

# Antarctic Krill Oil and Skeletal-Muscle Function: Human Evidence for Strength and Recovery

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## ABSTRACT

**Objective:** Krill oil supplies EPA and DHA in a phospholipid-rich matrix and has been studied in skeletal-muscle ageing and recovery from exercise. **Method:** We characterized optimized BCLC® Antarctic krill oil batches and examined randomized human studies reporting muscle outcomes. **Results:** EPA was 7.7–7.9%, DHA 3.8–4.0%, and total phospholipids 41.8–42.3%. In a 6-month trial of adults older than 65 years, 4 g/day krill oil increased knee-extensor torque, grip strength, and vastus lateralis thickness relative to control. A resistance-exercise study reported lower creatine kinase and faster recovery in several performance and oxidative-stress measures. A separate trial found no improvement in exercise performance despite differences in post-exercise immune responses. In an 8-week weight-loss intervention reported in 2025, krill oil attenuated losses of fat-free mass and handgrip strength. Population, exposure time, and the selected endpoint differed across the trials. **Novelty:** The reported measures provide practical outcomes for a formulation-specific study.

## INTRODUCTION

Ageing, prolonged inactivity, energy restriction, and demanding exercise can all challenge skeletal-muscle function, but they do not act through the same pathway. Changes in strength may reflect muscle size, neuromuscular activation, recovery from tissue stress, or the capacity to respond to anabolic stimuli. Long-chain omega-3 fatty acids have therefore been studied in several muscle settings rather than against a single outcome. In older adults, controlled trials have examined muscle-protein synthesis, muscle mass and function, and the response to strength training [1], [2], [3].

The clinical record is not uniform. A meta-analysis in older adults found that effects differed across muscle mass, strength and performance measures [4], while work on exercise-induced muscle damage has emphasized the timing of recovery assessments and the diversity of training protocols [5]. Reviews of human skeletal-muscle research likewise point to dose, treatment duration, baseline status and population as sources of variation [6]. These distinctions matter when a supplement is evaluated for muscle health, because preservation during weight loss, adaptation in later life and recovery after exercise are related but not interchangeable endpoints.

Krill oil adds a formulation variable to this literature. Its EPA and DHA are delivered in a phospholipid-rich lipid matrix rather than in the same structural distribution used in every fish-oil product. Reviews comparing krill and fish oils have

discussed this difference [7], and human studies have measured incorporation of EPA and DHA into plasma phospholipids after different omega-3 formulations [8]. A later 12-week comparison reported comparable overall omega-3 bioavailability among krill, fish and Calanus oils under the conditions studied [9]. These exposure studies do not predict a muscle response on their own, but they provide a reason to measure achieved omega-3 status alongside functional outcomes.

Krill-oil trials that directly measured muscle-related outcomes have been conducted in markedly different settings. In adults older than 65 years, six months of supplementation was associated with higher knee-extensor torque, grip strength and vastus lateralis thickness relative to control [10]. A resistance-exercise study in trained young men focused on creatine kinase and short-term recovery [11], whereas another trial found no improvement in cycling performance despite changes in selected post-exercise immune measures [12]. More recently, krill oil was studied during alternate-day fasting, where preservation of fat-free mass and handgrip strength was the relevant question rather than muscle gain [13]. A network meta-analysis of omega-3 interventions in sarcopenia further illustrates how conclusions depend on the outcome and population being considered [14].

For a formulation-specific study, exposure quality is therefore part of the experimental design. Krill-oil supplementation has been shown to raise the Omega-3 Index and plasma choline in trained adults [15], providing examples of biochemical measures that can sit beside direct tests of strength or recovery. The optimized BCLC® Antarctic krill oil batches used here contained 7.7–7.9% EPA, 3.8–4.0% DHA and 41.8–42.3% total phospholipids, with low peroxide values. We characterized that batch profile and then compared it with randomized human evidence on strength, muscle size, exercise recovery and preservation of fat-free mass, while keeping formulation measurements and clinical outcomes as separate levels of evidence.

