Unsaturated Fatty Acids promote carotenoid bioavailability \textit{in vitro}

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\textbf{ABSTRACT}

Dietary lipid is a known enhancer of carotenoid bioavailability, although information on the amounts and types of lipid on optimal absorption of these compounds is limited. We have investigated the effects of several common commercial lipids on carotenoid bioavailability using in vitro digestion and Caco-2 human intestinal cells. Meals consisted of a mixed vegetable salad (3g) with test lipid (180mg). Micellarization and cellular uptake of \textit{β}-carotene (\textit{β}C) and \textit{lycophene} during small intestinal digestion was increased by lipids rich in unsaturated FA: soybean oil > olive oil > canola oil > butter. In contrast, type of lipid minimally affected micellarization or cellular uptake of xanthophylls. Caco-2 cells grown on transwell membranes chronically exposed to micellar mixtures of FA (1.0mM) mimicking the types and ratio of saturated to unsaturated (mono- + poly-unsaturated) FA present in butter (70:30), olive oil (7:93) and soybean oil (11:89). Then cells were exposed to micelles containing \textit{β}C, LUT and a mixture of FA. Uptake and transcellular transport of \textit{β}C and LUT were greater in cells pre-treated with mixtures enriched in unsaturated compared to saturated FA. These results suggest that oils rich in unsaturated FA promote carotenoid bioavailability. (USDA NRI and OARDC)

\textbf{INTRODUCTION}

The bioavailability of carotenoids, which are the major dietary source of provitamin A, is generally low. Factors affecting bioavailability are, but not limited to, 1) Physico-chemical properties of carotenoids, 2) Food matrix (processing and formulation), 3) Nutritional and physiological status and 4) genotype. Evidences showed dietary lipid incorporation into meal can help the bioaccessibility and bioavailability of carotenoids. However, data on the effect of dietary lipid type and fatty acid profile (i.e. saturated vs unsaturated) to the bioavailability of carotenoids is limited.

\textbf{MATERIALS & METHODS}

\textbf{OBJECTIVES}

- To develop strategies for enhanced utilization of carotenoids from commonly consumed foods
- Examine impact of dietary fat profiles (TG fatty acyl chain length, degree of saturation) on 1) micellarization, 2) intestinal cell uptake, and 3) chylomicron mediated transport of carotenoids.

\textbf{RESULTS}

- Food Model: Salad was selected as a standard dietary model for the study. All ingredients were obtained from standard grocery store and then weighed according to normal salad proportion by USDA (Table 1). The salad was homogenized and pureed by commercial blender for 2 minutes.

- Experimental Design:
  - \textit{β}C, LUT and a mixture of FA were added to salad in the form of butter, canola oil, olive oil, and soybean oil.
  - Cells were exposed to micelles containing \textit{β}C, LUT and a mixture of FA.

- Bioaccessibility: Micellarization Efficiency
  - Impact of dietary fat type on \textit{β}C micellarization efficiency
  - Impact of dietary fat type on LUT micellarization efficiency

- Cellular Uptake
  - Impact of dietary fat type on \textit{β}C cellular uptake by Caco-2 cells
  - Impact of dietary fat type on LUT cellular uptake by Caco-2 cells

- Bioavailability: Cellular Transport
  - Impact of dietary fat type on \textit{β}C transcellular transport by Caco-2 cells
  - Impact of dietary fat type on LUT transcellular transport by Caco-2 cells

\textbf{CONCLUSIONS}

- Micellarization and cellular uptake of \textit{β}-carotene (\textit{β}C) and \textit{lycophene} during small intestinal digestion was increased by lipids rich in unsaturated FA: soybean oil > olive oil > canola oil > butter. In contrast, type of lipid minimally affected micellarization or cellular uptake of xanthophylls.
- Uptake and transcellular transport of \textit{β}C and LUT were greater in cells pre-treated with mixtures enriched in unsaturated compared to saturated FA.

\textbf{REFERENCES}

(1) Failla ML, Chitchumroonchokchai C. Oils rich in unsaturated FA may promote carotenoid bioavailability. The research was supported by USDA and also in part by funds from The Ohio Agricultural Research and Development Center (OARDC).

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