A cartotenoid-rich salad purée with varying amounts of either a structured lipid or dietary oil was digested using simulated gastric and small intestinal conditions. Lutein and carotenoids (∝-carotene, β-carotene and lycopene) in chyme and micelle fraction were quantified to determine digestive stability and efficiency of micellarization (“bioaccessibility”). Relative micellarization was as follows: lutein > ∝- and β-carotene > lycopene. Micellarization of carotenoids, but not lutein, was enhanced (P<0.05) by addition of lipid (2.5% v/w) to purée and dependent on fatty acid chain length in structured TG (c18:1 > c8:0 > c6:0). Micellarization efficiency for each carotenoid was similar when equivalent amounts of tri-oleate (c18:1), tri-linoleate (c18:2), and tri-linolenate (c18:3) were added to purée. Relatively low amounts of tri-oleate and canola oil (0.5-1.0%) were required for maximum micellarization of carotenoids, but more oil (∼2.5%) was required when TG with medium chain saturated fatty acids (e.g., tri-octanoate and coconut oil) was added to salad purée. The results suggest transfer of carotenoids from chyme to mixed micelles during digestion is inversely correlated with hydrophobicity of the pigment, generally requires minimum (0.5-1%) lipid in the purée, and is influenced by chain length, but not degree of saturation, of dietary fatty acids in TG. (Supported in part by OARDC Graduate Student Scholarship to TH)

Introduction

Carotenoids are lipophilic plant pigments with various biological properties that include pro-vitamin A activity, antioxidant activity, photoprotection of eye and skin, and vitamin A independent regulation of cell signaling and gene transcription. In order to deliver carotenoids and their metabolites to target tissues to mediate these activities, these compounds must be released from the food matrix and incorporated into micelles, taken up by enterocytes and incorporated in chylomicrons and secreted into lymph for distribution to target tissues. (6) The absorption of carotenoids is affected by numerous post-harvesting, physicochemical, dietary, physiological and pathological factors. (7) Dietary lipid is recognized as a potent promoter of carotenoid bioavailability. (8,9) This is likely associated with the ability of dietary fat to: a) provide a “sink” for transfer of carotenoids from food matrix to oil droplets, b) stimulate secretion of bile and pancreatic enzymes, and c) promote the synthesis and secretion of chylomicrons. The effects of quantity and composition of dietary lipids on processes required for the absorption of carotenoids have not been systematically investigated. The goal of this research is to clarify the influences of amount and type of dietary triglycerides (TG) on the following processes: micellarization; uptake of micellarized carotenoids by enterocytes; and carotenoid secretion across enterocyte brush borders.

2. Methods

2.1 Simulated gastric and small intestinal digestion

2.2 Carotenoid extraction and analysis

Results

1. Materials

1.1 Test Salad Purée

Salad purée was prepared by homogenizing carrot, romaine lettuce and orange pepper) and stored in -80 ˚C. The frozen salad purée contained LUT (1.95mg/100g) AC (1.17mg/100g), BC (3.83mg/100g) and LYC (3.72mg/100g). Carotenoids were stable in the frozen puree for at least 2 months. All reagents were purchased from Sigma-Aldrich (Milwaukee, WI). Carotenoids were stable in the frozen puree for at least 2 months. All reagents were purchased from Sigma-Aldrich (Milwaukee, WI).

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References

Acknowledgement

Impact of Composition and Quantity of Triglycerides on Micellarization of Dietary Carotenoids during Simulated Digestion

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Abstract

Efficiency of micellarization of carotenoids during digestion will be dependent on chain length and degree of saturation of fatty acids in TG, as well as amount of the dietary TG.

Hypothesis

Materials and Methods

1. Materials

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1. Test Triglycerides

Structural lipids include tributyrates (C4:0), trioleates (C18:1), tri-linoleates (C18:2), tri-linolenates (C18:3) and oil and water isosmotic of canola and soybean oils. Oil-in-water emulsion was prepared using Cox/COX (1:1), LUT, AC and BC (1:1:1:1) and stored at -80 ˚C.

2. Statistical analysis

Statistical analysis was performed using SPSS/WIN 14.0. The efficiency of micellarization was calculated for each carotenoid in each purée sample. Values are expressed as means ± SD. Significant differences for effects of amount and type of oil were tested by one-way ANOVA followed by Dunnett’s post hoc test. Three or six observation was made determined whether there is significantly different between groups (depending on the experiment). The differences are considered significant at P < 0.05.

Summary

- Partitioning of carotenoids in aqueous fraction (i.e., micellarization) during in vitro digestion of salad purée was enhanced by addition of TG in salad purée.
- Efficiency of micellarization of carotenoids from the salad is influenced by carotenoid structure : lutein > ∝-carotene, β-carotene > lycopene.
- Micellarization of carotenoids is dependent on chain length, but not the number and position (data not shown) of double bonds, of TG fatty acids.
- Relatively low amounts (approx. 0.5-1.0%, v/w) of trioleate and canola oil are required for maximum micellarization of carotenoids, but more oil is required (approx. 0.5%, v/w) if TG contains medium chain saturated fatty acids, e.g., tri-octanoate and coconut oil.

Abbreviations used: TG, triglyceride; LUT, lutein; BC, β-carotene; AC, ∝-carotene; LYY, lycopene.

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