



zoooca[®]
The Calanus[®] Company 

Zoooca Calanus[®] Oil

White paper

Unlocking the Potential of Zoooca Calanus[®] Oil: the Unique Composition Explained

By Alice Marie Pedersen, Phd

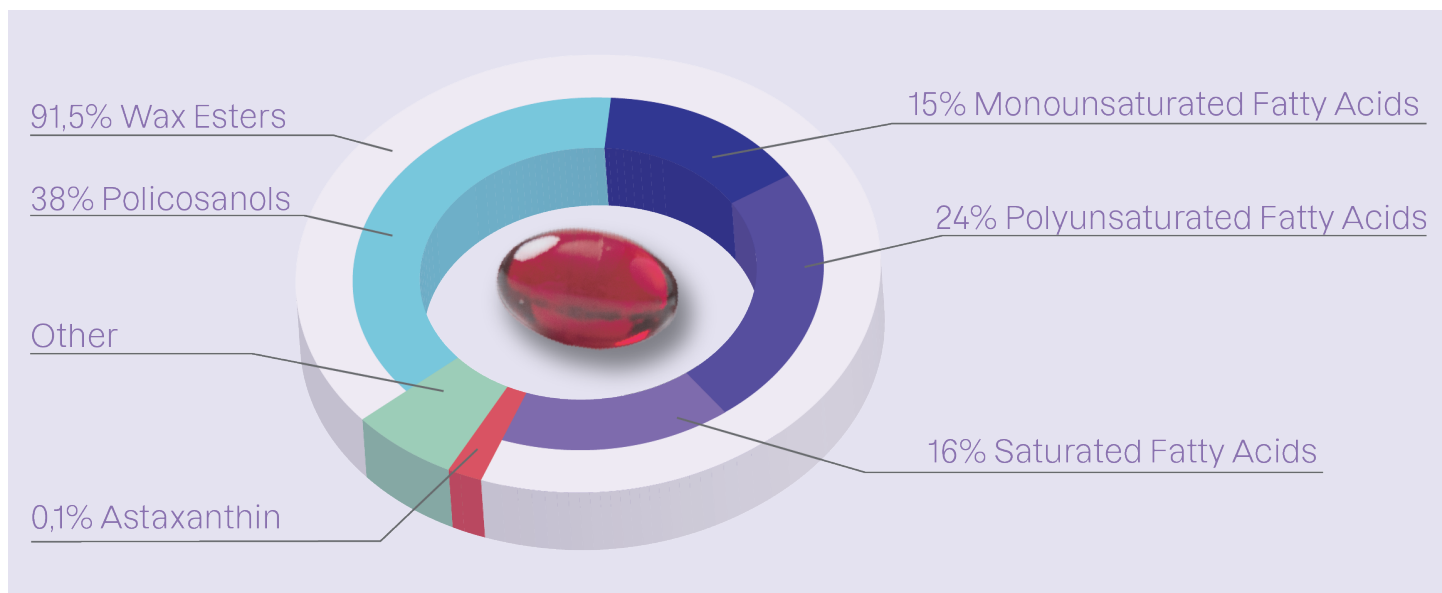


Figure 1: Graphical overview of the diverse composition of Zooca® Calanus® Oil, the way nature intended.

■ The relevance of Zooca® Calanus® Oil

Dietary nutrients play a crucial role in maintaining optimal human health and overall well-being. The human body requires a wide variety of nutrients, including macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals), to perform essential functions and support growth, maintenance, and repair. A well-balanced diet should provide an appropriate mix of nutrients to promote good health and prevent deficiencies or imbalances that can lead to health problems. A healthy diet typically includes a variety of fruits, vegetables, whole grains, lean proteins, and healthy fats.

However, in today's fast-paced world, it can be challenging to consistently consume a well-balanced diet that meets all our nutritional needs. Factors such as busy lifestyles, limited access to fresh produce, and the prevalence of processed foods can make it difficult to obtain the full spectrum of essential nutrients from diet alone. This is where dietary supplements can play a significant role in bridging the gap and ensuring that our bodies receive the necessary nutrients to maintain optimal health and well-being. Dietary supplements, when used appropriately, can help counteract deficiencies or imbalances and support various bodily functions, making them an important consideration in modern nutrition.



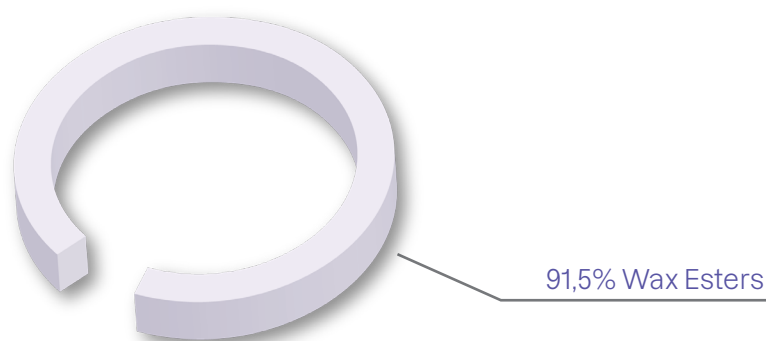
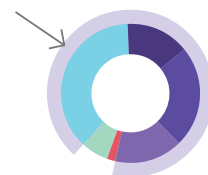
In recent years, Zooca Calanus Oil, a unique marine oil derived from the zooplankton *Calanus finmarchicus*, has gained significant interest due to its exceptional nutritional profile and potential health benefits. Sourced from the pristine waters of the North Atlantic, *Calanus*

finmarchicus serves as a vital component in the marine food chain, providing essential nutrients to various fish species. The resource is vast, with an estimated yearly biomass of up to 290 million metric tons in the North Atlantic alone. The sustainable harvesting of *Calanus finmarchicus* offers a promising alternative to traditional fisheries, providing a valuable source of nutrition while also supporting the long-term health of the ecosystem and the fish populations that depend on it.



