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[Int J Pharm.](#) 2010 Jun 15;392(1-2):57-63. Epub 2010 Mar 17.

The advantages of a novel CoQ10 delivery system in skin photo-protection.

[Yue Y](#), [Zhou H](#), [Liu G](#), [Li Y](#), [Yan Z](#), [Duan M](#).

Source

State Key Lab Biomembrane & Membrane Biotechnology, School of Life Sciences, Tsinghua University, Beijing, China.

Abstract

Skin photo-ageing induced by ultraviolet (UV) radiation is mainly ascribed to oxidative stress and reactive oxygen species (ROS). **Coenzyme Q10 (CoQ10)** has been reported as a powerful antioxidant in plasma. However, **CoQ10** was barely satisfactory in topical drug delivery because of its lipid solubility. To improve the anti-oxidative efficiency of **CoQ10** in **skin** photo-ageing, the present research prepared a novel **CoQ10** nano-structured lipid carrier (**CoQ10-NLC**) and characterised it by size and freeze-fracture transmission electron microscopy (FF-TEM). In UVA-irradiated fibroblasts, the protection of **CoQ10-NLC** was more effective than the **CoQ10-emulsion** as demonstrated by cell viability and morphological changes of the cell body and nucleus. In addition, malondialdehyde (MDA, the product of lipid peroxidation) concentration decreased by 61.5% in the group treated with **CoQ10-NLC** compared to the group subjected to general **CoQ10-emulsion**. In the presence of **CoQ10-NLC**, the activities of the anti-oxidative enzymes superoxide dismutase (SOD) and glutathione peroxidase (GSH-px) were reinstated to 81% and 75%, respectively, of the control group. In vivo, the **CoQ10-NLC** displayed a stronger capability to penetrate the stratum corneum and permeate the dermis after a topical **skin** application. These results reveal that **CoQ10-NLC** has greater antioxidant properties and topical **skin** penetration than the **CoQ10-emulsion**.

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PMID:
20302925

[Biofactors](#). 2009 Sep-Oct;35(5):435-41.

Coenzyme Q10 protects against oxidative stress-induced cell death and enhances the synthesis of basement membrane components in dermal and epidermal cells.

[Muta-Takada K](#), [Terada T](#), [Yamanishi H](#), [Ashida Y](#), [Inomata S](#), [Nishiyama T](#), [Amano S](#).

Source

Shiseido Research Center, Yokohama, Japan. keiko.muta@to.shiseido.co.jp

Abstract

Coenzyme Q10 (CoQ10), which has both energizing and anti-oxidative effects, is also reported to have antiaging action, e.g., reducing the area of facial wrinkles. However, the mechanism of its anti-aging activity is not fully established. Here, we examined the effect of **CoQ10** on human dermal and epidermal cells. **CoQ10** promoted proliferation of fibroblasts but not keratinocytes. It also accelerated production of basement membrane components, i.e., laminin 332 and type IV and VII collagens, in keratinocytes and fibroblasts, respectively; however, it had no effect on type I collagen production in fibroblasts. **CoQ10** also showed protective effects against cell death induced by several reactive oxygen species in keratinocytes, but only when its cellular absorption was enhanced by pretreatment of the cells with highly **CoQ10**-loaded serum. These results suggest that protection of epidermis against oxidative stress and enhancement of production of epidermal basement membrane components may be involved in the antiaging properties of **CoQ10** in skin.

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PMID:
19753652

[Int J Nanomedicine](#). 2011;6:611-7. Epub 2011 Mar 30.

Novel formulation and evaluation of a Q10-loaded solid lipid nanoparticle cream: in vitro and in vivo studies.

[Farboud ES](#), [Nasrollahi SA](#), [Tabbakhi Z](#).

Source

Department of Pharmaceutics, School of Pharmacy, Tehran University of Medical Sciences, Tehran, Iran.

