Coenzyme Q10 – A summary of current science and marketing trends supporting remarkable growth in global markets

Chemical Name and Class

Ubiquinone (2,3-dimethoxy-5-methyl-6-decaprenyl-1,4-benzoquinone); quinone

Common Names

CoQ_{10}, coenzyme Q_{10}, coenzyme Q, ubidecarenone

General Description

CoQ_{10} is a naturally occurring lipid-soluble antioxidant and electron-transporting coenzyme available as a dietary supplement in the form of a yellow to orange crystalline powder. CoQ_{10} is a component of the respiratory chain and acts as an effective scavenger of oxygen free radicals known to inhibit the oxidation of LDL-cholesterol. It functions as a bioenergetic, being the coenzyme for mitochondrial enzyme complexes that ultimately produce cellular ATP. CoQ_{10} bears a close relationship with vitamin E which it allows to regenerate in its active, reduced form (α-tocopherol). It also serves in the regeneration of the reduced form of ascorbate.

Applications

The demand for CoQ_{10} as a dietary supplement in the U.S. may be anticipated to grow substantially in coming years as awareness of its benefits continues to be shown in clinical trials in diverse conditions and deficiencies are discovered in the same and other conditions. Currently, CoQ_{10} is widely promoted in the U.S. as dietary supplement for maintaining cardiovascular health and as an antioxidant. The majority of clinical studies on CoQ_{10} have focused on and found positive effects from its application in cardiovascular disease, including heart surgery, ischemic heart disease, congestive heart failure, and hypertensive heart disease.[1,2] As of 2003, at least 13 double-blind, placebo-controlled trials of CoQ_{10} supplementation in heart disease involving over 1000 patients in total found statistically significant benefits in all but 3 studies in which the results were neutral. Based on those findings, it was concluded that CoQ_{10} is a

“promising, safe and effective approach in chronic heart failure” and a multicenter randomized, placebo-controlled trial in 550 patients with NYHA class III to IV heart disease taking CoQ_{10} (100 mg t.i.d.) along with standard therapy was initiated in Europe in the same year. A follow-up study lasting 2 years is planned to determine whether CoQ_{10} will reduce the number of unplanned hospitalizations caused by worsening heart failure (cardiovascular morbidity) which will help “to establish the future role of CoQ_{10} as part of a maintenance therapy in patients with chronic heart failure.”[3]

Statin-induced CoQ_{10} Deficiency

At the same time that congestive heart failure in the U.S. has attained epidemic proportions, the prevailing use of statins to treat heart disease and their confirmed depleting effect on CoQ_{10} levels is prompting many to recommend that patients taking statins supplement their diet with CoQ_{10}. Moreover, increasing potencies of statin drugs has caused a noticeable increase in the prevalence and severity of CoQ_{10} deficiency.[4]

In 2003 an estimated 36 million Americans were candidates for treatment with statins.[4] Over the next two years, sales of statins in the U.S. are expected to grow by 9% per annum and could further increase following their current investigation for potential use in other conditions (e.g., cancer, dementia, multiple sclerosis, proteinuria nephropathies, and transplant rejection).[5] Worldwide, an estimated one billion people are candidates for statin therapy owing to high serum cholesterol levels.[6]

Skin Care

The other major use of CoQ_{10} is found in cosmetics designed to correct or inhibit fine lines and a growing number of skin care products now contain the coenzyme. Since 1998, Nivea’s Visage product line containing CoQ_{10} became the best-selling anti-wrinkle cream in the world (e.g., Nivea Visage Coenzyme Q10 Plus Wrinkle Control Eye Cream, Nivea Visage Coenzyme Q10 Wrinkle Control Night cream, Nivea for Men Revitalizing Crème Q10). Others are attempting to follow with their own formulations containing CoQ_{10} (e.g., DermaQuest, Eucerin, Emergin-C, Juvena, etc).