The relevance of Zooca Calanus Oil stems from its distinct chemical composition of wax esters, which contain bioactive compounds (Figure 1). This unique composition sets it apart from other marine and plant oils. The key components in Zooca Calanus Oil include omega-3 fatty acids, specifically eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and stearidonic acid (SDA); monounsaturated fatty acids (MUFAs) such as cetoleic acid and gondoic acid; astaxanthin, a powerful antioxidant; and policosanols, a group of long-chain alcohols with potential health-promoting properties.

This white paper aims to provide an overview of the key chemical components found in Zooca Calanus Oil and explore their roles in human health. By understanding the importance of these essential nutrients, individuals can make informed dietary choices to optimize their well-being and reduce the risk of developing chronic disease.



91,5% Wax Esters

► The unique chemistry of Zooca Calanus Oil

Wax esters - What is it?

Most lipids comprise of several chains of carbon atoms bound to hydrogen atoms. The types of fats vary based on the number of carbon atoms in the chain, as well as the number and location of double bonds between them. Even slight variations in the structure of lipids can result in significant differences in their form and function, impacting physical traits of the lipids and physiological responses in the body.

Traditional dietary lipids such as triglycerides from generic fish oil and phospholipids found in krill oil consist of a glycerol backbone and esterified fatty acids, with either three fatty acids or two fatty acids and a phosphate group, respectively (Figure 2). The uniqueness of *Calanus finmarchicus*-derived lipids is the chemical form of so-called wax esters and this lipid form may constitute as much as 80-90 % of the oil. Described chemically, they are fatty acids esterified to fatty alcohols as monoesters. Wax esters are distinctly different from fat in any other marine (or terrestrial) oils in terms of chemistry, bioactivity, and health benefits¹.

This particular configuration results in a highly hydrophobic and nonpolar molecule, contributing to the physical properties of wax esters, such as their very low solubility in water and solidification at low temperatures. The presence of wax esters in Zooca Calanus Oil confers several advantages from a dietary perspective, setting it far apart from other dietary lipids.

Whereas other lipid-based supplements claim their benefits due to rapid absorption, Zooca Calanus Oil explains it the other way around; The unique chemistry of these new lipids allows them to withstand the first line of digestive enzymes, letting the lipids reach the distal part of the digestive tract without compromising the bioavailability of the fatty acids. This property is particularly advantageous for activating the GPR120 receptor, a nutrient sensor involved in regulating metabolic and inflammatory processes. GPR120 is expressed in various tissues throughout the body, including the distal intestine, colon, adipose tissue, and macrophages. It is a receptor for medium- and long-chain unsaturated fatty acids, such as omega-3 fatty acids, and recent studies have demonstrated that its activation can

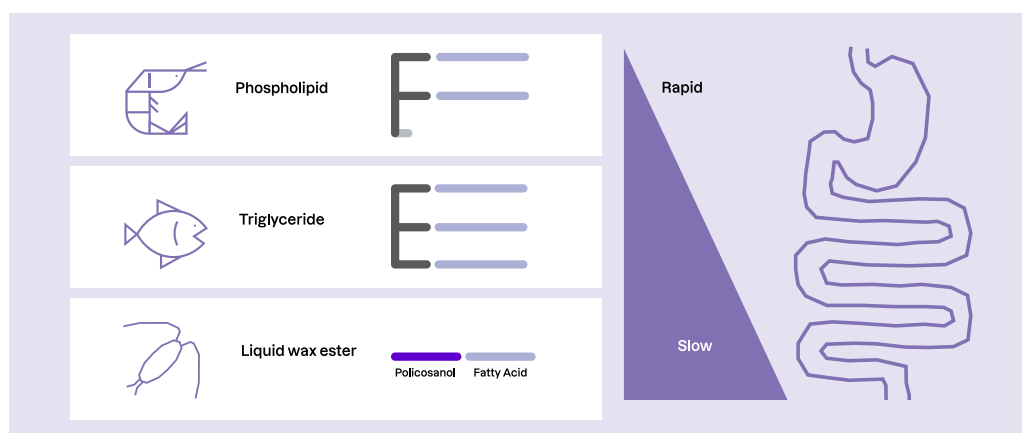


Figure 2. Schematic chemical structures of relevant lipid classes. Phospholipid consisting of a glycerol backbone, two fatty acids and a phosphate group. Triglyceride consisting of a glycerol backbone and three fatty acids. Wax ester consisting of one fatty alcohol and one fatty acid.