**Table 1.** Formulation-performance profile of optimized and comparator Antarctic krill oil preparations.

| Preparation        | Yield % | Phospholipid % | EPA % | DHA % | PV meq/kg | Insolubles % |
|--------------------|---------|----------------|-------|-------|-----------|--------------|
| Optimized 1        | 8.6     | 42.1           | 7.8   | 3.9   | 2.6       | 0.31         |
| Optimized 2        | 8.5     | 41.8           | 7.7   | 3.8   | 2.7       | 0.33         |
| Optimized 3        | 8.4     | 42.3           | 7.9   | 4.0   | 2.5       | 0.30         |
| Single 75% ethanol | 7.8     | 38.7           | 6.9   | 3.4   | 3.4       | 0.68         |
| Single 90% ethanol | 8.0     | 39.2           | 7.0   | 3.5   | 3.2       | 0.60         |
| No 8°C standing    | 8.5     | 41.6           | 7.7   | 3.8   | 2.8       | 0.52         |

## RESEARCH METHOD

### Lipid-composition framework

Three optimized batches were analyzed for yield, total phospholipids, EPA, DHA, and peroxide value. Oils made with a single ethanol concentration served as compositional comparators. These measurements defined the lipid matrix. Muscle outcomes came from the human studies rather than from the production-batch experiment.

### Human evidence synthesis

Randomized human studies were included if they measured strength, muscle thickness, exercise-induced muscle damage, functional performance, post-exercise immune responses, or preservation of fat-free mass. Chronic supplementation in older adults was considered separately from short exercise-recovery protocols and diet-induced weight-loss studies.

**Table 2.** Selected randomized human evidence on krill oil and skeletal-muscle outcomes.

| Study                    | Population/design                                                        | Intervention                                        | Muscle/performance observation                                                                                                                                                                             |
|--------------------------|--------------------------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Alkhedhairi et al., 2022 | 102 adults >65 y; double-blind RCT; 94 completed                         | 4 g/day krill oil for 6 months                      | Treatment effects: knee-extensor torque +9.3%, grip strength +10.9%, vastus lateralis thickness +3.5% vs control. Lower CK at 24/48 h and faster recovery in several performance/oxidative-stress indices. |
| Yang et al., 2023        | 30 resistance-trained college men; randomized                            | 3 g/day krill oil around a resistance-exercise bout | Exercise performance unchanged; post-exercise PBMC IL-2 and NK-cell cytotoxicity increased at 3 h.                                                                                                         |
| Da Boit et al., 2015     | 37 healthy young adults; randomized placebo-controlled                   | 2 g/day krill oil for 6 weeks                       | Attenuated decline in fat-free mass and handgrip strength compared with placebo.                                                                                                                           |
| Alblaji et al., 2025     | 41 adults with overweight/obesity completing alternate-day fasting trial | 4 capsules/day krill oil during 8-week weight loss  |                                                                                                                                                                                                            |

## RESULTS AND DISCUSSION

### Results

#### Reproducible EPA/DHA composition

Across the three optimized batches, EPA ranged from 7.7% to 7.9%, DHA from 3.8% to 4.0%, and total phospholipids from 41.8% to 42.3%. Single 75% and 90% ethanol extraction yielded 6.9–7.0% EPA, 3.4–3.5% DHA, and 38.7–39.2% total phospholipids. The optimized oils consequently provide a narrowly defined composition for later muscle studies.

