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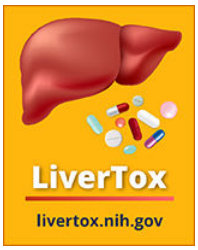


Coenzyme Q10

Updated: April 20, 2024.

OVERVIEW

Introduction

Coenzyme Q10, also known as ubiquinone, is an enzyme cofactor found in virtually all cells of the body and participates in many essential energy-producing and antioxidant enzymatic actions. While normally synthesized in the body in adequate amounts, coenzyme Q10 is used as a nutritional supplement for conditions highly dependent upon its actions, some of which are associated with low serum levels of the coenzyme. Coenzyme Q supplements are generally well tolerated and there is no evidence that they cause serum enzyme elevations or clinically apparent liver injury.

Background

Coenzyme Q10, also known as ubiquinone, is an enzyme cofactor found in virtually all cells of the body where it participates in essential energy-producing and antioxidant actions. Coenzyme Q10 is a fat-soluble vitamin K-like molecule that is found in highest concentrations in the heart, liver, kidney, and brain. It is an essential component of the respiratory chain in mitochondria where it acts as an oxygen acceptor during the production of adenosine triphosphate (ATP), the molecule used in all energy requiring metabolic reactions. Coenzyme Q10 has multiple critical cellular actions: it is an essential antioxidant, is required for energy conversion, and also stimulates cell growth and inhibits cell death. Because of its multiple actions and essential role in oxidative metabolism, coenzyme Q10 has been purposed as a means of preventing or ameliorating many medical conditions, including migraine headaches, Parkinson's disease, Huntington chorea, heart failure, hypertension, statin induced myalgias and myopathy, and even fatty liver disease. While preclinical and pilot clinical studies have demonstrated evidence of benefit from supplementation with coenzyme Q10, larger, more rigorously controlled clinical trials have failed to show definite evidence of its benefit in any of these conditions, and it is not approved by the FDA for any disease or medical condition. Nevertheless, the antioxidant effects and essential nature of coenzyme Q10 in metabolism makes it an attractive candidate for ameliorating otherwise poorly controlled conditions. Coenzyme Q10 is widely used and is available in multiple over-the-counter generic forms as tablets, capsules, gelcaps, wafers, and in liquid solution. Because it is lipid soluble, it is frequently given with lipids or vitamin E to improve absorption. The typical dose is 300 to 1200 mg in divided doses daily. Coenzyme Q10 is well tolerated even in high doses with side effect rates no higher than with placebo. Side effects are largely non-specific symptoms of gastrointestinal upset, nausea, headache, dizziness, and fatigue. They are usually mild and short-lived, rarely requiring dose adjustment or discontinuation. Serious adverse events are rare and usually considered unrelated. Long term use has not been associated with disease complications or cancer.

Q refers to the quinone ring which is the active catalytic site of the coenzyme; 10 refers to the 10 isoprene units that make up the long tail of the molecule. Coenzyme Q10 is somewhat similar in structure to vitamin K.

Hepatotoxicity

Coenzyme Q10 is generally recognized as safe and has not been linked to elevations in serum aminotransferase, alkaline phosphatase, or bilirubin levels. Despite wide scale use for several decades, there have been no convincing reports of clinically apparent liver injury due to coenzyme Q10.

Likelihood score: E (unlikely cause of clinically apparent liver injury).

