

REVIEW ARTICLE



Dried blood spot-based omega-3 fatty acid status assessment in dogs: The Omega-3 Index concept and its dermatological perspective – Short communication

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ABSTRACT

Long-chain omega-3 fatty acids (ω -3 FAs), particularly eicosapentaenoic acid (EPA, C20:5 ω -3) and docosahexaenoic acid (DHA, C22:6 ω -3), are widely used in canine medicine as nutritional adjuncts in chronic inflammatory and degenerative diseases. Blood-based biomarkers, especially erythrocyte fatty acid composition, provide an integrated measure of long-term ω -3 FA exposure and are less susceptible to short-term dietary fluctuations than plasma indices. Within this framework, the Omega-3 Index (O3I) - the sum of 2 prominent long-chain ω 3 fatty acids (EPA and DHA) in erythrocyte membranes, expressed as a percentage of total erythrocyte FAs - offers a standardised, biologically anchored metric of ω -3 FA status with potential relevance for clinical evaluation and monitoring. Studies in healthy dogs demonstrate low baseline O3I levels, while dietary supplementation with marine-derived ω -3 FAs reliably increases both circulating plasma concentrations and erythrocyte-based indices of ω -3 FA status. In dogs with chronic diseases such as osteoarthritis, cardiac diseases, and selected gastrointestinal disorders, reduced ω -3 FA status is observed and supplementation results in measurable biochemical changes (lower content of triglyceride and total cholesterol, better antioxidant status, reduced production of prostaglandin E2 and interleukin-6). In contrast, comparable erythrocyte-based data are very limited in canine dermatology. Although species-specific reference ranges and outcome-based targets are not yet established, assessment of ω -3 FA status offers a promising tool for monitoring FA supply, guiding supplementation and supporting individualised clinical nutritional management in canine practice.

KEYWORDS

dietary omega-3 fatty acids, eicosapentaenoic acid, docosahexaenoic acid, erythrocyte fatty acids, red blood cell fatty acids, Omega-3 Index

OMEGA-3 FATTY ACIDS IN DOGS

In small animal practice, long-chain omega-3 fatty acids (ω -3 FAs), most notably eicosapentaenoic acid (EPA, C20:5 ω -3) and docosahexaenoic acid (DHA, C22:6 ω -3), are commonly incorporated into nutritional strategies for managing chronic inflammatory and degenerative disorders, including osteoarthritis and canine atopic dermatitis (cAD) (Bauer, 2007, 2011; Vendramini et al., 2025). At the cellular level, the biological relevance of EPA and DHA is well established: these FAs are mostly incorporated into membrane phospholipids, where they influence membrane fluidity, receptor signaling and the synthesis of lipid mediators involved in the regulation and resolution of inflammation (Calder, 2010). A key mechanism underlying their clinical effects is the altered pattern of lipid mediator

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production. When incorporated into cell membranes, EPA and DHA partially replace arachidonic acid (AA, C20:4 ω -6) and give rise to eicosanoids and related lipid mediators that are generally less pro-inflammatory than those derived from ω -6 FAs (James et al., 2000; Calder, 2009). Through this shift in substrate availability and mediator balance, increasing dietary intake of long-chain ω -3 FAs has the potential to modulate inflammatory responses and thereby contribute to the prevention or management of a range of inflammatory conditions (Magalhães et al., 2021; Vendramini et al., 2025). In dogs, endogenous synthesis of long-chain ω -3 FAs from the plant-derived precursor α -linolenic acid (ALA) is extremely limited (Dominguez et al., 2021; Lindqvist et al., 2023). This reflects low activity of the shared desaturation and elongation pathways and is further constrained by competition from linoleic acid (LA, C18:2 ω -6), which is abundant in many canine diets (Bauer, 2011). Consequently, direct dietary sources of marine-derived EPA and DHA (marine fish [salmon, mackerel, herring, anchovy], fish oil, krill oil, microalgae) represent the primary determinants of ω -3 FA status in canine tissues (Bauer, 2007, 2011, 2016; Hall et al., 2006; Dahms et al., 2019).

