

Carnipure™ Focus

Exercise and Recovery

Lonza

Introduction

Sports nutritionals have gained wide acceptance as an essential component of any committed athletic lifestyle. Additionally, increasing numbers of consumers who aren't necessarily health club devotees are also turning to sports nutrition products, often in lieu of traditional beverages and snacks. This represents a significant opportunity for food and drinks marketers to take advantage of a fast-growing category trend.

The ingredients of those sports nutritionals, however, have to be chosen with efficacy, quality and safety in mind. There is evidence for a beneficial effect of Carnipure™ supplementation in sports nutrition regarding optimization of performance, delaying the onset of fatigue and improving recovery from strenuous exercise both in bodybuilders, athletes and in untrained people. Carnipure™ can thus be considered to be a winning ingredient, helping functional food and supplement manufacturers to capitalize on a healthy, growing market.

What is Carnipure™?

Carnipure™ is high quality L-Carnitine manufactured by the Swiss life-science company Lonza. L-Carnitine is a nutrient that plays an important role in energy metabolism. The proprietary Carnipure™ production process was invented by Lonza scientists in Switzerland. It directly produces the L-isomer of Carnitine, the beneficial form found in nature. Products displaying the Carnipure™ quality seal on the packaging show the consumer that they contain pure L-Carnitine from Lonza.



Carnipure™ offers purest L-Carnitine and is a trademark of Lonza Ltd, Switzerland.

What is L-Carnitine?

L-Carnitine, the biologically effective isomer of carnitine, is found ubiquitously in mammalian tissues and plays a key role within several cellular energy producing pathways¹⁻³. By way of example, L-Carnitine acts as a transport vehicle shuttling long chain fatty acids across the inner mitochondrial membrane. Once inside the mitochondria, L-Carnitine releases these fatty acids and they are broken down through a process called beta-oxidation for the production of ATP or energy. L-Carnitine is also important for the removal of potentially toxic acyl-CoAs from the mitochondria by forming acyl-L-Carnitines and serves as a temporal acetyl group buffer in the oxidation of carbohydrates during periods of augmented pathway flux. Not surprisingly, given its key role within carbohydrate and particularly fat metabolism, the functional role of L-Carnitine has been the subject of great scientific interest to date.



L-Carnitine metabolism during exercise

According to a recent report on the Sport nutrition market, people are purchasing more sports nutrition products than ever before, either in form of drinks and bars or as dietary supplements⁴. Not only for athletes sports nutritionals are a substitute from other snacks, drinks and energy providing products. This also has consequences on the normal diet: athletes wishing to consume a carbohydrate-rich diet often omit meat, which is the most reliable dietary source of L-Carnitine.

Thus they do not get sufficient L-Carnitine with the diet. Researchers observed that triathletes on a predominantly vegetarian diet had the lowest plasma levels of L-Carnitine. Supplementation with L-Carnitine for 6 weeks increased free L-Carnitine from 10 $\mu\text{mol/L}$ to 85 $\mu\text{mol/L}$ ⁵. This considerable increase also improved the ratio of free L-Carnitine to acetylated L-Carnitine, which is an indicator of the supply of functionally active L-Carnitine.

High performance athletes such as triathletes have been shown to have lower than normal plasma levels of L-Carnitine even when following an omnivorous diet⁵, as they have a higher excretion of esterified L-Carnitine via the kidneys⁶ and via perspiration^{7,8}. This loss may be followed by a decrease of L-Carnitine in the active muscles which may not always be rapidly replenished by the normal processes, thus Carnipure™ supplementation may be warranted⁹.

It has been demonstrated that with increasing exercise intensities, the concentration of acyl-L-Carnitine within the muscle is increased and the availability of free L-Carnitine is decreased¹⁰⁻¹². Decreased availability of free L-Carnitine in the mitochondria means decreased capacity of all energy generating pathways. Supplementation with L-Carnitine can increase the amount of free L-Carnitine inside the mitochondria and thus ensure energy generating processes to continue¹³.

Optimizing performance with Carnipure™

Although it has been known for many years that long-chain fatty acids are important sources of energy in the contracting muscle especially in endurance exercise, the mechanisms controlling fatty acid uptake and oxidation during the exercise are still not completely elucidated¹⁴⁻¹⁶.

