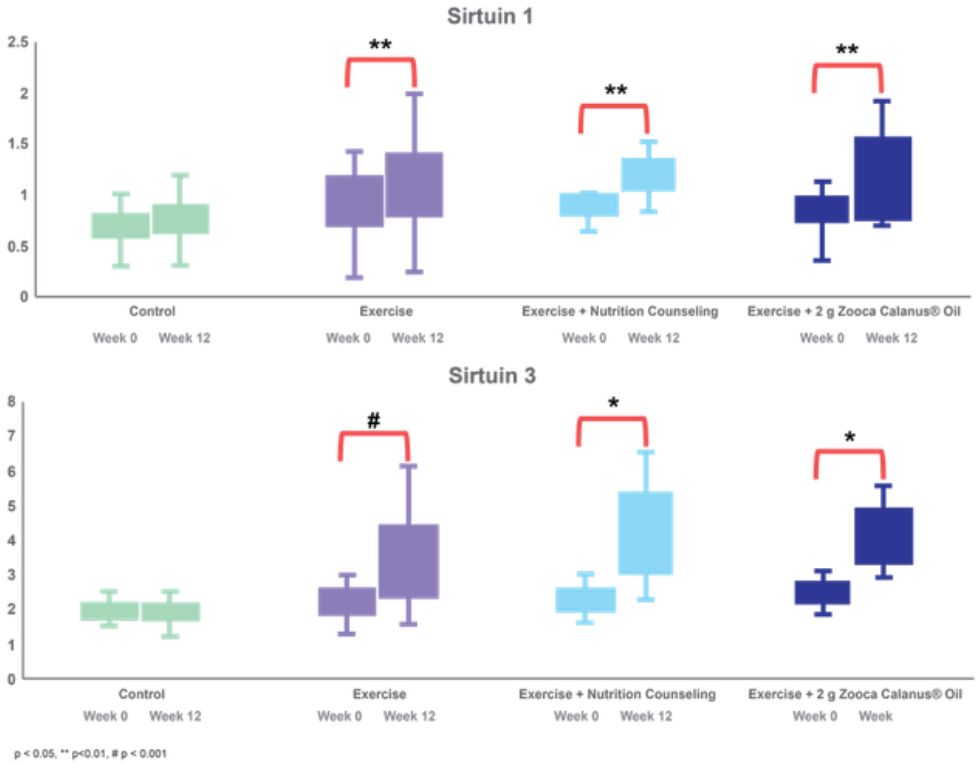


Figure 7: Exercise training was associated with increased activity of SIRT1 and SIRT3, proteins involved in cellular energy metabolism, mitochondrial function, and physiological adaptation to increased energetic demand (27).

Acute and long-term physiological responses

The physiological processes discussed occur across different timescales. Some processes are related to the immediate availability and utilization of nutrients, whereas others reflect adaptive responses that develop over weeks, months, or years. The distinctive wax ester matrix of calanus oil contributes to unique digestion and absorption characteristics that influence the temporal pattern of lipid availability following intake and helps define the oil's nutritional profile.

In contrast, the physiological changes reported in intervention studies, including changes in glucose homeostasis, body composition, functional strength, cardiovascular function, and cellular adaptation, reflect longer-term biological responses associated with repeated supplementation, physical activity, and metabolic adaptation. These observations suggest that the potential relevance of calanus oil spans multiple levels of physiology, from nutrient availability and metabolic regulation to adaptive processes that contribute to physical function and long-term physical capacity.

Recovery as part of adaptation

Recovery is not a pause between efforts. It is an active phase of the adaptive response to physical activity, during which physiological systems work to restore homeostasis, maintain energy balance, and support adaptation to previous challenges (24,28). The efficiency of these processes influences the capacity to sustain physical function, respond to future physiological demands, and remain resilient to repeated physical stress (1,18).

Moreover, recovery involves coordinated responses across metabolic, cardiovascular, and cellular pathways. These pathways help restore physiological balance while supporting the adaptations required for future physical demands. Within this broader context, calanus oil could be relevant to physiological processes that support resilience, physical function, and the maintenance of physical capacity over time (Figure 8).



