Enhancing the anti-aging effects of Coenzyme Q10 by antioxidants and energy metabolites

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Background: Coenzyme Q10 (Q10, Ubiquinone) is an ubiquitous coenzyme present in all human cells. Q10 exhibits a dual function. On the one hand, it is a lipid-soluble antioxidant found in plasma and cells where it inhibits lipid, protein, and DNA oxidation. On the other hand, Q10 is a crucial component of the mitochondrial respiratory chain responsible for cellular energy production. Several studies showed that endogenous Q10 level in human skin decline with age and under the influence of external stress factors such as UV irradiation [1, 2].

Objective: We investigated the effects of Q10 together with additional active ingredients, such as vitamin C (VitC) and creatine, on cellular bioenergetics and on UV stressed skin cells. VitC is a strong anti-oxidant and creatine's main function is to facilitate recycling of ADP to ATP from phosphocreatine in the creatine kinase reaction [3].

Methods: Extracellular Flux assay, ELISA, UV irradiation, HPLC–MS/MS

Results: Recently, it was shown that the addition of Q10 to human epidermal keratinocytes increases cellular respiration in vitro [4-6]. Further in vitro studies revealed that the combination of Q10 with VitC is much more effective in enhancing the cellular metabolism in keratinocytes than Q10 alone (readout: oxygen consumption rate (OCR)). Furthermore, we and others could show that UV stress diminishes Q10 levels in skin and generates reactive oxygen species as well as activates collagen degradating enzymes such as matrix metalloproteinase-1 (MMP-1) [7] . Pre-incubation of human dermal fibroblasts with Q10 and creatine strongly prevents UV stress induced upregulation of MMP-1.

Thus, we conclude that active ingredient combinations of Q10 with VitC and/or creatine would be an efficient treatment option to counteract photoaging.

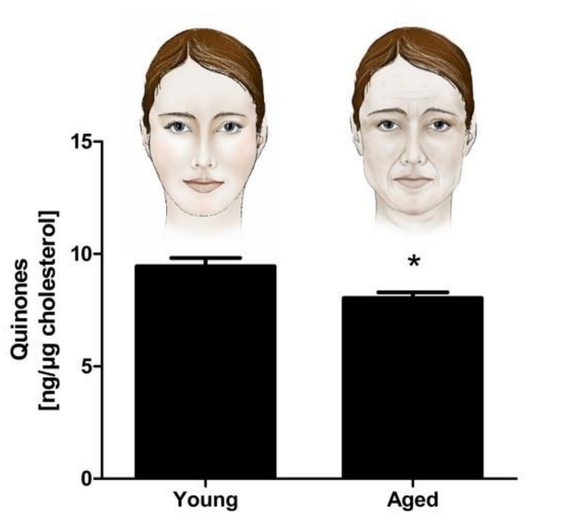

Fig. 1: Age-dependent decline of total Q10 levels in human epidermis.
Total Q10 concentrations from young (20-25 years; n = 28) and aged (60-66 years; n = 28) volunteers were measured using suction blister epidermis obtained from untreated forearm skin. Data are depicted as mean ± SEM. Significant differences are marked with an asterisk (* for $p \leq 0.05$). With permission from Knott, 2015.

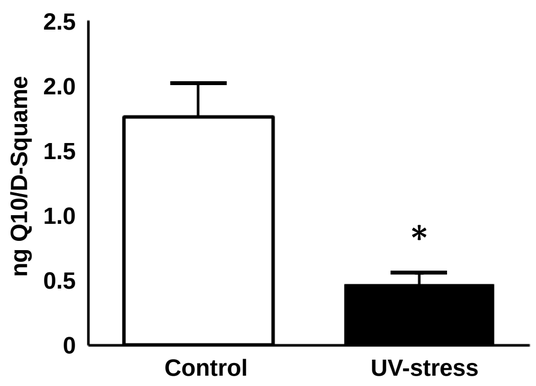

Fig. 2: In vivo UV irradiation of skin leads to a decline of Q10 levels in the epidermis. 1.5 MED were applied on the back of volunteers (n = 13). 2 h after irradiation Q10 levels were analyzed in D-Squame samples. Significant differences are marked with an asterisk (* for $p \leq 0.05$).