Drug Class: Nutritional Supplements

Other Names: Ubiquinone, Semiubiquinone, Ubiquinol, CoQ10

PRODUCT INFORMATION

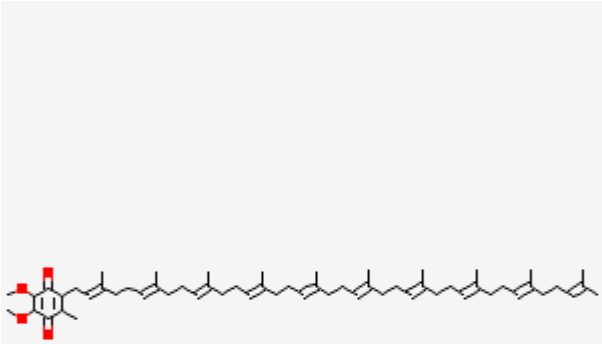
REPRESENTATIVE TRADE NAMES

Coenzyme Q10 – Generic

DRUG CLASS

Nutritional Supplements

CHEMICAL FORMULA AND STRUCTURE

DRUG	CAS REGISTRY NUMBER	MOLECULAR FORMULA	STRUCTURE
Coenzyme Q10	303-98-0	C59-H90-O4	

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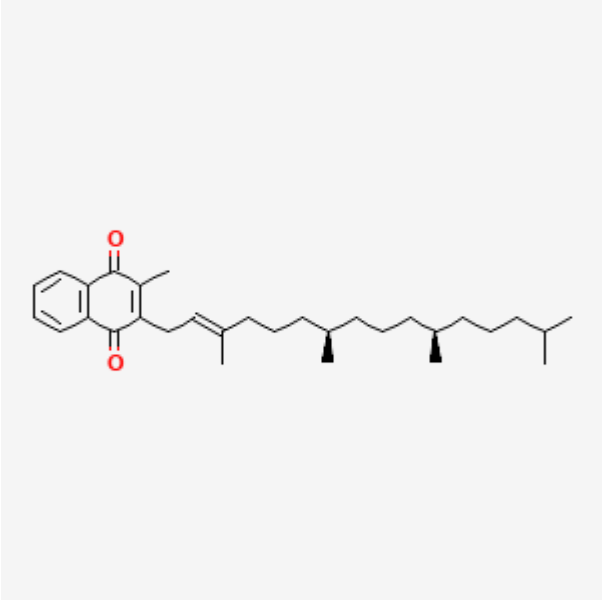
DRUG	CAS REGISTRY NUMBER	MOLECULAR FORMULA	STRUCTURE
Vitamin K	84-80-0	C31-H46-O2	

SELECTED ANNOTATED BIBLIOGRAPHY

References updated: 20 April 2024

Abbreviations: HDS, herbal and dietary supplements.

Zimmerman HJ. Unconventional drugs. Miscellaneous drugs and diagnostic chemicals. In, Zimmerman, HJ. Hepatotoxicity: the adverse effects of drugs and other chemicals on the liver. 2nd ed. Philadelphia: Lippincott,1999: pp. 731-4.

(Expert review of hepatotoxicity published in 1999; several herbal and dietary supplements are discussed, but not coenzyme Q10).

Liu LU, Schiano TD. Hepatotoxicity of herbal medicines, vitamins and natural hepatotoxins. In, Kaplowitz N, DeLeve LD, eds. Drug-induced liver disease. 2nd ed. New York: Informa Healthcare USA, 2007, pp. 733-54.

(Review of hepatotoxicity of herbal and dietary supplements [HDS] published in 2007; no mention of coenzyme Q10).

Coenzyme Q10. In, PDR for Herbal Medicines. 4th ed. Montvale, New Jersey: Thomson Healthcare Inc. 2007: pp. 958-961.

(Compilation of short monographs on herbal medications and dietary supplements, mentions that coenzyme 10 "has a very low toxicity profile" and has "no reports of overt hepatotoxicity").

Crane FL. Biochemical functions of coenzyme Q10. J Am Coll Nutr. 2001;20:591-8. PubMed PMID: 11771674.

(Review of the biochemistry of coenzyme Q10 which is an essential component in mitochondria for oxidative phosphorylation and production of ATP from carbohydrates and fatty acids; but it also participates in other enzyme activity, with antioxidant effects in cell membranes, maintenance of redox homeostasis and serves functions in cell membranes with antioxidant effects, maintenance of redox potential, and control of membrane channels and participating in other enzymatic synthetic functions).

Shults CW, Oakes D, Kieburtz K, Beal MF, Haas R, Plumb S, Juncos JL, et al.; Parkinson Study Group. Effects of coenzyme Q10 in early Parkinson disease: evidence of slowing of the functional decline. Arch Neurol. 2002;59:1541-50. PubMed PMID: 12374491.

(Among 80 patients with early Parkinson disease treated with coenzyme Q10 [300, 600, or 1200 mg) or placebo daily for 16 months, worsening of Parkinson disease rating scales was less with the highest dose of coenzyme Q10, but worsening was similar with placebo as overall with the 3 drug doses; the drug was well tolerated and adverse event rates including laboratory abnormalities were similar in all 4 groups).

Hidaka T, Fujii K, Funahashi I, Fukutomi N, Hosoe K. Safety assessment of coenzyme Q10 (CoQ10). Biofactors. 2008;32(1-4):199-208. PubMed PMID: 19096117.

(Review of safety data from animal and human studies of coenzyme Q10 concludes that it has "low toxicity" and "does not induce serious adverse events in humans" in doses of up to 1200 mg daily, common adverse events being generally mild, including stomach upset, nausea, diarrhea, headache, heartburn, and fatigue while changes in laboratory biochemistry were not dose related, not clinically significant, and similar in frequency to changes observed in placebo recipients).

Jacobsson I, Jönsson AK, Gerdén B, Hägg S. Spontaneously reported adverse reactions in association with complementary and alternative medicine substances in Sweden. Pharmacoepidemiol Drug Saf 2009; 18: 1039-47. PubMed PMID: 19650152.

(Among 778 spontaneous reports of adverse reactions to herbal and alterative medicines to a national Swedish Registry, coenzyme Q10 was the implicated agent in 42 [5%], the reaction being "mixed liver reaction" in 2, but no details provided).

Teschke R, Wolff A, Frenzel C, Schulze J, Eickhoff A. Herbal hepatotoxicity: a tabular compilation of reported cases. Liver Int 2012; 32: 1543-56. PubMed PMID: 22928722.

(A systematic compilation of all publications on the hepatotoxicity of specific herbal products identified 185 publications on 60 different herbs, herbal drugs and supplements but does not mention coenzyme Q10).