↑ Exploring the science behind the unique chemistry of Zooca Calanus® Oil.

play a central role in regulating gut hormone secretion, insulin sensitivity, and body weight². The potent fatty acids released by Zooca Calanus Oil during digestion can activate the GPR120 receptor and exert their beneficial effects, making it an exciting new option for supporting metabolic and inflammatory health.

The slower digestion and absorption of wax esters result in a more sustained release of nutrients, such as omega-3 fatty acids, into the bloodstream. This prolonged release may help maintain optimal blood levels of these essential nutrients, supporting their various health-promoting functions in the body.



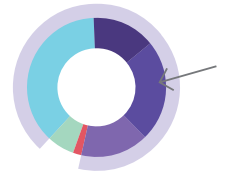
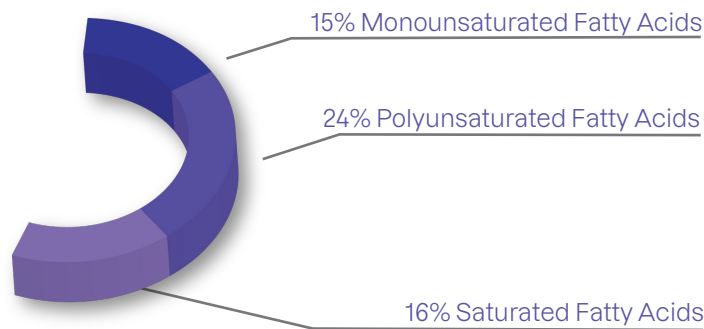
Additional benefits of this compact lipid structure may include reduced gastrointestinal distress; Wax esters in Zooca Calanus Oil are less likely to cause gastrointestinal distress, such as reflux or other discomforts, compared to triglyceride-based oils due to their unique digestive properties. This may result in a more comfortable consumption experience for individuals sensitive to traditional fish oils or those who have difficulties tolerating other lipid sources. This steady supply of nutrients could support the growth of beneficial gut bacteria and contribute to a more balanced gut microbial community. The anti-inflammatory properties of calanus oil, due to its omega-3 fatty acids and astaxanthin content, may help

modulate gut inflammation. A reduction in gut inflammation can create a more favourable environment for the growth and maintenance of a diverse and healthy gut microbiota³.



Natural Preservation: Wax esters are less prone to oxidation compared to triglycerides, making Zooca Calanus Oil more resistant to rancidity and degradation⁴. This inherent stability can enhance the shelf life of Zooca Calanus® Oil products, ensuring their quality and potency over time.

The presence of wax esters in Zooca Calanus Oil contributes to its unique dietary benefits, including enhanced bioavailability of potent fatty acids and other bioactive molecules, sustained nutrient release, reduced gastrointestinal distress and gut health, and natural preservation. Understanding the chemical structure and advantages of wax esters is essential to appreciating the potential of Zooca Calanus Oil as a valuable source of essential nutrients in human nutrition.



Broad-spectrum fatty acids

Zooca Calanus[®]Oil, a natural extract derived from the marine zooplankton *Calanus finmarchicus*, stands out for its broad-spectrum fatty acid composition, which closely resembles the natural distribution of fats found in the marine food chain. This comprehensive profile reflects the true essence of Zooca Calanus Oil as a natural extract, offering a multitude of health benefits and nutritional advantages.

The broad-spectrum fatty acid composition of Zooca Calanus Oil encompasses over 40 different fatty acids, ranging from 14 to 22 carbons in length, and includes saturated, monounsaturated (MUFAs), and polyunsaturated fatty acids (PUFAs)⁵. This broad range of fatty acids not only highlights the oil's natural origins but also provides a balanced and diverse nutrient profile, which is essential for maintaining optimal health and well-being. Different fatty acids hold different critical functions such as receptor signalling, gene expression, and regulation of systemic fuel energy homeostasis under various physiological conditions.

As such, it is worth highlighting some of the most prominent groups of the potent bioactive fatty acids present in Zooca Calanus Oil.

MUFAs and PUFAs

- Monounsaturated fatty acids (MUFAs) have one double bond in their carbon chain.
- Polyunsaturated fatty acids (PUFAs) have two or more double bonds in their carbon chain.

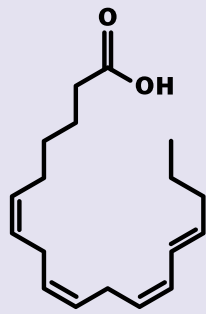
Omega-3 fatty acids

Omega-3 fatty acids are essential polyunsaturated fatty acids that play a vital role in maintaining optimal health and overall well-being. The content of eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3) is relatively low in Zooca Calanus Oil compared to other marine oils, but it has a high content of stearidonic acid (SDA, 18:4, n-3) (Figure 3). However, evidence from both acute and cumulative dosing studies demonstrates that Zooca Calanus Oil effectively increases omega-3 index levels⁶⁻⁹ establishing it as a fully viable and highly sustainable omega-3 source.

effectively
increases
omega-3
index levels⁶⁻⁹

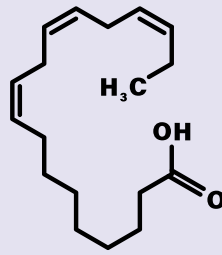
The long-chain PUFAs, EPA and DHA are particularly important due to their roles as parent molecules for the synthesis of eicosanoids, which are signalling molecules involved in regulating various physiological processes. Eicosanoids derived from EPA and DHA play a critical role in modulating inflammation, blood clotting, and immune responses. Additionally, DHA is a primary structural component of the brain and retina, making it essential for proper neural and visual function. Furthermore, omega-3 fatty acids have been associated with numerous health benefits, such as reducing the risk of cardiovascular disease, improving mental health, supporting healthy brain development during pregnancy and early childhood, and reducing inflammation in the body.