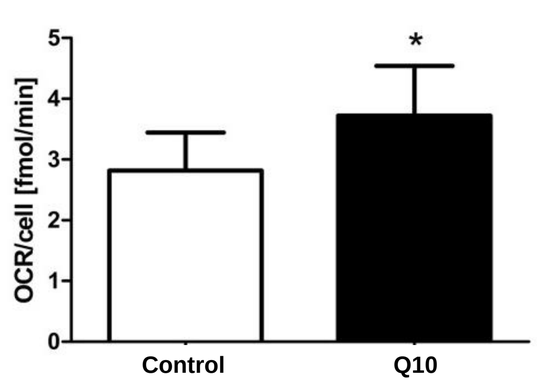

Fig. 3: Energy metabolism of cultured keratinocytes is increased after treatment with Q10. Cultured human keratinocytes were supplemented with Q10 (representing the amount of Q10 which was determined in the tissue after topical treatment) and the oxygen consumption rate (OCR) was determined (n = 6). Significant differences are marked with an asterisk (* for $p \leq 0.05$). With permission from Knott, 2015.

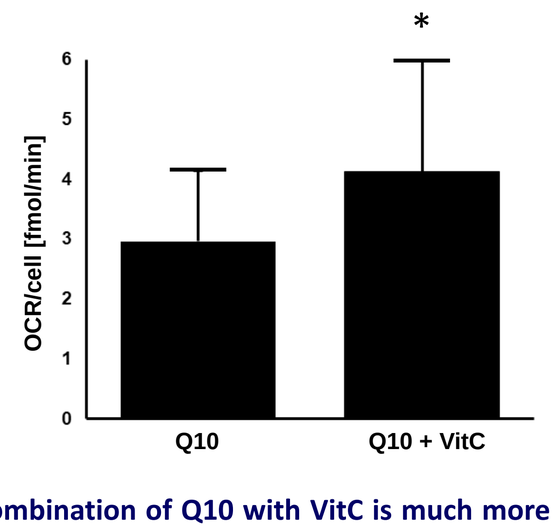

Fig. 4: The combination of Q10 with VitC is much more effective than Q10 alone in increasing energy metabolism. Cultured human keratinocytes were supplemented with Q10 and VitC and the oxygen consumption rate (OCR) was determined (n = 12). Significant differences are marked with an asterisk (* for $p \leq 0.05$).

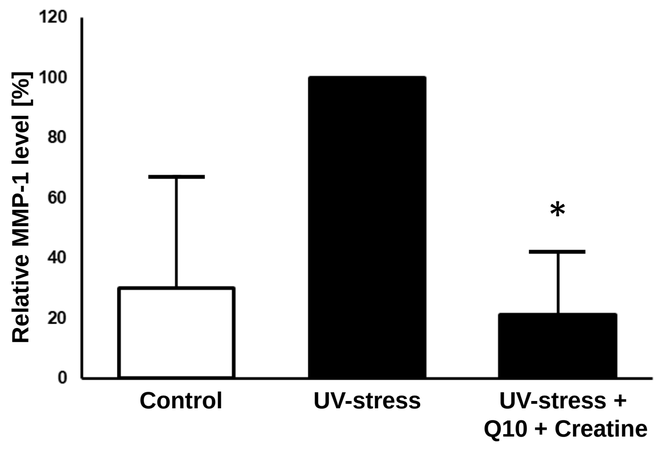

Fig. 5: The combination of Q10 with creatine prevents UV-dependent induction of MMP-1. Human dermal fibroblasts were pre-incubated with Q10 and creatine for 24 h. The cells were irradiated with 135 mJ/cm² SSR and incubated with the active ingredients for additional 48 h. MMP-1 levels (pg MMP-1/mg protein) were determined by Bioplex ELISA (n = 12). Significant differences are marked with an asterisk (* for $p \leq 0.05$).

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Literature:
[1] Hoppe et al, Biofactors, 1999
[2] Podda et al, Free Radic Biol Med, 1998
[3] Lenz et al, J Invest Dermatol, 2005
[4] Prahl et al, 2008, Biofactors
[5] Knott et al, Biofactors, 2015
[6] Schniertshauer et al, Photochem Photobiol, 2016
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