Carnipure™ *Focus*

Energy without Meat

Lonza

Introduction

The benefits of healthy eating and partaking in regular exercise are well established now and form part of everyday life for most people. As part of this growing interest in healthy eating, there has been a boost in the number of people consuming a diet devoid of meat and / or other animal products.

The move to vegetarian food has been chiefly driven by health and ethical issues[1]. For many years, governments and other bodies have been advising the public of the need for a balanced, lower-fat and higher-fiber diet, exemplified, in part, by vegetarianism. The consequent reduction in red-meat eating over recent years has been accelerated by the issue of bovine spongiform encephalopathy (BSE) as well as the concern for foot-and-mouth disease. Various campaigning bodies are still active in bringing to the public's notice the ethical issue of animal cruelty and the environmental problems resulting from animal farming. These are more often cited by true vegetarians as reasons for vegetarianism.

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™

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

Nutritional concerns associated with meat avoidance

The rising awareness and uptake of meat avoidance as a method of addressing health-related food scares and animal cruelty issues, plus the fact that broadening ranges of vegetarian products are bringing the sector into the mainstream market, have resulted in the need to look at the vegetarians' supply of certain nutrients. One nutrient that is almost totally devoid in a vegetarian diet is L-Carnitine.
L-Carnitine, the biologically effective isomer of Carnitine, plays a key role within several energy production pathways. It is essential for the transport of long-chain fatty acids across the inner mitochondrial membrane towards their oxidative fate (breakdown) inside the mitochondria and thus, ultimately energy generation.

Benefits of a vegetarian diet	Risks of a vegetarian diet
Lower intake of saturated fatty acids and cholesterol	Lower than ideal vitamin B_{12} consumption
Higher intake of vitamins and essential co-factors	Lower iron consumption and iron bioavailability
Higher intake of antioxidant nutrients and secondary plant compounds	Lower zinc, selenium and iodine consumption
Higher intake of fibers	Lower protein consumption and lower protein quality of plant food than of food of animal origin
Lower intake of purines	Lower consumption of L-Carnitine and some of the nutrients used for its biosynthesis

Table 1: risks and benefits of a vegetarian diet

Although a meat-reduced or vegetarian diet can be a healthy choice and has various benefits, there are certain nutritional risks associated with being a vegetarian[2, 3]. Dietary supplementation from non-animal based sources is required to meet nutritional guidelines. Animal products, such as lamb, beef and pork, contain the highest amounts of dietary L-Carnitine. Lower levels of L-Carnitine are found in dairy products. In many plant foods, L Carnitine levels cannot even be detected[4]. Therefore, other than the limited amount naturally produced by the body, strict vegetarians have negligible sources for this nutrient[5]. Table 2 shows data on the L-Carnitine content of various foods.

Definitions:

All vegetarian diets are devoid of meat and fish. The different types of vegetarianism can be further classified into:

Lacto-ovo-vegetarians: exclude meat and fish, include dairy products and eggs

Lacto-vegetarians: exclude meat, fish and eggs, include dairy products

Vegans: exclude meat, fish, eggs, dairy products or other products of animal origin such as honey, leather (strictest)

Part-time vegetarians: occasional meat and fish

Food of animal origin (uncooked)	L-Carnitine [mg/100g]	Food of plant origin (uncooked)	L-Carnitine [mg/100g]
Lamb	190	Mushroom	2.6
Beef	143	Carrot	0.4
Pork	25	Bread	0.4
Poultry	13	Rice	0.3
Fish	3–10	Banana	0.1
Egg	0.8	Tomato	0.1

Table 2: Foods of plant origin contain only traces of L-Carnitine while foods of animal origin contain higher amounts of this nutrient[6].