Market Demand

In 2003 it was estimated that world market demand for CoQ_{10} was 150 tons.[7] A market research study published forecasting demand for anti-aging products in the U.S. to 2007 and 2012 concluded that the demand for "age-defying appearance products" is anticipated to increase by 8% per annum. The study forecasted "stellar growth" for CoQ_{10}.[8] Another industry study with projections through to 2008 and 2013 concluded that "smaller-volume antioxidants, such as coenzyme Q_{10}, are expected to record the fastest growth through 2008".[9] Since CoQ_{10} was deregulated in Japan in March 2001, sales have grown by 150% per year. In 2004 the market reached US$150 million and is expected to reach US$200 million by 2005.[10]

Pharmacology

Antioxidant (against in vivo protein oxidative damage[11] and lipid peroxidation)[12-16] Sparing/ regenerative to vitamin E stores[17]

Apoptotic cell death-inhibiting[18]

Antihypertensive[19,20]

Anti-atherogenic[21-28]

Neuroprotective[29-31]

CoQ10 Deficiency-associated Conditions:

Normal aging[32,33]

Skin surface lipid levels after age 42 (men and women)[34]

Epidermal levels after age 30.[35]

Exposure of skin surface lipids to ultraviolet radiation[34]

Heart disease (ischemic)[36-38]

High cholesterol levels[39]

Bronchial asthma[40]

Smoking/smokers[39]

Periodontal disease[41]

Type 2 diabetes[42]

Impaired natural killer cell function[33]

Lewy body disease[43]
Cerebellar ataxia[44]
Varicocele[45]
Low sperm vitality[46]
Preeclampsia[47]
Sickle cell anemia[48]
Prader-Willi syndrome[38]
Myotonic dystrophy[49]
Quinone-responsive respiratory chain enzyme deficiency[50]
Cervical intraepithelial neoplasia[51]
AIDS[52]
β-thalassemia[53]
Patients taking certain cholesterol-lowering drugs (i.e. atorvastatin, lovastatin, pravastatin, simvastatin)[42,54-59]

Positive Effects in Clinical Studies

Antioxidant (against lipid peroxidation caused by organic solvent exposure[60]; in coronary artery disease[61]; in coronary heart disease patients treated with pravastatin[62]
Adjuvant (in addition to standard treatments) in chronic heart failure,[63,64] hypertension (in patients on blood pressure medication,[65,66] patients not taking BP medications,[67] and patients with type 2 diabetes[68,69]
Cardioprotection (after recent heart attack in patients taking lovastatin,[70] or other interventions[71])
Moderately raised serum lipoprotein(a) in acute coronary disease patients receiving conventional treatments[61]
Prevention of complications in patients chronic congestive heart failure (adjuvant to standard medications)[72]
Potentiating the beneficial effects of aerobic exercise training on brachial artery health in chronic heart failure patients[73]
Vision recovery in Leber hereditary optic neuropathy[74]
Neurogenic atrophies and muscular dystrophies (myotonic dystropy, Becker, Duchenne, and limb-

girdle dystrophies, Welander disease, and Charcot-Marie-Tooth disease)[75] Familial CoQ_{10} deficiency[76-78]

Symptom severity[79] and progressive deterioration of function in Parkinson's disease (CoQ_{10} combined with equal doses of vitamin E)[80]

Mitochondrial encephalopathy[50]

Progressive hearing loss in diabetes with mitochondrial DNA 3243 (A-G) mutation[81]

Improving endothelial function of peripheral circulation (brachial artery) in type 2 diabetes patients with dyslipidemia[82]

Restoration of CoQ_{10} levels in type 2 diabetes patients receiving HMG-CoA reductase inhibitors (e.g., pravastatin, simvastatin)[42]

Sperm motility-increasing in infertile men with idiopathic athenozoospermia.[83]

Topical Application Studies

Improving the resistance of the skin against oxidation caused by ultra violet radiation; reducing wrinkles around the eyes ("crow's feet")[35,84]

Adult periodontitis[85]

Regulatory Status

Sold freely in the U.S. Regulated as dietary supplement

Safety

No signs of toxicity or adverse events were found in rats of either sex orally administered CoQ_{10} at dosages of 100-1,200 mg/kg per day for 12 months.[86] Hypersensitivity reactions to CoQ_{10} are rare.[87]

Restrictions

Not to be taken concurrently with high-intensity exercise[88]; may accelerate the metabolism of the chemotherapy drug doxorubicin (adriamycin)[89,90]; may decrease the dosage requirement of antihypertensive medications[65]; effects during pregnancy unknown.

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