Abstract

Solid lipid nanoparticles (SLNs) of **coenzyme Q10 (CoQ10)** were formulated by a high-pressure homogenization method. The best formulation of SLN dispersion consisted of 13% lipid (cetyl palmitate or stearic acid), 8% surfactant (Tween 80 or Tego Care 450), and water. Stability tests, particle size analysis, differential scanning calorimetry, transmission electron microscopy, and release study were conducted to find the best formulation. A simple cream of **CoQ10** and a cream containing **CoQ10**-loaded SLNs were prepared and compared on volunteers aged 20-30 years. SLNs with particle size between 50 nm and 100 nm exhibited the most suitable stability. In vitro release profiles of **CoQ10** from simple cream, SLN alone, and **CoQ10**-loaded SLN cream showed prolonged release for SLNs compared with the simple cream, whereas there was no significant difference between SLN alone and SLN in cream. In vitro release studies also demonstrated that **CoQ10**-loaded SLN and SLN cream possessed a biphasic release pattern in comparison with simple cream. In vivo **skin** hydration and elasticity studies on 25 volunteers suggested good dermal penetration and useful activity of Q10 on **skin** as a hydratant and antiwrinkle cream.

[Nanoscale Res Lett.](#) 2010 Jul 20;5(10):1561-1569.

Characterisation and Skin Distribution of Lecithin-Based Coenzyme Q10-Loaded Lipid Nanocapsules.

[Zhou H](#), [Yue Y](#), [Liu G](#), [Li Y](#), [Zhang J](#), [Yan Z](#), [Duan M](#).

Abstract

The purpose of this study was to investigate the influence of the inner lipid ratio on the physicochemical properties and **skin** targeting of surfactant-free lecithin-based **coenzyme Q10**-loaded lipid nanocapsules (**CoQ10**-LNCs). The smaller particle size of **CoQ10**-LNCs was achieved by high pressure and a lower ratio of **CoQ10**/GTCC (Caprylic/capric triglyceride); however, the zeta potential of **CoQ10**-LNCs was above ± 60 mV/ with no distinct difference among them at different ratios of **CoQ10**/GTCC. Both the crystallisation point and the index decreased with the decreasing ratio of **CoQ10**/GTCC and smaller particle size; interestingly, the supercooled state of **CoQ10**-LNCs was observed at particle size below about 200 nm, as verified by differential scanning calorimetry (DSC) in one heating-cooling cycle. The lecithin monolayer sphere structure of **CoQ10**-LNCs was investigated by cryogenic transmission electron microscopy (Cryo-TEM). The **skin** penetration results revealed that the distribution of Nile red-loaded **CoQ10**-LNCs depended on the ratio of inner **CoQ10**/GTCC; moreover, epidermal targeting and superficial dermal targeting were achieved by the **CoQ10**-LNCs application. The highest fluorescence response was observed at a ratio of inner **CoQ10**/GTCC of 1:1. These observations suggest that lecithin-based LNCs could be used as a promising topical delivery vehicle for lipophilic compounds.

[Int J Pharm.](#) 2009 Jul 30;377(1-2):207-14. Epub 2009 May 22.

Q10-loaded NLC versus nanoemulsions: stability, rheology and in vitro skin permeation.

[Junyaprasert VB](#), [Teeranachaideekul V](#), [Souto EB](#), [Boonme P](#), [Müller RH](#).

Source

Department of Pharmacy, Faculty of Pharmacy, Mahidol University, Thailand.
pyvbp@mahidol.ac.th

Abstract

In this study, nanoemulsions (NE) of medium chain triacylglycerols (MCT) and nanostructured lipid carriers (NLC) of cetyl palmitate/MCT were produced to load coenzyme Q(10) (Q(10)) and characterized for their stability before and after incorporation into xanthan gum hydrogels. After storage at 4, 25 and 40 degrees C, the particles remained in the nanosize range for 12 months, with zeta potential higher than $|40 \text{ mV}|$. Similar results were found in xanthan gum-based hydrogels containing NE or NLC. The crystallinity index of Q(10)-loaded NLC increased after being incorporated into hydrogels. The Q(10) entrapped in NLC and NE remained higher than 90% at all temperatures for 12 months but dramatically decreased when exposed to light. From the rheological studies, both NLC and NE dispersions possessed pseudoplastic flow having more liquid characteristics, whereas NLC and NE hydrogels exhibited plastic flow with thixotropy, showing more elastic rather than viscous properties. The occurrence of a spatial arrangement of lipid molecules was observed in the matrix of NLC when entrapped into hydrogels. From in vitro permeation studies, it could be stated that the amount of Q(10) released and occlusiveness were major keys to promote the deep penetration of Q(10) into the **skin**.

