

Stabilization and Solubilization of Astaxanthin by Inclusion Complex Formation with Cyclodextrin

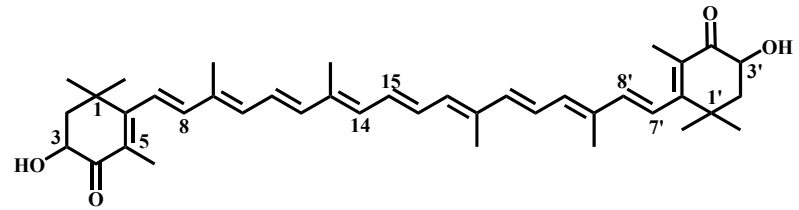
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Introduction

Astaxanthin

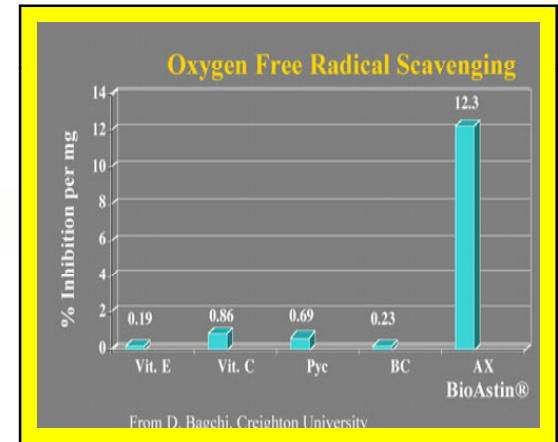


- ▣ A carotenoid pigment found in certain marine animals and plants such as shrimp and algae
- ▣ similar structure to beta-carotene
- ▣ protecting DNA, enzyme and cells against oxidative damage
- ▣ powerful antioxidant properties

Astaxanthin (550 times) >> Vit E

Types of currently available astaxanthin

- ▣ Chemical synthetic forms : free
 - ▣ Natural forms
 - Krill and crayfish oils (~ 0.15 %), esterified
 - *Phaffia* yeast (~ 0.40 %), free
 - *Hamatococcus* species (1.5-3.0 %), esterified



Dosage of astaxanthin : 2 mg/day
(FDA)

Research purpose

The problem of astaxanthin

Poor aqueous solubility



limits its application
in aqueous phase

Highly unsaturated molecule



damaged by heat or light

**Water-solubilization
and stabilization of astaxanthin
for functional food & cosmetics**



Material and method

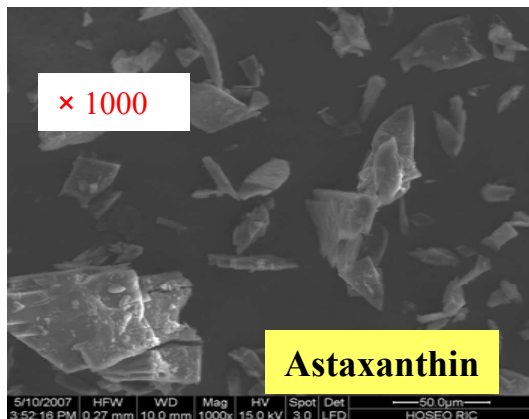
■ Material

- Astaxanthin
- α -, β -, γ - cyclodextrin(CD) : Wako, Japan
- HP β -, HP γ -CD : Sigma, USA
- Cyclo B(β -CD) : Corn products, USA

■ Analysis

- particle size : Scanning electron microscope(SEM)
- Change of structure : FT-IR

■ Water-solubility & stability



Astaxanthin in dichlo:Ace.



Cyclodextrin in DW, 50 °C



Astaxanthin : CD = 1: 1 - 1: 200



Stirring (50°C, 7hr)