A Broader View of Performance Support

Physical capacity emerges from the coordinated interaction of metabolic, muscular, cardiovascular, and adaptive physiological systems. Their coordinated activity regulates energy availability, physical function, processes relevant to recovery, and the ability to respond to repeated physiological challenges. Research on calanus oil suggests relevance across several of these interconnected domains. Through its unique composition of wax esters, fatty acids, marine policosanols, and naturally occurring astaxanthin, the calanus oil has been associated with promising effects on metabolic regulation, body composition, muscular function, and cardiovascular physiology.

Within this broader physiological framework, calanus oil represents a distinct marine lipid matrix that could contribute to the biological processes involved in adaptation, resilience, and the maintenance of physical capacity over time.

This could provide a scientifically grounded narrative: performance is not built on stimulation alone, but on the body's ability to regulate energy, support function, adapt to effort, and recover for the next challenge.

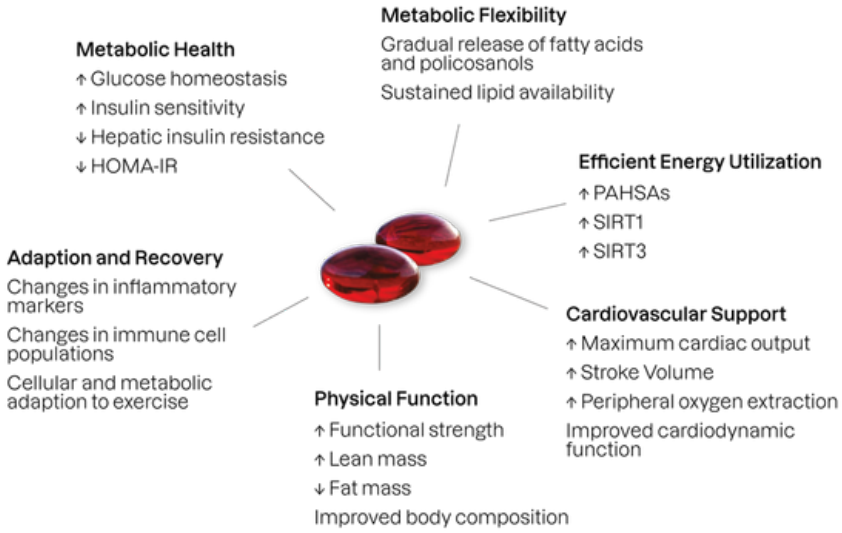


Figure 8: Physical capacity emerges from the coordinated interaction of metabolic, cardiovascular, muscular, and adaptive physiological systems. Published studies on Zooca® Calanus® Oil have reported findings across several of these interconnected domains.

Calanus finmarchicus

Small, mighty, and highly sustainable

At the heart of Zooca® Calanus® Oil is Calanus finmarchicus, a tiny marine zooplankton sustainably harvested from the North Atlantic. As one of the largest renewable marine resources in the Norwegian Sea, it represents a unique source of marine wax esters naturally containing omega-3 fatty acids, marine policosanols, and astaxanthin. Unlike conventional marine oils, EPA and DHA are delivered within a wax ester structure, creating a distinctive marine lipid matrix.

This unique composition has served as the foundation for more than 20 years of research and innovation, supporting ongoing scientific interest in its role in metabolism, physical function, and human health.

Sustainability is integrated throughout the entire value chain, from responsible harvesting practices in the North Atlantic to the production, quality control, and documentation of finished ingredients.

Each stage is supported by continuous research and monitoring to ensure traceability, consistency, and long-term stewardship of marine resources. This comprehensive approach extends beyond the ingredient itself, encompassing harvesting technologies, processing methods, environmental responsibility, and scientific documentation.

Through rigorous quality standards and a commitment to responsible resource utilization, Zooca® aims to deliver ingredients that combine scientific credibility, product quality, and ecological integrity.

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