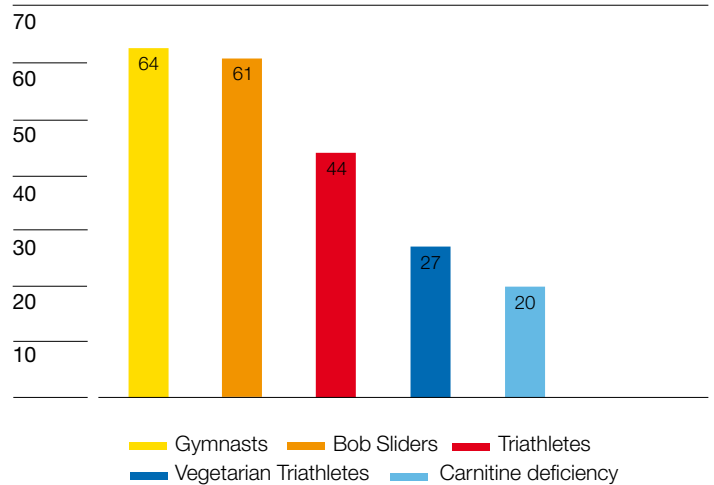
Studies in athletes have shown that Carnipure™ supplementation aids in exercise performance¹⁷. $VO_2\text{max}$ is the maximum amount of oxygen that an individual can utilize during exercise in a set period of time and often used as a predictor of potential in endurance sports¹⁸. The positive effect of L-Carnitine supplementation on $VO_2\text{max}$ has been subject of many research studies involving athletes of various disciplines such as top rowers¹⁹, marathon runners²⁰, competitive long distance walkers²¹ and trained cyclists^{22, 23}.

Both an increase in maximal oxygen consumption and a lowering of the respiratory quotient indicate that L-Carnitine has the potential to stimulate lipid metabolism²⁴. In humans it was shown that fat oxidation and muscle L-Carnitine concentration were tightly coupled during incremental exercise¹⁵. In healthy adults, Carnipure™ supplementation has been shown to stimulate *in vivo* long chain fatty acid metabolism even without exercise training^{25, 26} and in exercise trained rats L-Carnitine supplementation also was found to change the flux of substrates through the Krebs cycle, increasing the oxidation of fatty acids and decreasing that of glucose²⁷⁻²⁹.

Any “sparing” of glucose, however, can be regarded as highly beneficial since carbohydrate stores in the body can be exhausted following 1-2h of intense exercise, assuming that the ultimate goal of prolonged exercise is to maintain glycogen stores as long as possible³⁰.

It has been shown that gene expression of the enzyme CPT1 (Carnitine palmitoyltransferase 1) can be increased both by Carnipure™ supplementation and endurance exercise training³¹⁻³³.

Figure 1: Average plasma L-Carnitine levels of athletes of various disciplines. Triathletes and especially vegetarian triathletes have very low L-Carnitine plasma levels⁵.



Delaying the onset of fatigue with Carnipure™

Fatigue during exercise is undesirable as it ultimately compromises performance. It can have a central origin, by reducing cognitive performance or lowering excitation of motoneurons³⁴. Various mediators are in question (serotonin, moduline, dopamine). On the metabolic level, the most-often evoked changes are reduced pH and increased intracellular lactate level. However, that “lactic acid hypothesis” has been seriously challenged in recent years^{35, 36}. During endurance activities, the limiting factors are glycogen reserves and levels of oxidative enzymes.

Intense activities that demand a high output of energy in a short time frame, such as sprinting, quickly deplete glycogen stores³⁷. If the use of fat as an energy source can be increased during exercise, this may spare muscle glycogen, thereby delaying the onset of fatigue. Again, there is research to indicate that L-Carnitine may be beneficial in this respect²⁰. In endurance trained athletes, L-Carnitine supplementation (2 g/day for 28 days) led to a significant reduction in Respiratory Quotient (RQ) during a 45 minute cycling exercise, as compared to placebo. This decrease in RQ indicates a glycogen sparing effect and ultimately, should be associated with improved performance³⁸.