EPA and DHA are potent agonists on the previously mentioned GPR120 receptor, but recent studies have shown that SDA is one of the most potent agonists². While researchers are actively developing synthetic agonists with delayed release systems to target these receptors, the wax ester form of delivery in Zooca Calanus Oil provides these bioactive molecules naturally



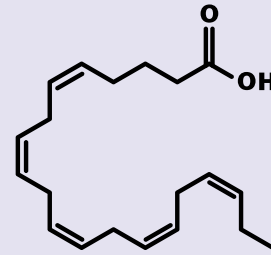
SDA

Stearidonic Acid



EPA

Eicosapentaenoic Acid



DHA

Docosahexaenoic Acid

Figure 3: Zooca® Calanus® Oil is rich in SDA, EPA and DHA.

and with perfect timing. The sustained release of omega-3 fatty acids from wax esters in Zooca Calanus Oil may lead to prolonged activation of the receptors. This activation could result in a more pronounced and lasting impact on physiological processes, such as reduced inflammation,

improved insulin sensitivity, and better appetite control. Therefore, the diverse fatty acids in Zooca Calanus Oil, including SDA, offer several advantages and could potentially serve as a valuable addition to a balanced diet.

SDA, EPA and DHA

Stearidonic acid (SDA):

An intermediate in ALA-to-EPA conversion, with potential benefits for inflammation, insulin sensitivity, and gut hormone regulation due to GPR120 activation.

Eicosapentaenoic acid (EPA):

A long-chain omega-3 known for regulating inflammation, improving cardiovascular health, and supporting brain function and mental health.

Docosahexaenoic acid (DHA):

Crucial for brain and eye health, DHA also offers cardiovascular benefits and supports cognitive function throughout life.

A diet rich in omega-3 fatty acids supports heart health, brain function, and overall well-being.



↑ Zooca® Calanus® Oil.

Long chain monounsaturated fatty acids

The Zooca Calanus Oil contains a diverse group of MUFAs, including a significant amount of long-chain MUFAs from the omega-7, -9, and -11 families. Among these, the oil is rich especially in gondoic acid (20:1 n-9) and cetoleic acid (22:1 n-11), as well as the more commonly known palmitoleic acid (16:1n-7) and oleic acid (18:1n-9)⁵.

Studies in the 1960s revealed that long-chain MUFAs could have positive health effects¹⁰, sparking interest in olive oil and the Mediterranean diet, which remains a healthy choice today. These MUFAs have been suggested to play a crucial role in cardiovascular health, as they exhibit favourable effects on metabolic syndrome and cardiovascular disease risk markers such as blood pressure, blood lipids, and insulin sensitivity, as well as potentially reducing obesity risk.

Most health-related MUFA studies have focused exclusively on oleic acid (C18:1 n-9), which is abundant in the Mediterranean diet. Currently there is limited information available regarding the effects of other dietary MUFAs, such as MUFAs with chains longer than 18 carbons. However, more attention has been brought to these fatty acids as science progress, and studies have shown that long-chain MUFA have the ability to decrease atherosclerotic lesion formation, reduce cholesterol efflux and alter gene expression related to inflammation, lipid metabolism and energy expenditure in different tissues¹¹. It appears that the carbon chain length of the dietary MUFA can be an important factor that determines its metabolic effects.

The body is able to make some MUFAs from oleic acid, but specifically the long chain omega-11, must come from food. Eating a diet rich in these fats from marine sources has been shown to have many health benefits. These fats can help reduce fat production and inflammation, while increasing

fat breakdown in the liver and fat tissues. They can also help lower fat build-up and immune cell build-up in blood vessels, leading to better blood lipid levels and a healthier balance of fatty acids. Overall, these effects can help improve fat metabolism, insulin sensitivity, and reduce the risk of heart diseases¹²⁻¹³. Recent studies also suggest that cetoleic acid in particular can be good for skin health¹⁴.

Zooca Calanus Oil contains a variety of fatty acids that work together to promote health, such as reducing inflammation, supporting heart health, and lipid metabolism. By consuming this diverse lipid source, the body can take advantage of their combined benefits.