PMID:
19465098

[Coll Antropol.](#) 2010 Sep;34(3):1145-53.

Modern approach to topical treatment of aging skin.

[Puizina-Ivić N](#), [Mirić L](#), [Carija A](#), [Karlica D](#), [Marasović D](#).

Source

Clinic of Dermatovenereology, School of Medicine, Split University and Split University Hospital Center, Split, Croatia. neira.puizina@kbsplit.hr

Abstract

The main processes involved in **skin** aging are intrinsic and extrinsic. Apart from them, so called stochastic aging connotes cell damage caused by metabolic processes, free radicals and cosmic irradiation. The clinical expression of intrinsic aging include smooth, dry, and thinned **skin** with accentuated expression lines. It is inevitable and time dependent. Extrinsically aged **skin** shows signs of photodamage which include appearance of wrinkles, pigmented lesions, actinic keratoses and patchy hypopigmentations. Therapeutic modalities imply photoprotection with sunscreens that prevent sunburns and block ultraviolet irradiation. Other modalities include use of retinoids which regulate gene transcription with subsequent cellular differentiation and proliferation. The topical and peroral administration of network antioxidants, such as vitamin E and C, **coenzyme Q10**, alpha-lipoic acid and glutathione, enhance antiaging effect. The other antioxidants such as green tea, dehydroepiandrosterone, melatonin, selenium and resveratrol, have also antiaging and anti-inflammatory effects. Topical bleaching agents such as hydroquinone, kojic acid and azelaic acid can reduce signs of aging. Studies confirm the efficacy of these topical agents in combination with superficial and/or medium depth or deep peeling agents for photodamaged **skin** treatment. Indications for type of chemical peels according to various clinical diagnosis are done, as well as advantages and disadvantages of different types of chemical peels.

[PLoS One](#). 2010 Jul 30;5(7):e11897.

Treatment of CoQ(10) deficient fibroblasts with ubiquinone, CoQ analogs, and vitamin C: time- and compound-dependent effects.

[López LC](#), [Quinzii CM](#), [Area E](#), [Naini A](#), [Rahman S](#), [Schuelke M](#), [Salviati L](#), [Dimauro S](#), [Hirano M](#).

Source

Department of Neurology, Columbia University Medical Center, New York, New York, United States of America.

Abstract

BACKGROUND:

Coenzyme Q(10) (CoQ(10)) and its analogs are used therapeutically by virtue of their functions as electron carriers, antioxidant compounds, or both. However, published studies suggest that different ubiquinone analogs may produce divergent effects on oxidative phosphorylation and oxidative stress.

METHODOLOGY/PRINCIPAL FINDINGS:

To test these concepts, we have evaluated the effects of CoQ(10), coenzyme Q(2) (CoQ(2)), idebenone, and vitamin C on bioenergetics and oxidative stress in human **skin** fibroblasts with primary CoQ(10) deficiency. A final concentration of 5 microM of each compound was chosen to approximate the plasma concentration of CoQ(10) of patients treated with oral ubiquinone. CoQ(10) supplementation for one week but not for 24 hours doubled ATP levels and ATP/ADP ratio in CoQ(10) deficient fibroblasts therein normalizing the bioenergetics status of the cells. Other compounds did not affect cellular bioenergetics. In COQ2 mutant fibroblasts, increased superoxide anion production and oxidative stress-induced cell death were normalized by all supplements.

CONCLUSIONS/SIGNIFICANCE:

THESE RESULTS INDICATE THAT: 1) pharmacokinetics of CoQ(10) in reaching the mitochondrial respiratory chain is delayed; 2) short-tail ubiquinone analogs cannot replace CoQ(10) in the mitochondrial respiratory chain under conditions of CoQ(10) deficiency; and 3) oxidative stress and cell death can be counteracted by administration of lipophilic or hydrophilic antioxidants. The results of our in vitro experiments suggest that primary CoQ(10) deficiencies should be treated with CoQ(10) supplementation but not with short-tail ubiquinone analogs, such as idebenone or CoQ(2). Complementary administration of antioxidants with high bioavailability should be considered if oxidative stress is present.

