β-Carotene
(trans or cis isomer)
Overview

- Natural beta-carotene contains a mixture of different isomers (cis and trans) of the beta-carotene molecule.
- Synthetically produced beta-carotene is *nature identical*.
- Most food sources contain both trans and cis isomers, although some foods such as raw carrots contain up to 98% trans isomers, making their beta-carotene content similar to synthetic sources.
## B-Carotene Compositions

<table>
<thead>
<tr>
<th>Source</th>
<th>Composition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All-trans-β-carotene</td>
</tr>
<tr>
<td>Palm oil</td>
<td>36</td>
</tr>
<tr>
<td>Algae</td>
<td>48</td>
</tr>
<tr>
<td>Synthesis</td>
<td>98</td>
</tr>
<tr>
<td>Fermented</td>
<td>96</td>
</tr>
</tbody>
</table>
Are the Two Isomers of Beta-Carotene Absorbed Differently?

- Conversions between isomeric forms occur in various cells and tissues of the body.


- Formulations containing only trans isomers are absorbed more efficiently and raise plasma levels of all beta-carotene isomers to a greater extent than cis-trans mixtures.
Digestion and Absorption of Beta-Carotenones

- Absorption of Beta-carotene and other carotenoids from vegetables is usually 5-30 percent of the absorption from synthetic supplements.
- Gastric pH level has been found to alter B-carotene absorption.
- Dietary fat is a factor in carotenoid absorption.
- Absorption studies exploring individual isomers are difficult given that some B-carotene is converted to vitamin A in the intestinal lumen and some is unabsorbed and lost in the feces.
Cis Versus All-trans and Differences in Absorption

- The majority of carotenoids in nature occur in the all-trans form, which is molecularly identical to synthetically produced trans B-carotene.

- Raw carrots, tomatoes, and sweet potatoes are nearly devoid of the cis isomer; 98 percent of the B-carotene in raw carrots is in the trans form.
Cis Versus All-trans and Differences in Absorption

- Multiple studies have compared human absorption of trans B-carotene with a natural isomeric mix of trans and cis B-carotene from algal sources.
- The trans isomer is the most common form in human tissue, comprising up to 60 percent of the total B-carotene content.
- Data from absorption studies show clear differences in absorption among the isomeric forms. Multiple studies have compared human absorption of trans B-carotene with a natural isomeric mix of trans and cis B-carotene from algal sources.
Cis Versus All-trans and Differences in Absorption (Study Parameters)

- Gaziano, et al. 24 adult M + F for 6 days 100 mg synthetic vs. 66 or 100 mg algal source (trans/cis ratio=50:50)
- Jensen, et al. 16 adult M and F for 7 days 24 mg [Beta]-carotene algal source: (trans/cis ratio=40:60) 24 mg [Beta]-carotene raw carrot: (98% all-trans)
- You, et al. 3 adult M and F single dose 1 mg [Beta]-carotene (99.4% cis)- radioactively labeled ([sup.13]C)
- Tamai, et al. 30 adult M 60 mg of either: algal [Beta]-carotene (trans/9-cis ratio=50:50) vs. all trans or placebo - 44 weeks
Cis Versus All-trans and Differences in Absorption (Results)

- Gaziano, et al. 160% increase in plasma [Beta]-carotene with synthetic, all trans form. 87% increase in plasma [Beta]-carotene with natural algal form.
- You, et al. >95% of 13 C [Beta]-carotene in plasma found as trans isomer (14-52%) and retinol.
- Tamai, et al. Levels of both cis (77%) and trans (116%) isomers significantly higher with all-trans [Beta]-carotene.
Conclusion

- The efficient uptake of trans B-carotene and isomerization in the gut to cis B-carotene appears to make the synthetic form more desirable for effective absorption.
- The transport mechanisms of cis B-carotenoids may be different than those defined for trans B-carotenoids and may explain their appearance in tissues at greater levels than those found in plasma.