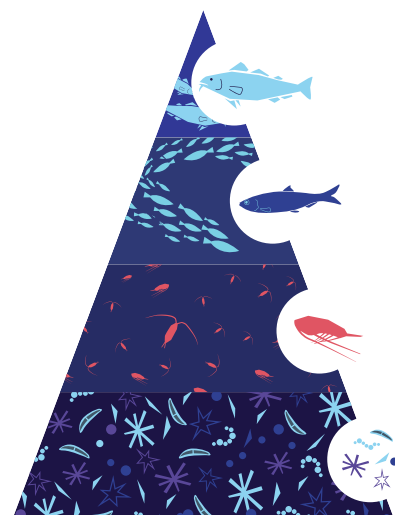
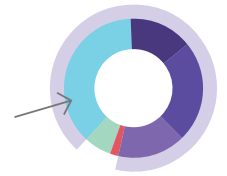
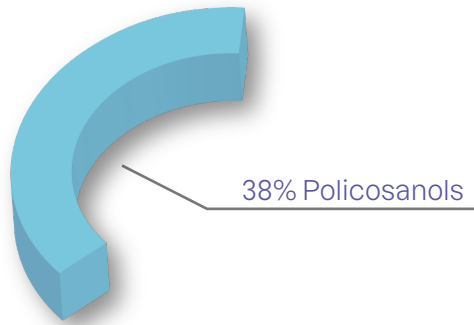


Figure 4: The MUFAs and PUFAs found in fish and fish oils originate from the lower levels in the marine food chain, such as *Calanus finmarchicus*.





Marine policosanols

The alcohol fraction of marine wax esters of Zooca Calanus Oil has not been extensively investigated as a dietary lipid. Nevertheless, it has a close chemical similarity to the well-known policosanols. As the trivial name implies, are a class of long-chain saturated fatty alcohols, containing 20 or more carbon atoms. These components originate from the natural wax from terrestrial sources such as wheat germ oil, rice bran oil, fruits, leaves, plant surfaces, and whole seeds. These plant-based policosanols extracts have been gaining attention as dietary supplements since they are considered to exhibit a range of beneficial physiological effects¹⁵⁻¹⁶. Policosanols studies have demonstrated a potential in improving physical performance and exhibiting anti-inflammatory properties. It is theorized that these policosanols may boost physical performance by promoting lipid oxidation, which in turn spares muscle glycogen stores.

↓ Good for you. Good for the planet



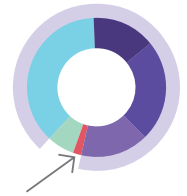
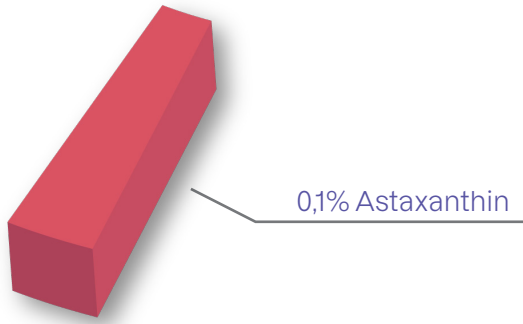
The policosanols in Zooca Calanus Oil are quantitatively important and may constitute nearly 40% by weight of the wax ester molecules. This fraction is comprised of a group of aliphatic alcohols, which notably differ from their terrestrial counterparts. These marine policosanols feature comparatively shorter carbon chain lengths, ranging between 14 and 22 carbons.

consist of
nearly 40%
of the wax ester

Additionally, they exhibit double bonds akin to monounsaturated fatty acids. The most prominent constituents within this fraction are eicosenol (20:1n-9) and docosenol (22:1n-11), which together make up the majority of the policosanols in Zooca Calanus Oil. Classical research conducted on rodent models has demonstrated that policosanols can be oxidized into their corresponding fatty acids during hepatic metabolism in the endoplasmic reticulum and subsequent chain shortening within peroxisomes¹⁷⁻¹⁹. A recent study proposed that the metabolic effects observed in response to policosanols supplementation may be attributed to the conversion of these fatty alcohols into their respective fatty acids²⁰.

Of note, Brezinova et al.²¹ reported in 2020 that serum from participants consuming Zooca Calanus Oil contained elevated levels of so-called unique lipids which were recognized as calanus-derived fatty alcohols incorporated into carrier lipids, especially TAGs, showing that the marine policosanols are absorbed and sent into circulation to be utilized by the body thereafter.

The novel marine policosanols found in Zooca Calanus Oil may offer ergogenic benefits by improving physical performance and exhibiting anti-inflammatory properties. These unique lipids are absorbed and utilized by the body, further supporting their potential role in promoting metabolic health.



Astaxanthin

Astaxanthin, a potent carotenoid antioxidant found in Zooca Calanus Oil, is responsible for its striking red color and extended shelf life. Derived from the extract of *Calanus finmarchicus*, astaxanthin boasts numerous health benefits that distinguish it from other omega-3 fatty acid sources.

Renowned for its exceptional ability to neutralize free radicals and diminish oxidative stress in the body, astaxanthin's antioxidant capacity outshines other carotenoids like beta-carotene and lutein, and even surpasses some vitamins, such as vitamin C and E. By combating oxidative stress, astaxanthin helps shield cells, tissues, and organs from harm, thereby promoting overall health²².



In terms of cardiovascular health, astaxanthin aids in maintaining healthy cholesterol levels by encouraging a balance between high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol. It also enhances blood flow and curbs inflammation in blood vessels, supporting heart health²³.