Navarro VJ, Seeff LB. Liver injury induced by herbal complementary and alternative medicine. Clin Liver Dis 2013; 17: 715-35. PubMed PMID: 24099027.

(Review of the epidemiology, regulatory status, diagnosis, pathogenesis and causes of liver injury from herbal products with specific discussion of conjugated linoleic acid, ephedra, germander, green tea, usnic acid, flavocoxid, aloe vera, chaparral, greater celandine, black cohosh, comfrey, kava, skullcap, valerian, noni juice, pennyroyal, and traditional herbal remedies but does not mention coenzyme Q10).

Navarro VJ, Barnhart H, Bonkovsky HL, Davern T, Fontana RJ, Grant L, Reddy KR, et al. Liver injury from herbals and dietary supplements in the U.S. Drug-Induced Liver Injury Network. Hepatology 2014; 60: 1399-408. PubMed PMID: 25043597.

(Among 839 cases of liver injury from drugs collected in the US between 2004 and 2013, 130 were due to HDS products, including 45 from body building agents [probably anabolic steroids] and 85 from diverse HDS products but does not mention coenzyme Q10).

Parkinson Study Group QE3 Investigators; Beal MF, Oakes D, Shoulson I, Henchcliffe C, Galpern WR, Haas R, Juncos JL, et al. A randomized clinical trial of high-dosage coenzyme Q10 in early Parkinson disease: no evidence of benefit. JAMA Neurol. 2014;71:543-52. PubMed PMID: 24664227.

(Among 600 patients with Parkinson disease treated with coenzyme Q10 [1200 or 2400 mg] or placebo daily for 16 months, worsening of the disease rating scales were similar in all 3 groups as were adverse event rates [2.5% vs 2.0%]).

Brown AC. Liver toxicity related to herbs and dietary supplements: Online table of case reports. Part 2 of 5 series. Food Chem Toxicol 2017; 107: 472-501. PubMed PMID: 27402097.

(Description of an online compendium of cases of liver toxicity attributed to HDS products does not mention coenzyme Q10).

Medina-Caliz I, Garcia-Cortes M, Gonzalez-Jimenez A, Cabello MR, Robles-Diaz M, Sanabria-Cabrera J, Sanjuan-Jimenez R, et al.; Spanish DILI Registry. Herbal and dietary supplement-induced liver injuries in the Spanish DILI Registry. Clin Gastroenterol Hepatol. 2018;16:1495-1502. PubMed PMID: 29307848.

(Among 856 cases of hepatotoxicity enrolled in the Spanish DILI Registry between 1994 and 2016, 32 were attributed to herbal and dietary supplements, the most frequent cause being green tea [n=8] and Herbalife products [n=6]; no mention of coenzyme Q10).

Ayers J, Cook J, Koenig RA, Sisson EM, Dixon DL. Recent developments in the role of coenzyme Q10 for coronary heart disease: a systematic review. Curr Atheroscler Rep. 2018;20:29. PubMed PMID: 29766349.

(Systematic review of controlled clinical trials of coenzyme Q10 in coronary artery disease including studies in statin related myalgias, chronic heart failure, hypertension, hyperlipidemia, and glycemic control concluded that evidence does not support its use, although it appears to be associated with minimal adverse events; no mention of ALT elevations or hepatotoxicity).

Ballotin VR, Bigarella LG, Brandão ABM, Balbinot RA, Balbinot SS, Soldera J. Herb-induced liver injury: systematic review and meta-analysis. World J Clin Cases. 2021;9:5490-5513. PubMed PMID: 34307603.

(Systematic review of the literature on HDS induced liver injury identified 446 references describing 936 cases due to 79 different herbal products, the most common being He Shou Wu [91], green tea [90] Herbalife products [64], kava kava [62], and greater celandine [48]; does not mention coenzyme Q10).

Bessone F, García-Cortés M, Medina-Caliz I, Hernandez N, Parana R, Mendizabal M, Schinoni MI, et al. Herbal and dietary supplements-induced liver injury in Latin America: experience from the LATINDILI Network. Clin Gastroenterol Hepatol. 2022;20:e548-e563. PubMed PMID: 33434654.

(Among 367 cases of hepatotoxicity enrolled in the Latin American Drug-Induced Liver Injury Network between 2011 and 2019, 29 [8%] were attributed to herbal products, the most frequent being green tea [n=7], Herbalife products [n=5], and garcinia [n=3]; no mention of coenzyme Q10).

Hansen KS, Mogensen TH, Agergaard J, Schiøttz-Christensen B, Østergaard L, Vibholm LK, Leth S. High-dose coenzyme Q10 therapy versus placebo in patients with post COVID-19 condition: a randomized, phase 2, crossover trial. Lancet Reg Health Eur. 2023;24:100539. PubMed PMID: 36337437.

(Among 121 adults with symptomatic post-COVID syndrome treated with coenzyme Q10 [100 mg] or placebo five times daily for 6 weeks with a crossover after a 4-week washout period, symptoms improved in both groups equally and adverse events were uncommon and mild, mostly diarrhea and nonspecific symptoms; no mention of ALT elevations or hepatotoxicity).