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Review Article

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Effects of Chondrus Crispus Marine Algae Supplementation on Vo2Max and Aerobic Performance in Healthy Adults

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Abstract

Background: Marine algae-derived bioactive compounds have emerged as potential ergogenic agents capable of modulating oxidative metabolism and aerobic performance.

Objective: To investigate the effects of *Chondrus crispus* marine algae supplementation on VO_2max, exercise tolerance, and metabolic responses in healthy adults.

Methods: Fifty-seven healthy adults participated in a randomized, double-blind, placebo-controlled clinical trial for 30 days. Participants were allocated into three groups: *Chondrus crispus* marine algae 500 mg/day, 250 mg/day, or placebo. Assessments included VO_2max, respiratory quotient (RQ), indirect calorimetry, 6-minute stepper test (6MST), and fatigue perception.

Results: The 500 mg/day group demonstrated significant improvement in VO_2max (+1.54 ml/kg.min^{-1}; $p<0.01$), greater increases in exercise performance, and reduced fatigue perception compared with placebo.

Conclusion: *Chondrus crispus* marine algae supplementation demonstrated favorable effects on aerobic performance and oxidative metabolism.

Introduction

VO_2max is one of the most important physiological markers of aerobic fitness and mitochondrial oxidative efficiency. Nutritional interventions capable of enhancing oxidative metabolism have gained increasing relevance in exercise physiology and sports nutrition.

Chondrus crispus, a red marine algae rich in bioactive compounds associated with nitric oxide metabolism and mitochondrial function, has emerged as a promising nutritional strategy for improving aerobic performance and exercise tolerance.

The aim of the present study was to evaluate the effects of *Chondrus crispus* marine algae supplementation on VO_2max, exercise tolerance, and metabolic responses in healthy adults.

Methods

A randomized, double-blind, placebo-controlled clinical trial was conducted over 30 days. Participants were allocated into three groups receiving either 500 mg/day of *Chondrus crispus* marine algae, 250 mg/day, or placebo. The study included 57 healthy adults of both sexes. VO_2max was assessed using incremental cardiopulmonary exercise testing with breath-by-breath gas

analysis. Indirect calorimetry was performed to evaluate resting oxygen consumption, respiratory quotient, minute ventilation, and basal metabolic rate.

Exercise tolerance was evaluated through the 6-minute stepper test (6MST), while perceived exertion and fatigue were assessed using Borg scales and the Multidimensional Fatigue Symptom Inventory Short-Form (MFSI-SF).

Statistical analysis was performed using mixed-effects repeated-measures models with significance established at $p<0.05$ [1-15].

Results

Baseline Characteristics

A total of 57 healthy adults completed the study protocol and were allocated into three experimental groups: *Chondrus crispus* marine algae 500 mg/day (n=20), *Chondrus crispus* marine algae 250 mg/day (n=20), and placebo (n=17).

At baseline, no statistically significant differences were observed among groups regarding age, sex distribution, body mass index (BMI), or baseline aerobic performance parameters, demonstrating adequate homogeneity of the study population and minimizing potential confounding factors related to metabolic variability.

Participants presented mean BMI values ranging from 27.3 to 28.6 kg/m², characterizing an adult population with preserved metabolic stability and functional capacity.

VO_2max

VO_2max was established as the primary endpoint of the study due to its recognized role as a robust physiological marker of aerobic conditioning, mitochondrial oxidative capacity, and oxygen utilization efficiency.

Following the 30-day intervention, participants receiving *Chondrus crispus* marine algae at 500 mg/day demonstrated a significant increase in VO_2max, rising from 33.68 to 35.22 $ml \cdot kg^{-1} \cdot min^{-1}$, corresponding to a mean improvement of +1.54 $ml \cdot kg^{-1} \cdot min^{-1}$ ($p<0.01$).

Conversely, the 250 mg/day group demonstrated minimal variation, while the placebo group exhibited a slight numerical reduction in VO_2max over time.

Although intergroup comparisons did not achieve formal statistical significance, a clear numerical superiority pattern was observed in the 500 mg/day group when compared with placebo, suggesting biologically relevant improvements in aerobic metabolism and exercise adaptation.

From a physiological perspective, the increase in VO_2max may reflect enhanced oxygen extraction, improved mitochondrial ATP production, and greater oxidative phosphorylation efficiency during exercise (Figure 1).