Astaxanthin contributes to skin health by safeguarding the skin from harmful UV radiation and environmental pollutants through neutralizing free radicals and alleviating inflammation. It bolsters skin elasticity, hydration, and appearance by augmenting the skin's moisture-retention capacity and minimizing fine lines and wrinkles²⁴.

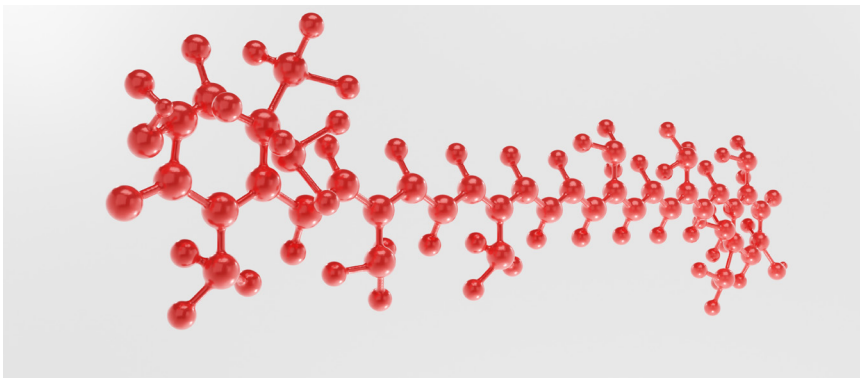
For eye health, astaxanthin has been demonstrated to lower the risk of age-related macular degeneration and other eye conditions by defending the retina against oxidative damage. It also helps relieve eye fatigue and sharpen visual acuity²⁵.

Astaxanthin's powerful antioxidant and anti-inflammatory properties boost immune function, fortifying the immune system and decreasing the risk of infections, illnesses, and chronic diseases.

Furthermore, it fosters joint health by reducing inflammation and oxidative stress in the joints, potentially easing arthritis symptoms and other joint-related conditions.

Lastly, astaxanthin can improve cognitive function by shielding neurons from oxidative damage and diminishing inflammation in the brain, potentially protecting against age-related cognitive decline²⁶.

The high concentration of astaxanthin present in Zooca Calanus Oil may provide a wide range of health benefits, thanks to its potent antioxidant properties and ability to combat oxidative stress and inflammation. Incorporating Zooca Calanus Oil into the diet can help harness the power of astaxanthin to support cardiovascular, skin, eye, immune, joint, as well as cognitive health.



Astaxanthin acts as UV protection for the calanus in the Arctic midnight sun

↑ Astaxanthin molecule

Calanus Catch and Nutrient Extraction

- Waste-free, fully integrated process
- Gentle, low-heat process
- Processed without solvents or additives



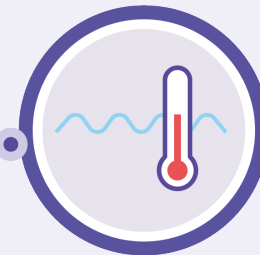
Calanus converts plankton to nutrients.



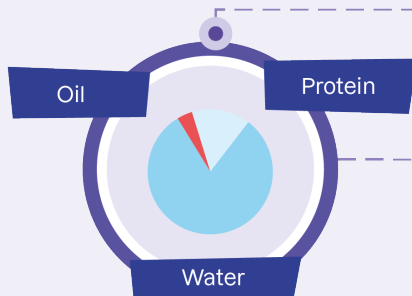
Rapidly frozen after harvest.



Frozen blocks are grinded, water and a small amount of enzyme added.



The temperature is controlled during the process.



Easy separation by centrifugal force.



Mild and solvent free extraction of functional nutrients.