Whereas the number of vegetarians (the majority being young females) has become static, the number of meat-reducers and red meat-avoiders is increasing. Market research shows continued growth in vegetarian food purchases, which does not only come from "true" vegetarians, but also from a higher number of meat-reducers and red meat-avoiders. Vegetable-based versions of meat and fish products, such as vegetable fingers and grills, as well as soy- and texturized vegetable protein based items and those made from the fermentation product Quorn have all grown steadily in popularity, becoming increasingly part of consumers' everyday food purchases. The total vegetarian market in the UK was found to be worth £670 million in 2006[7].

The typical non-vegetarian, Western diet is estimated to provide around 100-300 mg L-Carnitine per day[5]. In Europe, however, the average L-Carnitine intake has decreased by about 20% over the last decade, mainly as a result of a decrease in beef intake[6, 8].

Lacto-ovo-vegetarians are estimated to have an intake of about 10-40 mg L-Carnitine per day[9]. With a strict vegetarian diet, the total amount of ingested L-Carnitine is further reduced and was found to be around 1-4 mg/day[4, 9]. The consequences of such reduced L-Carnitine ingestion upon vegetarian health and nutrition have received relatively little or no attention to date in humans. This is surprising as dietary L-Carnitine is provided almost exclusively from the consumption of meat, with limited de-novo synthesis[10]. If intake of L-Carnitine is low, however, the body must almost entirely rely on the endogenous synthesis to meet the needs. A vegetarian diet is frequently low in some of the nutrients that are essential for L-Carnitine biosynthesis in the body, such as the amino acids lysine and methionine as well as bioavailable iron[11, 12].

L-Carnitine is synthesized in the human body from the essential amino acids lysine and methionine. The immediate precursor of L-Carnitine, gamma-butyrobetaine, can be synthesised in various tissues. The last step, however, the conversion into L-Carnitine, occurs only in the liver and kidneys. Only these tissues contain gamma-butyrobetaine hydroxylase, the enzyme which catalyzes the final reaction in the biosynthesis of L-Carnitine[13, 14]. There is evidence to suggest that the hepatic gamma-butyrobetaine hydroxylase enzyme activity is age-dependent. The enzyme activity of gamma-butyrobetaine hydroxylase in infants was reported to be only 12% of the normal adult activity. By 2.5 years the activity rises to 30% and by 15 years is within the standard deviation of the adult mean[15]. At old age, L-Carnitine biosynthesis has been found to decrease again[16].

Vegetarians have lower L-Carnitine plasma levels

Indeed, humans ingesting a lacto-ovo- or a strict vegetarian diet over years have shown to have decreased plasma L-Carnitine concentrations[11, 14, 17, 18]. In a study comparing several blood parameters of 46 lacto-ovo-vegetarians and 49 non-vegetarians, the lacto-ovo-vegetarians were found to have a favourable lipoprotein profile, but decreased total and free serum L-Carnitine concentrations[19]. Serum L-Carnitine levels seem to be even more depressed in vegetarian children and infants who do not receive a dietary source of L-Carnitine[13, 17]. These differences are suggested to be due to relatively higher requirements for L-Carnitine because of growth and tissue distribution[17]. When omnivorous college students were provided with an L-Carnitine free enteral diet, plasma total L-Carnitine declined by 42% within the first 7 days[20].

L-Carnitine in vegetarian mothers and infants

L-Carnitine is a natural component of breast milk and cow's milk. Manufacturers of soy-based infant formula routinely fortify their products with L-Carnitine. A study relating breast milk L-Carnitine concentrations to dietary habits of the mothers reported that the L-Carnitine content of milk of lacto-ovo-vegetarian mothers was lower than that of omnivorous mothers at any time throughout the study[21]. L-Carnitine deficiency as a consequence of a vegetarian diet in infancy has been described by various scientists[22–25]. Swiss researchers reported the case of a 7.5-month-old infant with failure to thrive, developmental delay, muscular hypotonia, a visible goitre and severe osteopenia. Laboratory examination revealed, among other, L-Carnitine deficiency. The infant was breastfed until the age of 2.5 months and was then given a mixture of almond extract in water. The mother was following a strict vegan diet[26]. Also a 12 year