Despite their widespread clinical use, recommendations for ω -3 FA supplementation in dogs remain largely dose-based and rely on dietary formulation or product labelling rather than on objective assessment of biological demand (Bauer, 2011; Vendramini et al., 2025). Such approaches implicitly assume uniform absorption and tissue incorporation. Both experimental and clinical studies demonstrate substantial inter-individual variability (Hall et al., 2006). Baseline diet composition, physiological state, particularly growth and reproduction (including lactation and pregnancy), gastrointestinal function and concurrent disease may also influence the extent to which supplemented EPA and DHA are absorbed and incorporated into circulating and cellular lipid pools (Brown et al., 2000; Harris et al., 2022). Blood-based assessment of ω -3 FA status, therefore provides a practical means of quantifying biological exposure and evaluating the biochemical response to dietary EPA and DHA supplementation. In dogs, guidance based on the National Research Council (NRC) includes a recommended allowance of $30 \text{ mg} \cdot 0.75 \text{ BW kg} \cdot \text{day}^{-1}$ for combined EPA + DHA, with higher adjunctive amounts suggested for selected disorders, including osteoarthritis ($310 \text{ mg} \cdot 0.75 \text{ BW kg} \cdot \text{day}^{-1}$) and atopy or other immunologic conditions ($125 \text{ mg} \cdot 0.75 \text{ BW kg} \cdot \text{day}^{-1}$), up to a safe upper limit of $370 \text{ mg} \cdot 0.75 \text{ BW kg} \cdot \text{day}^{-1}$. However, clinically validated canine target ranges for ω -3 FA status have not yet been established (Bauer, 2011; Harris et al., 2022).

MONITORING THE OMEGA-3 STATUS IN DOGS

Evaluation of ω -3 FA status in dogs has been based on FA analysis of biological compartments, most commonly plasma, erythrocyte membrane fractions and whole blood-derived matrices. Although these approaches differ in their analytical handling and the time frame of dietary exposure they reflect,

studies using these compartments describe a broadly consistent pattern. Dogs fed conventional commercial diets typically exhibit FA profiles dominated by ω -6 FAs (main FA is LA), with only low proportions of long-chain ω -3 FAs (Hall et al., 2006). This profile appears to be characteristic of habitual canine feeding practices and provides important context for interpreting responses to ω -3 FA supplementation.

Plasma FA analysis has historically been one of the most commonly used approaches for assessing ω -3 FA status in dogs. Because circulating lipid pools turn over rapidly, plasma EPA and DHA concentrations primarily reflect recent dietary intake and are sensitive to factors such as recent meals, fasting status and acute metabolic changes (Hodson et al., 2008). These characteristics make plasma a useful matrix for short-term FA feeding studies and early FA supplementation trials, where rapid biochemical responses are of interest. At the same time, this sensitivity introduces substantial variability, which limits the value of single plasma measurements as indicators of longer-term ω -3 FA status in individual dogs (Stoeckel et al., 2013).

In contrast, erythrocyte membrane FAs provide a more stable measure of ω -3 FA exposure, reflecting longer-term dietary intake with the net effects of absorption and metabolic handling over several weeks (Harris, 2010; Harris et al., 2013; Sala-Vila et al., 2022; Stoeckel et al., 2011). FAs are incorporated into erythrocyte membrane phospholipids during erythropoiesis and are subsequently modified only slowly over an erythrocyte lifespan of approximately 93–103 days in dogs, although breed-related variation has been reported (Garon et al., 2010). As a result, erythrocyte FA composition is less affected by short-term dietary fluctuations or transient metabolic changes (Stoeckel et al., 2011). This approach is comparable to the use of haemoglobin A1c in glucose metabolism, which reflects average glycaemic control over time and is less affected by short-term fluctuations than a single plasma glucose measurement. For this reason, erythrocyte-based metrics are increasingly regarded as the most appropriate biological compartment for assessing habitual ω -3 FA status in dogs. The Omega-3 Index (O3I) is defined as the sum of EPA and DHA expressed as a percentage of total identified FAs in erythrocyte membranes. FAs are quantified after extraction and transesterification and are typically reported as weight percent of total FA methyl esters. The O3I has been adapted to the veterinary medicine (Harris et al., 2022).

Whole blood-based approaches are conceptually related to erythrocyte FA analysis, as erythrocytes account for a substantial proportion of total blood FAs. In practice, whole blood FA measurements are most often implemented through the use of dried blood spot (DBS) sampling. DBS samples contain both plasma and divergent cellular lipid fractions and therefore capture FAs derived from erythrocytes alongside circulating lipids. From a biological perspective, DBS can be regarded as a practical method for erythrocyte-based assessment rather than a fundamentally distinct compartment (Harris et al., 2022). DBS sampling procedure requires only small volumes of blood, it is minimally invasive and dried samples can be stored and transported at ambient temperature without specialised

infrastructure (Gunash et al., 2019). When appropriate species-specific calibration is applied, DBS-derived EPA and DHA values show close agreement with directly measured erythrocyte membrane FA values. This makes DBS particularly attractive for longitudinal monitoring, large-scale studies and routine clinical use, where repeated sampling and logistical simplicity are important considerations (Harris et al., 2022).