A consequence of high-intensity training is hypoxia, which increases the concentration of ammonia in blood¹⁷. Additionally superimposed heat stress is postulated to augment systemic ammonia response³⁹. Ammonia accumulation has been associated with fatigue. Carnipure™ tartrate supplementation in male cyclists has been found to decrease ammonia levels in a well-controlled study⁴⁰. As there has not been any change in amino acid metabolism, this effect may be explained by reduced AMP deamination.

Improving recovery processes with Carnipure™

Exercise places oxidative stress on the body derived from two different stimuli⁴¹⁻⁴³. First, the mechanical forces associated with exercise cause cellular structural damage, and subsequently, chemical responses related to muscle damage and the muscle repair process cause tissue alterations that can be observed for up to ten days post-exercise⁴⁴. This sensation of discomfort or pain in the skeletal muscles frequently occurs following unaccustomed muscle exertion and is commonly referred to as DOMS (Delayed Onset Muscle Soreness).

The findings by researchers at the University of Connecticut, USA, however, have opened new avenues with regard to a role for Carnipure™ apart from its classical muscle energetic function: Using a balanced, placebo-controlled, cross-over design, ten healthy active men volunteered taking either a placebo or a Carnipure™ tartrate supplement (equivalent to 2 g L-Carnitine/day) for 3 weeks prior to the performance of a controlled exercise session⁴⁵. The study results indicated that supplementing with Carnipure™ tartrate prior to high intensity exercise can attenuate the biochemical and structural stress responses to high-intensity squat exercise and is significantly effective in assisting recovery. More specifically, Carnipure™ supplementation allows for decreased production of free radicals, less tissue damage, reduced muscle soreness and better utilization of fat as an energy source during recovery.

Potentially, Carnipure™ may improve blood flow during and following exercise, and optimize the signals supporting tissue repair processes⁴⁴. A speedy and less painful recovery is important for all people who exercise, whether professionally or recreationally, as recovery affects how quickly a person can return to exercising optimally. These results are in line with previous findings^{46, 47}, and have important practical applications for athletes, as performance after damaging exercise bouts is primarily affected by strength loss and pain.

Most interestingly, latest research shows that this amelioration of post-exercise metabolism increases in response to the daily dosage of Carnipure™ tartrate, however that it is already statistically significant at a dosage of 1 g L-Carnitine/day⁴⁸.



Carnipure™ and immune function in athletes

While moderate training has an immune-stabilizing or even immune-stimulatory effect, acute bouts of prolonged, strenuous exercise are often associated with immune suppression and an increased risk of infection⁴⁹⁻⁵¹. Although high performance athletes cannot be described as immuno-deficient, there is evidence that several parameters of the immune system are suppressed after intense physical exercise. Supplementation with Carnipure™ may thus be especially helpful for professional athletes with this respect⁵².

And so to conclude

The physiological function of L-Carnitine in facilitating the production of energy from fat is crucial during exercise, especially endurance exercise, because fat is one of the main fuels used to provide energy for physical activity. An increasing body of scientific evidence illustrates the favorable effects of Carnipure™ for athletes and recreationally physically active people with regard to optimizing performance, delaying the onset of fatigue and improving the recovery process. The growing interest in Carnipure™ can be attributed to a number of factors including its basic function in helping convert fat into energy, its efficacy, its excellent safety profile and, of course, its suitability for processing.

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Note: This document is an overview of published scientific information on L-Carnitine and published scientific information on clinical and nutritional trials with L-Carnitine and its derivatives. No claims are made herein for any particular consumer product, nor can these statements be used on such consumer products.

The recommended use for L-Carnitine is as a nutrient or dietary supplement. The statements in this document have not been evaluated by any Food and Drug Administration. Lonza's Carnipure™ is not intended to diagnose, treat, cure or prevent any disease.

No statement is intended or should be construed as a recommendation to infringe any existing patent. The information contained herein is believed to be correct and corresponds to the latest state of scientific and technical knowledge.

This Carnipure™ Focus has been reviewed by Professor William Kraemer from the University of Connecticut, USA.



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