old boy who adhered to a vegetarian diet and suffered episodes of vomiting, lethargy and hypoglycaemia responded promptly to supplementation with L-Carnitine[27]. Recent animal studies provide support for these findings: supplementing the mother sow's diet, which normally is devoid of any animal products and thus devoid of L-Carnitine, with this nutrient during pregnancy and lactation results in larger litters, increased weight of the piglets, faster growing during the suckling period and higher concentrations of L-Carnitine in the milk[28].

L-Carnitine excretion is decreased in vegetarians

L-Carnitine homeostasis in humans is maintained by dietary L-Carnitine intake, a modest rate of endogenous synthesis and efficient conservation of L-Carnitine by the kidney[29]. In healthy omnivorous sedentary individuals, renal excretion of L-Carnitine ranges between 20 and 60 mg/day, depending on the dietary intake. Generally, losses are reduced to less than 20 mg/day on a long-term meat- and L-Carnitine free diet[30]. Researchers documented a reduction of urinary excretion of L-Carnitine from 32.5 to 2.4 mg/day when changing from a meat to an almost isocaloric vegetable diet[31].

L-Carnitine and exercise

High performance athletes such as triathletes have been shown to have lower than normal plasma levels of L-Carnitine, even when maintaining an omnivorous diet. This has been attributed to a higher excretion of esterified L-Carnitine via the kidneys after severe exercise[32–34], and, to a lesser extent, via perspiration[35]. Due to the high fat and protein content of meat, however, many athletes wishing to consume a carbohydrate-rich diet often omit meat and may be "silent" vegetarians. Researchers observed that those triathletes who were on a predominantly vegetarian diet had the lowest plasma levels of L-Carnitine. Supplementation with 30 mg L-Carnitine/kg body weight for 6 weeks increased total L-Carnitine from 27 µmol/L to 100 µmol/L and free L-Carnitine from 10 µmol/L to 85 µmol/L. This considerable increase also improved the ratio of Acyl-L-Carnitine to total L-Carnitine, which is a means to express the supply of functionally active L-Carnitine[36].

Vegetarians and anyone following a meat-reduced diet can benefit from additional L-Carnitine. Since L-Carnitine is directly involved in the metabolism of fatty acids and carbohydrates, a good supply is important for active people providing the energy they need. After heavy exercise, vegetarians may get a functional L-Carnitine deficiency, meaning that there is a lack of available, free L-Carnitine in the cell. Such people can include L-Carnitine in their daily diet in the form of Carnipure™ enriched conventional foods or dietary supplements to optimize performance, delay the onset of fatigue and enhance recovery processes.

„Twenty-two years of tofu is a lot of time."

Paul Obis, founder of Vegetarian Times, on why he started eating meat again

And so to conclude

Meat-avoiders have a significantly reduced dietary intake of L-Carnitine and may be missing out on the tremendous health benefits of this nutrient. Consequently, addition of Carnipure™ into foods that mimic L-Carnitine-rich foods but are low in L-Carnitine, e.g. soy burgers, soy hot dogs and soy cheese, can only be recommended. Although L-Carnitine is naturally present in meat products, Lonza's Carnipure™ is not derived from animal sources and is synthesized by a patented multi-step biological production process. The time has come for vegetarian food manufacturers to ensure that their consumers are getting both what they want and what they can benefit from nutritionally – the time has come to fortify with Carnipure™.

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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 Newsletter has been reviewed by Professor Paul Walter (emeritus) from the University of Basel, Switzerland.

For more information:

Worldwide
Lonza Ltd, Basel, Switzerland
Tel +41 61 316 81 11

In the USA
Lonza Inc, Allendale, NJ
Tel +1 800 365 8324

carnipure@lonza.com
www.carnipure.com
www.lonza.com.

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