[Macromol Biosci.](#) 2010 Oct 8;10(10):1171-6.

The design of polymer-based nanocarriers for effective transdermal delivery.

[Kim J](#), [Shim J](#), [Kim YJ](#), [Char K](#), [Suh KD](#), [Kim JW](#).

Source

School of Chemical and Biological Engineering, Seoul National University, Seoul, Korea.

Abstract

This study reports a facile and practical means to non-invasively deliver biologically active ingredients through the **skin** using polymer-based nanocarriers. For this, polymer nanocapsules were fabricated with different surface charges as well as glass transition temperatures and we observed their ability to deliver the encapsulated active ingredient, **coenzyme Q10**, through the **skin** layer. Direct imaging of a probe molecule, Nile Red, and a matrix polymer labeled with fluorescence moiety, Lucifer Yellow, allowed us to demonstrate that the probe molecule readily permeates into the deep **skin**, while the matrix polymer stays in the stratum corneum layer due to electrostatic interactions. Quantitative characterization of the penetrating amount of **coenzyme Q10** using the Franz cell method proved that, to achieve improved delivery efficiency, the nanocapsule should have a low glass transition temperature as well as positive surface charges.

[FASEB J.](#) 2010 Oct;24(10):3733-43. Epub 2010 May 21.

Reactive oxygen species, oxidative stress, and cell death correlate with level of CoQ10 deficiency.

[Quinzii CM](#), [López LC](#), [Gilkerson RW](#), [Dorado B](#), [Coku J](#), [Naini AB](#), [Lagier-Tourenne C](#), [Schuelke M](#), [Salviati L](#), [Carrozzo R](#), [Santorelli F](#), [Rahman S](#), [Tazir M](#), [Koenig M](#), [DiMauro S](#), [Hirano M](#).

Source

Department of Neurology, Columbia University Medical Center, 630 W. 168th St., P&S 4-423, New York, NY 10032, USA.

Abstract

Coenzyme Q(10) (CoQ(10)) is essential for electron transport in the mitochondrial respiratory chain and antioxidant defense. The relative importance of respiratory chain defects, ROS production, and apoptosis in the pathogenesis of CoQ(10) deficiency is unknown. We determined previously that severe CoQ(10) deficiency in cultured **skin** fibroblasts harboring COQ2 and PDSS2 mutations produces divergent alterations of bioenergetics and oxidative stress. Here, to better understand the pathogenesis of CoQ(10) deficiency, we have characterized the effects of varying severities of CoQ(10) deficiency on ROS production and mitochondrial bioenergetics in cells harboring genetic defects of CoQ(10) biosynthesis. Levels of CoQ(10) seem to correlate with ROS production; 10-15% and >60% residual CoQ(10) are not associated with significant ROS production, whereas 30-50% residual CoQ(10) is accompanied by increased ROS production and cell death. Our results confirm that varying degrees of CoQ(10) deficiency cause variable defects of ATP synthesis and oxidative stress. These findings may lead to more rational therapeutic strategies for CoQ(10) deficiency.

PMID:
20495179

[Biofactors](#). 2008;32(1-4):245-55.

Aging skin is functionally anaerobic: importance of coenzyme Q10 for anti aging skin care.

[Prahl S](#), [Kueper T](#), [Biernoth T](#), [Wöhrmann Y](#), [Münster A](#), [Fürstenau M](#), [Schmidt M](#), [Schulze C](#), [Wittern KP](#), [Wenck H](#), [Muhr GM](#), [Blatt T](#).

Source

R&D, Beiersdorf AG, Hamburg, Germany.

Abstract

The functional loss of mitochondria represents an inherent part in modern theories trying to explain the cutaneous aging process. The present study shows significant age-dependent differences in mitochondrial function of keratinocytes isolated from **skin** biopsies of young and old donors. Our data let us postulate that energy metabolism shifts to a predominantly non-mitochondrial pathway and is therefore functionally anaerobic with advancing age. **CoQ10** positively influences the age-affected cellular metabolism and enables to combat signs of aging starting at the cellular level. As a consequence topical application of **CoQ10** is beneficial for human **skin** as it rapidly improves mitochondrial function in **skin** in vivo.