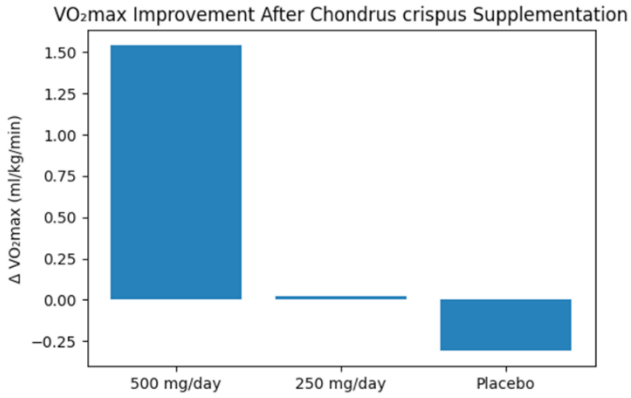

Figure 1: VO_2max improvement after *Chondrus crispus* supplementation.

Respiratory Quotient (RQ)

Respiratory quotient values were evaluated to investigate substrate oxidation and metabolic flexibility during resting conditions.

The group supplemented with *Chondrus crispus* marine algae at 250 mg/day demonstrated a statistically significant increase in RQ after supplementation, increasing from 0.839 to 0.858 ($p=0.016$) (Figure 2).

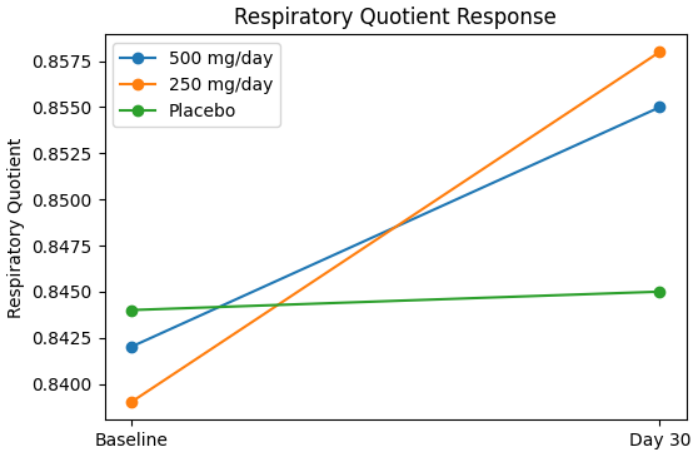

Figure 2: Respiratory quotient response during intervention.

A similar upward trend was also identified in the 500 mg/day group, although without reaching statistical significance.

These findings suggest enhanced carbohydrate utilization and improved metabolic responsiveness following supplementation, potentially reflecting greater metabolic flexibility and energetic adaptation.

Importantly, placebo participants demonstrated virtually unchanged RQ values throughout the study period.

Resting Metabolic Parameters

Resting oxygen consumption (VO_2), minute ventilation (VE), and basal metabolic rate (BMR) remained physiologically stable in all experimental groups throughout the intervention.

No significant intra- or intergroup differences were observed for these variables.

The stability of resting metabolic parameters suggests that the physiological effects associated with *Chondrus crispussupplementation* occur predominantly under increased energetic demand conditions rather than through substantial alterations in basal metabolism.

Functional Exercise Performance

Exercise tolerance and cardiorespiratory endurance were assessed through the 6-minute stepper test (6MST).

All groups demonstrated improvements in total step count after the intervention period. However, the magnitude of improvement was consistently greater in participants receiving *Chondrus crispus* supplementation.

The 500 mg/day group demonstrated the highest increase in performance, with a mean improvement of +49.9 steps ($p<0.0001$), while the 250 mg/day group demonstrated an increase of +41.6 steps ($p<0.0001$). In comparison, placebo participants exhibited a smaller increase of +33.4 steps ($p=0.001$).

The progressive superiority pattern observed across supplemented groups strongly suggests enhanced exercise adaptation, improved cardiorespiratory efficiency, and greater tolerance to physical exertion (Figure 3).

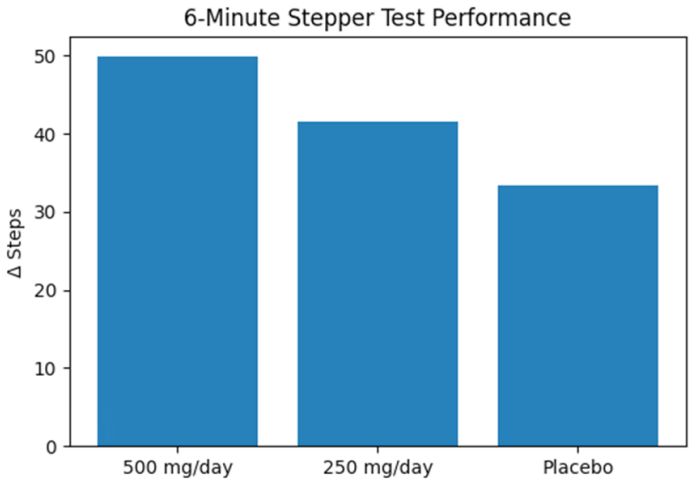

Figure 3: 6-minute stepper test performance after supplementation.

