Coenzyme Q_{10} (*Ubiquinone*)

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General Features

CoQ_{10} is an essential component of the electron transfer system in the mitochondria. More specifically, it functions to shuttle hydrogen electrons from NAD to cytochrome b, facilitating the release of energy required to recouple ADP with inorganic phosphate in the synthesis of ATP. As such, CoQ_{10} is an integral part of the bioenergetic system that enables cells to produce adequate amounts of ATP through aerobic pathways. ATP is the primary fuel required to power the body's metabolic reactions, maintain optimal function of cells and sustain life. A deficit in ATP synthesis can compromise any number of energy-dependent cellular functions and hasten the onset of dysfunction and if severe enough, cell death.

Although the body can synthesize CoQ_{10}, deficiency states of CoQ_{10} tend to exist and are associated with various health conditions. Moreover, supplementation studies with CoQ_{10} have been shown to effectively treat and sometimes reverse a number of these conditions.

There is evidence that a decline in CoQ_{10} synthesis occurs with aging, predisposing individuals to a number of CoQ_{10} deficiency-related disorders and diseases.

Professor F.L. Crane and his colleagues at the University of Wisconsin first discovered CoQ_{10} in 1957. Since then, Dr, Karl Folkers at the University of Texas (Austin) is most responsible for the ongoing research on CoQ_{10}.[1-4]

Coenzyme Q_{10} is also a fat soluble antioxidant, which has been shown to reduce oxidation of LDL-cholesterol and the mitochondrial DNA.[5,6] CoQ_{10} supplementation has been shown to modulate immune system function, enhancing levels of immunoglobulin G (IgG), in the serum of patients provided with 60 mg CoQ_{10} per day.[7]

The average person may consume about 5 mg per day of CoQ_{10} from foods, with the main sources being meat, fish, soybeans and some vegetable oils. Clinical Coenzyme Q_{10} studies have involved daily supplemental intake levels ranging from 60 mg to 300 mg per day; far greater than food alone can provide.[8]

Supplementation Studies and Clinical Applications

1. Cardiovascular Disease

Biopsy results from heart tissue in patients with various cardiovascular diseases (especially congestive heart failure) show a deficiency in CoQ_{10} in 50 to 75 percent of cases. Low blood levels of CoQ_{10} are also a consistent finding in the majority of these patients.[9-12]

Supplementation studies with patients suffering from various cardiomyopathies (i.e. ischemic cardiomyopathy, dilated cardiomyopathy, heart valve disorders) and congestive heart failure have demonstrated significant improvement in heart function (according to the New York Heart Association functional scale) in a high percentage of cases.

Many patients in these studies have been able to reduce the number of cardiac drugs required (1-3 medications reduced in 43 percent of CoQ_{10} supplemented patients in one study of 424 patients, over an eight year period).

Heart function parameters monitored have included left ventricular wall thickness, mitral valve inflow slope, and fractional shortening.[13,14,15]

a. Congestive Heart Failure - Several controlled studies using Coenzyme Q_{10} supplementation in patients with congestive heart failure have demonstrated significant improvement in cardiac ejection fraction, reduced shortness of breath, and increased muscle strength. Other studies have demonstrated increased stroke volume and cardiac index, improved survival and improved quality of life, in general. Of great significance is the fact that when patients discontinue CoQ_{10} supplementation, cardiac function deteriorates. Thus, CoQ_{10} needs to be a lifelong intervention in these cases.[16,17,18]
b. Angina - A small study has shown that CoQ_{10} supplementation can reduce angina episodes and nitroglycerine use and improve treadmill exercise tolerance. Larger trials are required to substantiate this data.[19]
c. Hypertension - Several studies have provided evidence that CoQ_{10} supplementation can lower systolic and diastolic blood pressure (i.e. systolic 164-146, diastolic 98-86) in hypertensive patients. Improved blood cholesterol levels also occurred in one study, with a rise in HDL and a reduction in total cholesterol from 229.9 mg/dl to 213.3 mg/dl.[18-22]

2. Periodontal Disease

Several intervention trials involving patients with periodontal disease have revealed that CoQ_{10} supplementation can be useful in reversing the condition to various degrees.[23,24]

3. Aerobic Exercise Performance

A study of 25 cross-country skiers has provided preliminary evidence that CoQ_{10} supplementation may improve exercise performance in endurance athletes.[25]

Sedentary individuals have also demonstrated improvement with work capacity, oxygen consumption, fat burning and oxygen transport after beginning an exercise program. The group supplemented with CoQ_{10} demonstrated greater improvement in these aerobic parameters compared to the placebo group, in a 4-8 week trial period.[26]

Dosage Ranges

1. Cardiovascular Conditions: typical dosage is 50-60 mg, three times per day. Large doses (up to 300 mg) may be needed in severe heart disease. Some studies use a dosage of 2 mg CoQ_{10} for each kilogram of body weight.
2. Periodontal Disease: 50 mg per day has been used in clinical trials
3. Exercise Performance Studies: 60 mg per day[27]

Toxicity and Contraindications

Coenzyme Q_{10} is well tolerated, and no serious adverse effects have been reported with long-term use.[27]

Drug-Nutrient Interactions

1. **Warfarin**

   CoQ_{10} supplementation has been shown to antagonize the anti-coagulant effects of warfarin, requiring dose adjustment.

2. **Beta-Blockers and HMG**

   CoA Reductase (statin) drugs for cholesterol lowering are known to inhibit the endogenous synthesis of CoQ_{10}. CoQ_{10} supplementation can compensate for this inhibition effect and is indicated as a concurrent therapy when these drugs are in use (100 mg of CoQ_{10} per day is recommended in these cases).

3. **Psychotropic Drugs**

   Coenzyme Q_{10} supplementation has been shown to reduce the cardiac side effects of phenothiazines and tricyclic antidepressant drugs.

4. **Chemotherapy**

   Q_{10} supplementation can mitigate the cardiac side effects and cardiotoxicity of the chemotherapy drug known as adriamycin (100 mg per day of $_{CoQ10}$ supplementation). Even children with lymphoblastic leukemia or non-Hodgkin lymphoma realized this benefit compared with the placebo group.[28-34]

5. **Anticoagulants**

   As noted above, there are reported cases of CoQ_{10} countering the action of warfarin. Thus, the physician prescribing warfarin may need to adjust the warfarin dose if CoQ_{10} is to be used and therefore must be consulted.[34,35]

The following drugs may reduce the body's levels of CoQ_{10}:

1. Orlistat: reduces CoQ_{10} absorption.[36]
2. Beta blockers: decreases CoQ_{10} synthesis.[37]
3. Biguanides: decreases CoQ_{10} synthesis.[38]
4. Clondine: decreases CoQ_{10} synthesis.[39]
5. Gemfibrozil: (cholesterol-lowering drug).[40]
6. Haloperidol: decreases CoQ_{10} synthesis.[41]
7. HMG-CoA Reductase inhibitors: decreases CoQ_{10} synthesis.[42]
8. Hydralazine: decreases CoQ_{10} synthesis.[37]
9. Methydopa: decreases CoQ_{10} synthesis.[39]
10. Phenothiazines: decreases CoQ_{10} synthesis.[41]
11. Sulfonylureas: some of these drugs decrease CoQ_{10} synthesis (acetohexamide, glyburide, tolazamide).[38]
12. Thiazide Diuretics: decrease CoQ_{10} synthesis.[39]
13. Tricyclic Antidepressants: decrease CoQ_{10} synthesis.[41]

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