PMID:
19096122

[Acta Dermatovenerol Alp Panonica Adriat.](#) 2008 Jun;17(2):47-54.

Skin aging.

[Puizina-Ivić N.](#)

Source

Department of Dermatovenerology, Split Clinical Hospital Center, Soltanska 1, 21 000 Split, Croatia.
neira@radogost.com

Abstract

There are two main processes that induce **skin** aging: intrinsic and extrinsic. A stochastic process that implies random cell damage as a result of mutations during metabolic processes due to the production of free radicals is also implicated. Extrinsic aging is caused by environmental factors such as sun exposure, air pollution, smoking, alcohol abuse, and poor nutrition. Intrinsic aging reflects the genetic background and depends on time. Various expressions of intrinsic aging include smooth, thinning **skin** with exaggerated expression lines. Extrinsically aged **skin** is characterized by photo damage as wrinkles, pigmented lesions, patchy hypopigmentations, and actinic keratoses. Timely protection including physical and chemical sunscreens, as well as avoiding exposure to intense UV irradiation, is most important. A network of antioxidants such as vitamins E and C, **coenzyme Q10**, alpha-lipoic acid, glutathione, and others can reduce signs of aging. Further anti-aging products are three generations of retinoids, among which the first generation is broadly accepted. A diet with lot of fruits and vegetables containing antioxidants is recommended as well as exercise two or three times a week.

PMID:
18709289

[Cell Mol Biol \(Noisy-le-grand\)](#). 2007 Apr 15;53(1):94-101.

Beneficial effects of pro-/antioxidant-based nutraceuticals in the skin rejuvenation techniques.

[de Luca C](#), [Deeva I](#), [Mikhal'Chik E](#), [Korkina L](#).

Source

Lab. Tissue Engineering & Cutaneous Physiopathology, Istituto Dermopatico dell'Immacolata, IRCCS, Rome, Italy. c.deluca@idi.it

Abstract

Modern technologies of **skin** rejuvenation include many physical and chemical intervention tools--laser irradiation, oxygen and ozone therapy, chemical peels, plastic surgery operations--affecting by different mechanisms the sensitive physiological free radical/antioxidant balance in the **skin**. All these interventions induce from mild to severe tissue damage, providing beneficial biochemical stimuli for **skin** re-epithelization and rejuvenation. Paradoxically, free radical production in the course of tissue inflammation helps to combat free radical damage consequent to the ageing process. We have studied two animal models (experimental burn and trichloroacetic peeling), reproducing on the Wistar rat the effects generated by the commonly practiced aesthetic medicine procedures of laser resurfacing and chemical peels, demonstrating that the severe oxidative stress induced both systemically and on **skin** can be modulated by the oral pre- and post treatment administration of specific nutraceutical formulations. Potent antioxidants (RRR-alpha-tocopherol, **coenzyme Q10**), enhancing antioxidant defences, coupled with mild pro-oxidants, enhancers of a specific immune defense (soy phospholipids, L-methionine), at the blood and the **skin** levels, proved in fact to be beneficial in vivo, on the rat, for **skin** healing, trophism and accelerated re-epithelization. Data obtained allow us to predict the possibility of innovative protocols for dermocosmetology, enabling successful lowering of the risk of permanent adverse effects, and prolonging the duration of the beneficial effects of dermocosmetologic procedures.

PMID:
17519117

[J Neurol Sci.](#) 2004 May 15;220(1-2):41-8.

Effect of coenzyme Q10 on the mitochondrial function of skin fibroblasts from Parkinson patients.

[Winkler-Stuck K](#), [Wiedemann FR](#), [Wallesch CW](#), [Kunz WS](#).

Source

Klinik für Neurologie der Otto-von-Guericke-Universität Magdeburg, Leipziger Strasse 44, 39120 Magdeburg, Germany.