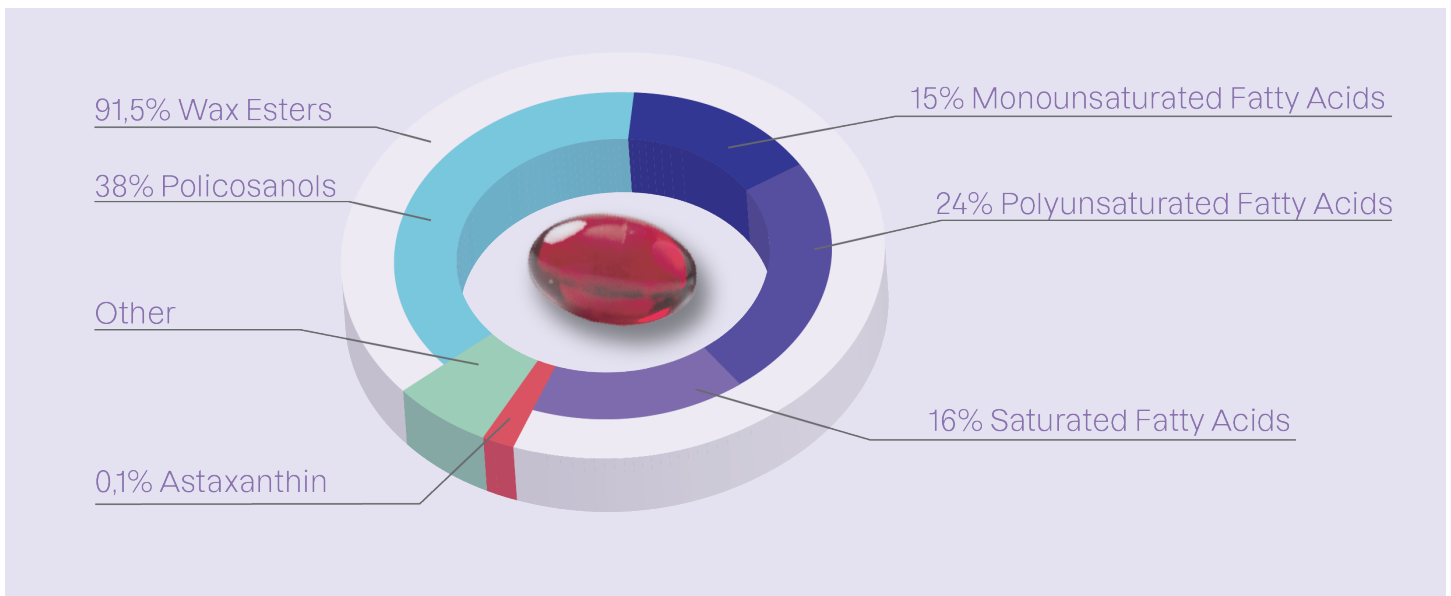


Figure 5: Graphical overview of the diverse composition of Zooca® Calanus® Oil, the way nature intended.

Putting the pieces together the way nature intended

Derived from the marine zooplankton *Calanus finmarchicus*, Zooca Calanus Oil stands out as a unique and potent dietary lipid source. Its distinctive composition includes omega-3 fatty acids, monounsaturated fatty acids, astaxanthin, and policosanols, all delivered in a natural wax ester form (Figure 5). This rich array of bioactive components synergistically provides health benefits, making Zooca Calanus Oil a valuable addition to a well-rounded diet.

Omega-3 fatty acids, such as EPA, DHA, and SDA, promote cardiovascular health, cognitive function, and immune system support while reducing inflammation. MUFAs, including cetoleic acid and gondoic acid, also contribute to cardiovascular and metabolic health and help regulate inflammation. Astaxanthin, a potent antioxidant, offers a variety of benefits, encompassing protection from oxidative stress and support for cardiovascular, skin, eye, immune, joint, and cognitive health. Policosanols, which may have ergogenic effects, can enhance physical performance, fuel utilization and exhibit anti-inflammatory properties.

Moreover, the gradual digestion of wax esters in Zooca Calanus Oil may provide potential benefits for gut microbiota, such as steady nutrient release, fermentation by gut bacteria, modulation of gut inflammation.

The synergistic effects of these components render Zooca Calanus Oil a unique and valuable dietary lipid source. By integrating Zooca Calanus Oil into a balanced diet, individuals can capitalize on the diverse components that support overall health and well-being. As a natural extract with a comprehensive fatty acid composition, Zooca Calanus Oil serves as an exceptional alternative to other marine oil sources, offering a complete nutrient profile that promotes optimal health across various physiological systems.

Zooca Calanus Oil stands out as a unique and potent dietary lipid source.