#### Strength and muscle-size evidence in older adults

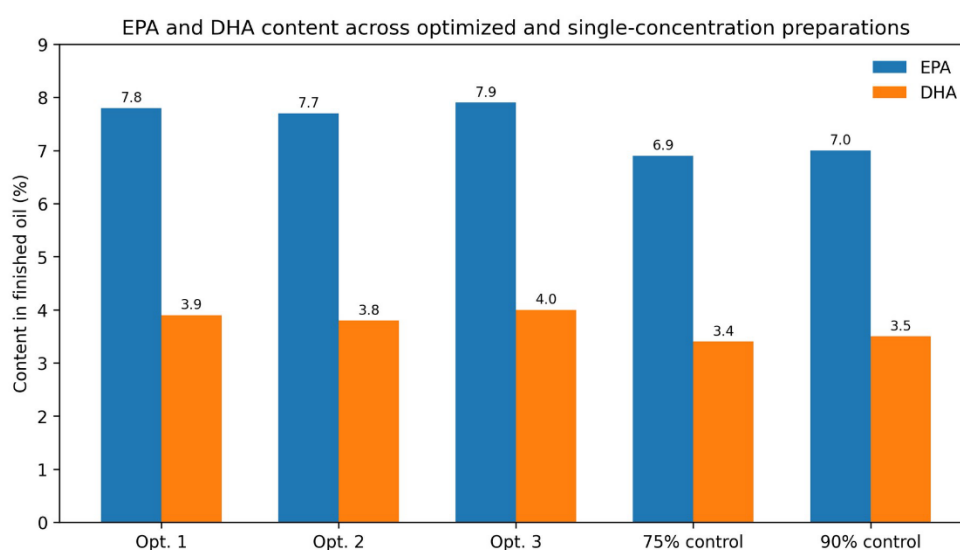
Alkhedhairi et al. randomized 102 adults older than 65 years to 4 g/day krill oil or control for 6 months. Relative to control, knee-extensor maximal torque increased by 9.3%, grip strength by 10.9%, and vastus lateralis thickness by 3.5%. Erythrocyte EPA, DHA, and Omega-3 Index increased as well [10].

#### Exercise recovery and performance context

Yang et al. assigned 30 resistance-trained young men to 3 g/day krill oil or control around a muscle-damaging exercise bout. Creatine kinase was lower at 24 and 48 h; several measures of isokinetic strength, agility, and antioxidant recovery also favored krill oil [11]. Da Boit et al. tested 2 g/day for 6 weeks. Cycling performance was unchanged, although IL-2 production and NK-cell cytotoxic activity were higher 3 h after exercise [12]. The recovery, immune, and performance measures did not respond uniformly.

#### Muscle preservation during weight loss

A randomized study reported in 2025 examined adults following alternate-day fasting. Of the 41 participants who completed the 8-week intervention, those receiving krill oil had smaller losses of fat-free mass and handgrip strength than those receiving vegetable-oil placebo [13].



**Figure 1.** EPA and DHA content across optimized BCLC® batches and single-concentration extraction controls.

## Discussion

EPA, DHA, and total phospholipids changed little across the optimized production batches. When a fixed daily oil dose is used, this batch consistency reduces one source of variation in biological exposure. Low peroxide values were also retained, limiting variation related to oxidative deterioration.

The human evidence came from three distinct settings. Adults older than 65 years gained strength and muscle thickness over 6 months while erythrocyte EPA and DHA increased [10]. Shorter exercise studies produced a less uniform pattern: several recovery measures changed, but cycling performance did not [11], [12]. The weight-loss trial measured preservation, not muscle gain [13]. Larger omega-3 syntheses likewise report differences by outcome and study design [4], [14]. Duration, training status, and endpoint selection remain central to interpretation.

Phospholipid-associated EPA and DHA can change membrane fatty-acid composition, inflammatory signaling, and the muscle response to anabolic stimuli [1], [2], [6]. Krill phospholipids also carry choline species relevant to neuromuscular physiology [15], [7]–[9]. In the available clinical reports, clearer muscle changes appeared after longer exposure or during an age- or energy-related challenge rather than in every exercise-performance test.

## Current Scope and Future Directions

A dose-defined BCLC® trial could record erythrocyte Omega-3 Index alongside muscle strength, appendicular lean mass, muscle thickness, and functional tests. Exercise protocols could add recovery biomarkers. Age, baseline omega-3 status, training level, and energy balance should be specified before analysis so that response differences can be examined directly.

## CONCLUSION

**Fundamental Finding :** BCLC® Antarctic krill oil had a reproducible phospholipid-rich EPA/DHA profile across optimized batches. Randomized studies reported higher strength and muscle thickness in older adults, changes in recovery markers after resistance exercise, and better preservation of fat-free mass during weight loss. **Implication :** Measuring achieved omega-3 exposure together with direct muscle outcomes can show which populations respond most consistently. **Limitation :** Other performance outcomes were unchanged, indicating that the observed benefits were not consistent across all performance measures. **Future Research :** Measuring achieved omega-3 exposure together with direct muscle outcomes can show which populations respond most consistently.

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