Abstract

Several lines of evidence suggest an impairment of mitochondrial function in the brain of patients with Parkinson's disease (PD). However, the presence of a detectable mitochondrial defect in extracerebral tissue of these patients remains a matter of dispute. Therefore, we investigated mitochondrial function in fibroblasts of 18 PD patients applying biochemical micromethods. Putative beneficial effects of coenzyme Q(10) (CoQ(10)), a potent antioxidant, on the mitochondrial function of **skin** fibroblast cultures were evaluated. Applying inhibitor titrations of the mitochondrial respiration to calculate flux control coefficients of respiratory chain complexes I and IV, we observed deficiencies of both complexes in cultivated **skin** fibroblasts of PD patients. Cultivation of fibroblasts in the presence of 5 microM CoQ(10) restored the activity of impaired respiratory chain complexes in the fibroblast cultures of 9 out of 18 PD patients. Our data support the presence of a generalised mitochondrial defect in at least a subgroup of patients with PD that can be partially ameliorated in vitro by coenzyme Q(10) treatment.

PMID:
15140604

[Free Radic Res.](#) 2002 Apr;36(4):471-7.

Lipophilic antioxidants in human sebum and aging.

[Passi S](#), [De Pità O](#), [Puddu P](#), [Littarru GP](#).

Source

IDI-IRCCS, Rome, Italy.

Abstract

Skin surface lipids (SSL), a very complex mixture of sebum mixed to small amounts of epidermal lipids, mantle the human epidermis, thus representing the outermost protection of the body against exogenous oxidative insults. The present work is a systematic and quantitative analysis of upper-chest SSL and their content in antioxidants in 100 healthy volunteers, divided into five age groups using TLC, HPLC, and GC-MS methods. Further, the effect of exposing SSL in vitro to increasing doses of UV irradiation was examined. Straight monounsaturated and diunsaturated as well as branched monounsaturated fatty acids of triglycerides and pooled fractions were found to be higher at maturity than in childhood and in advancing age. Diunsaturated fatty acids were below 3% of the total and constituted exclusively of C18:2 Δ 5,8, C20:2 Δ 7,10, C18:2 Δ 9,12. Squalene, vitamin E (vit. E) and **Coenzyme Q10 (CoQ10)** were found to increase from childhood to maturity to decrease again significantly in old age. Vitamin E and **CoQ10** were the only known lipophilic antioxidants present in SSL. In spite of their low levels they were found to synergically inhibit the UV induced depletion of squalene, cholesterol and of unsaturated fatty acids of SSL. In fact, exposure of SSL to increasing amounts of UV irradiation led preferentially to lowering of the levels of vit. E and **CoQ10**. Four minimal erythema dose (MED) (5.6J/cm²) were able to deplete 84% vit. E and 70% ubiquinone, and only 13% squalene. Diunsaturated and monounsaturated fatty acids as well as cholesterol were unaffected even following 10 MED UV exposures, which produced a 26% loss of squalene. The same UV dose when applied in the absence of vit. E and **CoQ10** produced a 90% decrease of squalene.

PMID:
12069113

[Biofactors](#). 1999;9(2-4):371-8.

Coenzyme Q10, a cutaneous antioxidant and energizer.

[Hoppe U](#), [Bergemann J](#), [Diemebeck W](#), [Ennen J](#), [Gohla S](#), [Harris I](#), [Jacob J](#), [Kielholz J](#), [Mei W](#), [Pollet D](#), [Schachtschabel D](#), [Sauermann G](#), [Schreiner V](#), [Stäb F](#), [Steckel F](#).

Source

Paul Gerson Unna Research Center, Beiersdorf AG, Hamburg, Germany.

Abstract

The processes of aging and photoaging are associated with an increase in cellular oxidation. This may be in part due to a decline in the levels of the endogenous cellular antioxidant **coenzyme Q10** (ubiquinone, **CoQ10**). Therefore, we have investigated whether topical application of **CoQ10** has the beneficial effect of preventing photoaging. We were able to demonstrate that **CoQ10** penetrated into the viable layers of the epidermis and reduce the level of oxidation measured by weak photon emission. Furthermore, a reduction in wrinkle depth following **CoQ10** application was also shown. **CoQ10** was determined to be effective against UVA mediated oxidative stress in human keratinocytes in terms of thiol depletion, activation of specific phosphotyrosine kinases and prevention of oxidative DNA damage. **CoQ10** was also able to significantly suppress the expression of collagenase in human dermal fibroblasts following UVA irradiation. These results indicate that **CoQ10** has the efficacy to prevent many of the detrimental effects of photoaging.

PMID:

10416055