Is there an influence of the carotenoids lutein and beta-carotene on iron absorption and do these two compounds differ in their effectiveness?

Project: 420

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Introduction: Carotenoids are a large group of fat-soluble pigments which are intensely coloured and usually responsible for the yellow, orange and red colours in fruits and vegetables. In Western diets, the most abundant carotenoids are the xanthophyll lutein and the oxygen-free β-carotene. Based on European consumption data, the mean intake of lutein and β-carotene varies between 1.6-3.3 mg/d and 3.0-5.8 mg/d. In relation to health, there is a suggestion that carotenoids increase iron absorption. Iron deficiency is the most widespread nutritional deficiency in both industrialized and developing countries. If carotenoids could increase iron absorption, they would become only the third food component known to enhance iron absorption beside ascorbic acid and the haem protein from animal food.

Study design: 32 female subjects were randomly assigned to two groups (study 1 and 2) of 16 subjects each, differing in the added component given. The test meals consisted of 100 g wheat bread roll, spread with 10 g of margarine (M Budget, Migros) and 50 g of cheese (Gouda M Budget, Migros). The three test meals were consumed on three consecutive days as breakfast. To each test meal 4 mg of Fe was added as $^{57}FeSO_4$, $^{58}FeSO_4$, and $^{54}FeSO_4$, respectively. In both studies a plain test meal with labeled iron was administered as control. In study 1, 3 mg lutein were added directly in form of beadlets to the second meal. The third meal contained ascorbic acid as positive control. In study 2, 3 mg β-carotene were added directly in form of beadlets to the second meal, whereas the third meal consisted of a wheat bread with baked-in β-carotene. 14 days after the last test meal a blood sample was taken to measure Fe isotopic composition in haemoglobin to calculate fractional iron absorption.

Results: In study 1 the basal iron absorption of the control test meal was very low with 2.96%. However, 3 mg of directly added lutein increased iron absorption slightly but statistically significant ($p<0.05$) to 4.11%. In the positive control with the added vitamin C iron absorption was in average almost threefold than the negative control (8.45%). In study 2 the average basal iron absorption of the blank test meal was 2.82%, i.e. almost identical to the basal iron absorption in the lutein study with. The addition of 3 mg β-carotene directly on the bread roll decreased iron absorption slightly but not statistically significant to 2.41%. The test meal with the baked-in β-carotene increased iron absorption marginally to 3.08%, also without statistical differences.

Additionally, we measured plasma vitamin A levels of the subjects, caused by the assumption that the vitamin A status might play an important role for iron absorption. In comparison to WHO cut off for vitamin A deficiency (0.7µmol/L), we found an average serum retinol concentration of 2.29 ± 0.59 µmol/L in study 1 (lutein) and 2.01 ± 0.74 µmol/L in study 2 (β-carotene), respectively.

Outlook: The biochemical mechanism how lutein can increase iron absorption and why only lutein showed this effect, is still unknown. Therefore some *in vitro* studies are being carried out to investigate iron solubility under gastric conditions in the presence of lutein an β-carotene. Specifically, the study will test the influence of both carotenoids on solubility of iron sulphate ($FeSO_4$), iron fumarate ($FeC_4H_2O_4$) and iron phosphate ($FePO_4$), which are characterized by increasing solubility. The influence of different molar ratios (iron: carotenoid), pH and incubation time on iron solubility will be determined.