Dyspnea and Fatigue Perception

Subjective dyspnea perception assessed using the Borg scale demonstrated a reduction tendency in the 500 mg/day supplementation group, approaching statistical significance ($p=0.059$).

Participants receiving *Chondrus crispus* supplementation also demonstrated lower perceived fatigue scores following exercise when compared with baseline values.

Additionally, multidimensional fatigue assessment using the MFSI-SF revealed a significant reduction in fatigue perception in the 500 mg/day group.

These findings reinforce the hypothesis that marine algae-derived bioactive compounds may contribute not only to improved aerobic metabolism but also to enhanced exercise recovery and fatigue resistance (Figure 4).

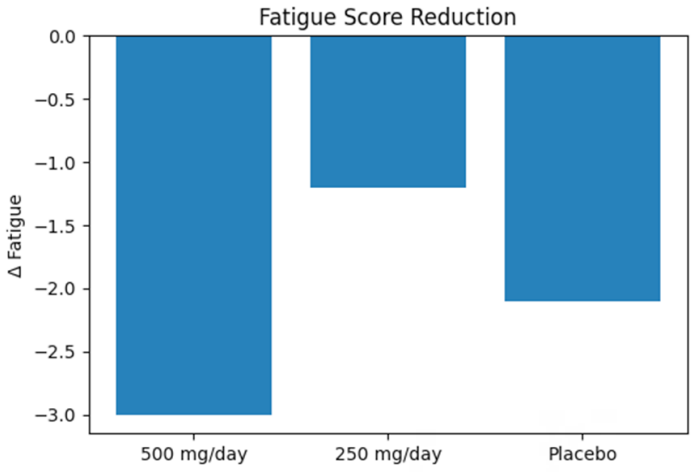

Figure 4: Fatigue score reduction after supplementation.

Discussion

The present study demonstrated that supplementation with *Chondrus crispus* marine algae promoted significant improvements in VO_2max, exercise tolerance, and fatigue perception in healthy adults, particularly at the dosage of 500 mg/day.

VO_2max represents one of the most important physiological markers of aerobic conditioning and mitochondrial oxidative function. Therefore, the increase observed after supplementation suggests improved oxygen transport, mitochondrial ATP synthesis, and oxidative phosphorylation efficiency.

The improvement in aerobic performance observed in the supplemented groups may be associated with bioactive compounds naturally present in *Chondrus crispus*, including citrulline, arginine, and citrulline-arginine related molecules. These compounds may contribute to nitric oxide production, improved endothelial responsiveness, enhanced peripheral perfusion, and greater muscular oxygen delivery during exercise.

From a metabolic standpoint, the increase in respiratory quotient observed after supplementation suggests modulation of substrate utilization and improved metabolic flexibility. Enhanced carbohydrate oxidation during exercise may reflect improved energetic turnover and greater metabolic responsiveness under physical stress conditions.

Importantly, resting metabolic parameters remained stable throughout the intervention. This finding suggests that the observed physiological effects are likely exercise-dependent and associated with enhanced metabolic efficiency during increased energetic demand rather than alterations in basal metabolic activity.

The superior improvements observed in the 6-minute stepper test reinforce the potential ergogenic effects associated with *Chondrus crispus* supplementation. Enhanced cardiorespiratory adaptation and improved exercise tolerance may have contributed directly to the increase in physical performance and reduction in perceived fatigue.

Another clinically relevant finding was the reduction in subjective fatigue perception and dyspnea scores. Fatigue is a multifactorial physiological phenomenon closely associated with mitochondrial bioenergetics, substrate availability, oxidative stress, and neuromuscular efficiency. Therefore, the observed reductions in fatigue perception may indicate improved recovery capacity and enhanced physiological adaptation to exercise.

Although some intergroup comparisons did not achieve statistical significance, likely due to sample size limitations and the relatively short intervention period, the magnitude and consistency of the physiological responses observed strongly support the biological relevance of the findings.

Collectively, these results suggest that *Chondrus crispus* marine algae supplementation may represent a promising nutritional strategy for improving aerobic performance, mitochondrial efficiency, and exercise tolerance in healthy individuals.

Future investigations involving larger populations, longer supplementation periods, and direct mitochondrial biomarkers are warranted to further elucidate the mechanisms underlying these physiological adaptations.

Conclusion

Chondrus crispus marine algae supplementation improved VO_2max, exercise tolerance, and fatigue perception in healthy adults. These findings support the potential role of marine algae-derived compounds as nutritional strategies for improving aerobic performance and oxidative metabolism.

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