References

1. Schots, P. C., Pedersen, A. M., Eilertsen, K. E., Olsen, R. L. & Larsen, T. S. (2020). Possible Health Effects of a Wax Ester Rich Marine Oil. *Front Pharmacol*, 11, 961.
2. Ulven, T. & Christiansen, E. (2015) Dietary Fatty Acids and Their Potential for Controlling Metabolic Diseases Through Activation of FFA4/GPR120. *Annu Rev Nutr*, 35, 239-63.
3. Liu, F., Smith, A.D., Solano-Aguilar, G. et al. (2020) Mechanistic insights into the attenuation of intestinal inflammation and modulation of the gut microbiome by Krill oil using in vitro and in vivo models. *Microbiome* 8, 83
4. Gorreta, F., Bernasconi, R., Galliani, G., Salmona, M., Tacconi, M.T. & Bianchi, R. (2002) Wax Esters of n -3 Polyunsaturated Fatty Acids: A New Stable Formulation as a Potential Food Supplement. 1 – Digestion and Absorption in Rats, *LWT - Food Science and Technology*, 35, 5, p458-465
5. Pedersen, A.M., Vang, B. & Olsen, R. L. (2014) Oil from *Calanus finmarchicus*—Composition and Possible Use: A Review, *Journal of Aquatic Food Product Technology*, 23:6, 633-646.
6. Cook, C. M., Larsen, T. S., Derrig, L. D., Kelly, K. M. & Tande, K. S. (2016) Wax Ester Rich Oil From The Marine Crustacean, *Calanus finmarchicus*, is a Bioavailable Source of EPA and DHA for Human Consumption. *Lipids*, 51, 1137-1144.
7. Wasserfurth, P., Nebel, J., Boßlau, T. K., Krüger, K., Hahn, A. & Schuchardt, J. P. (2021) Intake of *Calanus finmarchicus* oil for 12 weeks improves omega-3 index in healthy older subjects engaging in an exercise programme. *Br J Nutr*, 125, 432-439.
8. Burhop, M., Schuchardt, J.P., Nebel, J., Müller, M., Lichtinghagen, R., Hahn, A. (2022) Marine Oil from *C. finmarchicus* Enhances Glucose Homeostasis and Liver Insulin Resistance in Obese Prediabetic Individuals. *Nutrients*, 14, 396
9. Vosskötter, F., Burhop, M., Hahn, A., Schuchardt, J.P. (2023) Equal bioavailability of omega-3 PUFA from *Calanus* oil, fish oil and Krill oil: A 12-week randomized parallel study. *Lipids*.
10. Keys, A., Aravanis, C., Blackburd, H. W., Van Buchem, F. S., Buzina, R. & Djordjevic, B. D. (1966) Epidemiological studies related to coronary heart disease: characteristics of men aged 40-59 in seven countries. *Acta Medica Scandinavica Supplementum*, 460.
11. Yang, ZH., Emma-Okon, B. & Remaley, A.T. (2016) Dietary marine-derived long-chain monounsaturated fatty acids and cardiovascular disease risk: a mini review. *Lipids Health Dis* 15, 201.
12. Yang, Z.H., Miyahara, H., Iwasaki, Y. & Katayama M. (2013) Dietary supplementation with long-chain monounsaturated fatty acids attenuates obesity-related metabolic dysfunction and increases expression of PPAR gamma in adipose tissue in type 2 diabetic KK-Ay mice. *Nutr Metab (Lond)* 10, 16
13. Yang ZH, Amar M, Sorokin AV, Troendle J, Courville AB, Sampson M, Playford MP, Yang S, Stagliano M, Ling C, Donkor K, Shamburek RD, Mehta NN & Remaley AT (2020) Supplementation with saury oil, a fish oil high in omega-11 monounsaturated fatty acids, improves plasma lipids in healthy subjects. *J Clin Lipidol*. 14(1):53-65.e2.
14. Mildenerger, J & Midtbø, L.K (2022) Nutritional Study of Fish Oil in Skin Quality in Healthy Women (OPTIHUDD) *Epax Cetoleic 10 – Rev 10.22*
15. Shen, J., Luo, F. & Lin, Q. (2019). Policosanol: Extraction and biological functions. *Journal of Functional Foods*, 57, 351-360.
16. Weerawatanakorn, M., Meerod, K., Wongwaiwech, D. & Ho, C.-T. (2019) Policosanols: Chemistry, Occurrence, and Health Effects. *Current Pharmacology Reports*, 5, 131-149.
17. Blomstrand, R., and Rumpf, J. A. (1954). The conversion of [1-14C] cetyl alcohol into palmitic acid in the intestinal mucosa of the rat. *Acta Physiol. Scand.* 32, 374–383
18. Hargrove, J. L., Greenspan, P., and Hartle, D. K. (2004). Nutritional significance and metabolism of very long chain fatty alcohols and acids from dietary waxes. *Exp. Biol. Med.* 229, 215–226.
19. Stetten, D., and Schoenheimer, R. (1940). The biological relations of the higher aliphatic alcohols to fatty acids. *J. Biol. Chem.* 133, 347–357.
20. Sharma, R., Matsuzaka, T., Kaushik, M. K., Sugasawa, T., Ohno, H., Wang, Y., Shimano, H. (2019) Octacosanol and policosanol prevent high-fat diet-induced obesity and metabolic disorders by activating brown adipose tissue and improving liver metabolism. *Scientific Reports*, 9, 5169.
21. Brezinova, M., Cajka, T., Oseeva, M., Stepan, M., Dadova, K., Rossmeislova, L., Matous, M., Siklova, M., Rossmeisl, M., & Kuda, O. (2020). Exercise training induces insulin-sensitizing PAHSAs in adipose tissue of elderly women. *Biochimica et Biophysica Acta (BBA) - Molecular and Cell Biology of Lipids*, 1865(2), 158576
22. Yunrui Cao, Lu Yang, Xing Qiao, Changhu Xue & Jie Xu (2021): Dietary astaxanthin: an excellent carotenoid with multiple health benefits, *Critical Reviews in Food Science and Nutrition*
23. Kishimoto, Yoshimi, Hiroshi Yoshida, and Kazuo Kondo. 2016. Potential Anti-Atherosclerotic Properties of Astaxanthin. *Marine Drugs* 14, no. 2: 35
24. Singh, KN, Patil, S & Barkate, H. (2020) Protective effects of astaxanthin on skin: Recent scientific evidence, possible mechanisms, and potential indications. *J Cosmet Dermatol*; 19: 22– 27
25. Giannaccare G, Pellegrini M, Senni C, Bernabei F, Scordia V, Cicero AFG. (2020) Clinical Applications of Astaxanthin in the Treatment of Ocular Diseases: Emerging Insights. *Marine Drugs*; 18(5):239.
26. Grimmig, B., Kim, SH., Nash, K. et al. (2017) Neuroprotective mechanisms of astaxanthin: a potential therapeutic role in preserving cognitive function in age and neurodegeneration. *GeroScience* 39, 19–32



zooca[®]
The Calanus[®] Company 

Calanus AS
Kystens hus
NO-9008 Tromsø, Norway

info@zooca.no | +47 401 99 993
www.zooca.eu