Studies reporting erythrocyte-based metrics, including O3I values, indicate that healthy dogs generally have EPA + DHA levels around 1–2% when marine-derived ω -3 sources are not part of the diet (Dominguez et al., 2021; Harris et al., 2022; Lindqvist et al., 2023). These levels are much lower than those usually seen in supplemented human populations and emphasise the limited inclusion of long-chain ω -3 FAs under standard canine feeding conditions (Schuchardt et al., 2024). Dietary intervention studies consistently show that supplementation with marine sources increases circulating and erythrocyte EPA and DHA (Hall et al., 2006; Hall and Jewell, 2012). In contrast, supplementation with ALA-rich plant oils results in little or no increase in long-chain ω -3 FA status, which is consistent with the limited conversion capacity of the canine ω -3 pathway (Dominguez et al., 2021; Lindqvist et al., 2023). These studies emphasise the importance of preformed EPA and DHA for achieving biologically meaningful changes in ω -3 FA status.

THE OMEGA-3 INDEX IN CANINE PATHOLOGIES

Among chronic diseases in dogs, osteoarthritis is the condition in which longitudinal assessment of O3I has been most frequently reported. Osteoarthritis is a complex, progressive and degenerative disorder of synovial joints and it is a major source of chronic pain, reduced mobility and decreased quality of life in dogs (Meeson et al., 2019; Pye et al., 2022). In a recent field study using DBS sampling from whole blood, FA supplementation with approximately 70 mg EPA + DHA/kg BW*day⁻¹ for 16 weeks increased the O3I from around 1.4% at baseline to 3.3% at study end, alongside improvements in owner-reported pain and, in smaller dogs, quality-of-life scores (Carlisle et al., 2024). In a randomised, double-blind, placebo-controlled osteoarthritis trial with repeated DBS sampling from whole blood, baseline ω -3 FA values were low and shifted markedly after supplementation with ω -3 oil (average dose of 69 mg EPA + DHA/kg BW/day): median EPA increased from 0.2 to 2.7% and DHA from 0.64 to 2.13%, while AA declined from 22.4 to 18.5% over 84 days. Reported AA/(EPA + DHA) ratio decreased from 28.31 to 3.48, and these biochemical changes coincided with significant improvements in clinician-scored lameness, discomfort and joint severity compared with placebo (Mehler et al., 2016). In canine dermatology, mainly in cAD, a substantial body of clinical literature supports the use of ω -3 FAs as adjuvant treatment (Eisenschenk, 2025) however, biomarker-based documentation of ω -3 FA status remains

limited compared with osteoarthritis. CAD is a chronic inflammatory skin disease associated with genetic and environmental factors, barrier dysfunction and immune dysregulation (Marsella, 2021; Banovic, 2025). Most dermatological trials focus on clinical outcomes (Saevik et al., 2004; Mueller et al., 2004) and, where available, plasma FA changes, rather O3I-values [e.g. pruritic dogs: (Nesbitt et al., 2003)]. In a skin and coat model where erythrocyte membranes were analysed, supplementation with approximately 20.4 mg/kg BW*day⁻¹ combined EPA and DHA for 90 days resulted in a well-defined temporal pattern. Erythrocyte EPA and DHA levels (expressed in $\mu\text{g} \cdot 100 \text{ mg}^{-1}$ erythrocytes) increased significantly. By day 60, median EPA increased from 2.22 to 4.35, while DHA rose from 1.1 to 2.85 and the AA/(EPA + DHA) ratio decreased from 19.49 to 8.95. Clinical scores improved most prominently between days 60 and 90. Following withdrawal of supplementation, both clinical parameters and erythrocyte ω -3 FA levels gradually returned toward baseline (Combarros et al., 2020). These findings indicate that erythrocyte membranes capture biologically meaningful ω -3 FA exposure in skin-relevant contexts and support the potential application of DBS-based measurements.

CONCLUSION

Dogs receiving similar nominal doses of fish oil often show markedly different changes in blood EPA and DHA, reflecting differences in diet, metabolism and concurrent diseases. Measurement of ω -3 FA status therefore helps distinguish between inadequate treatment response and insufficient biological supply and can support rational adjustment of dose of the FA supplementation.

In the multimodal management of chronic diseases, including osteoarthritis and cAD, documenting changes in ω -3 FA status provides objective confirmation that a nutritional intervention has achieved its intended biochemical effect. Evidence from osteoarthritis studies illustrates how erythrocyte-based measurements can serve as a blood marker alongside clinical outcomes, a role that remains largely unexplored in canine dermatology. Such an approach may be particularly valuable in conditions where clinical improvement is gradual or influenced by concurrent therapies. Beyond disease management, ω -3 FA status testing can support nutritional counselling and preventive care, especially in dogs fed home-prepared or unconventional diets with limited marine-derived ω -3 FAs.

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