cooling



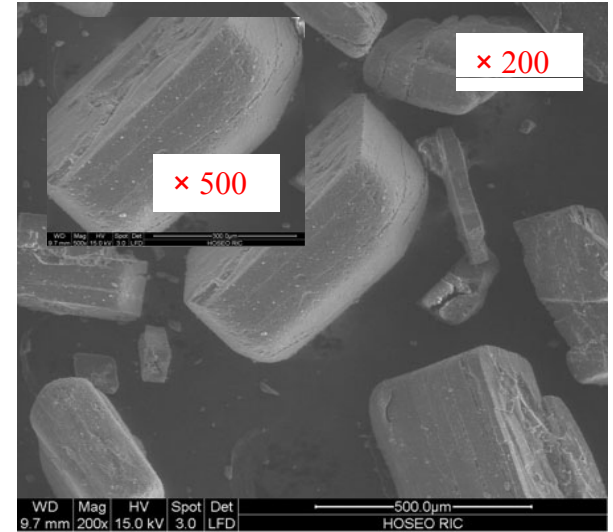
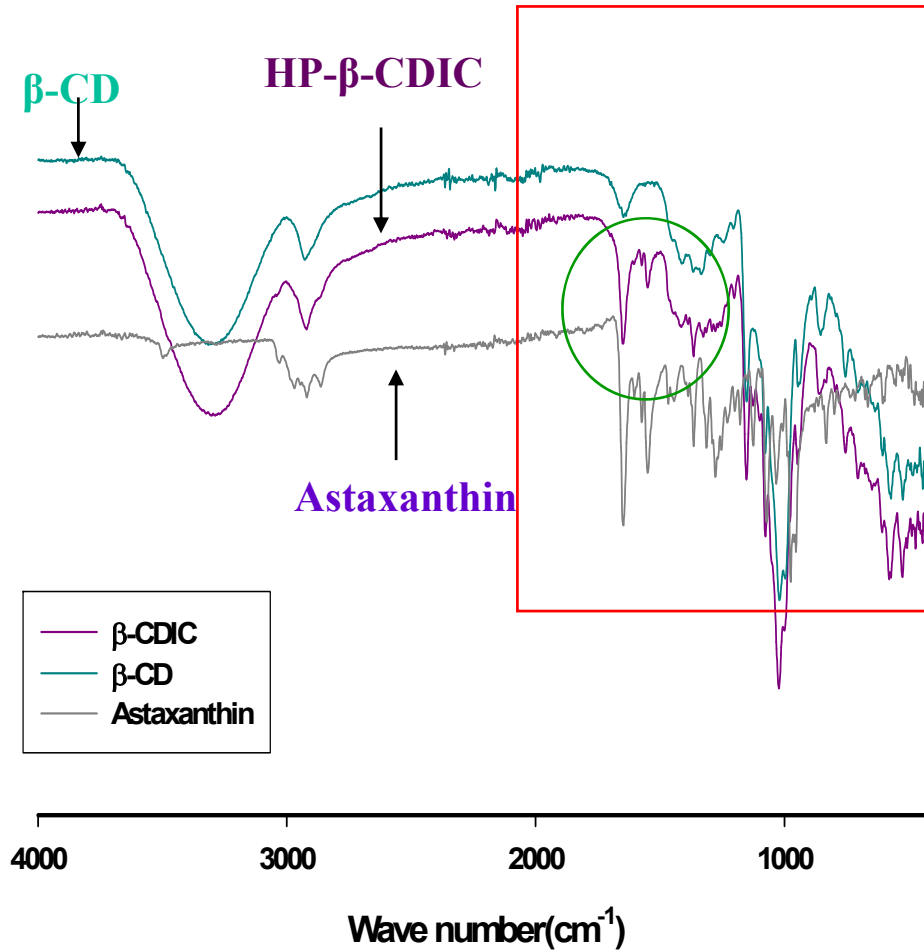
evaporating



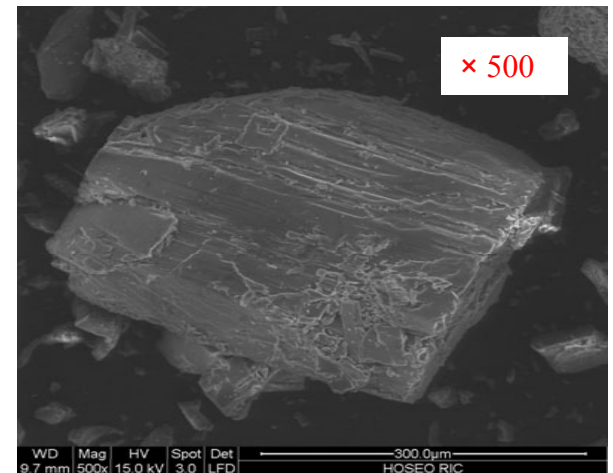
Inclusion complex

Results

FTIR spectra and SEM : β -CD

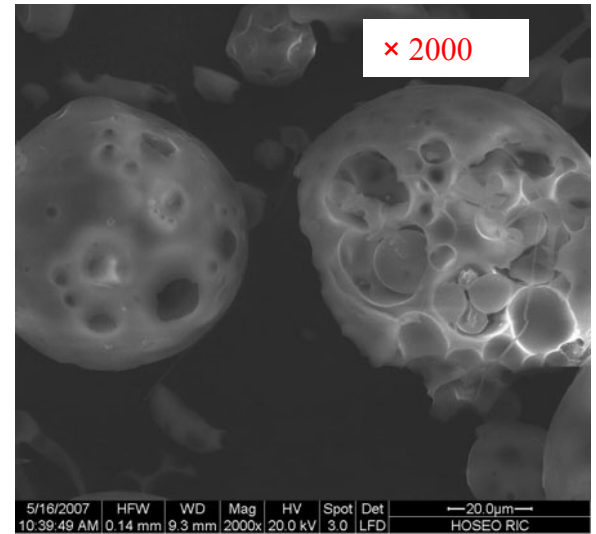
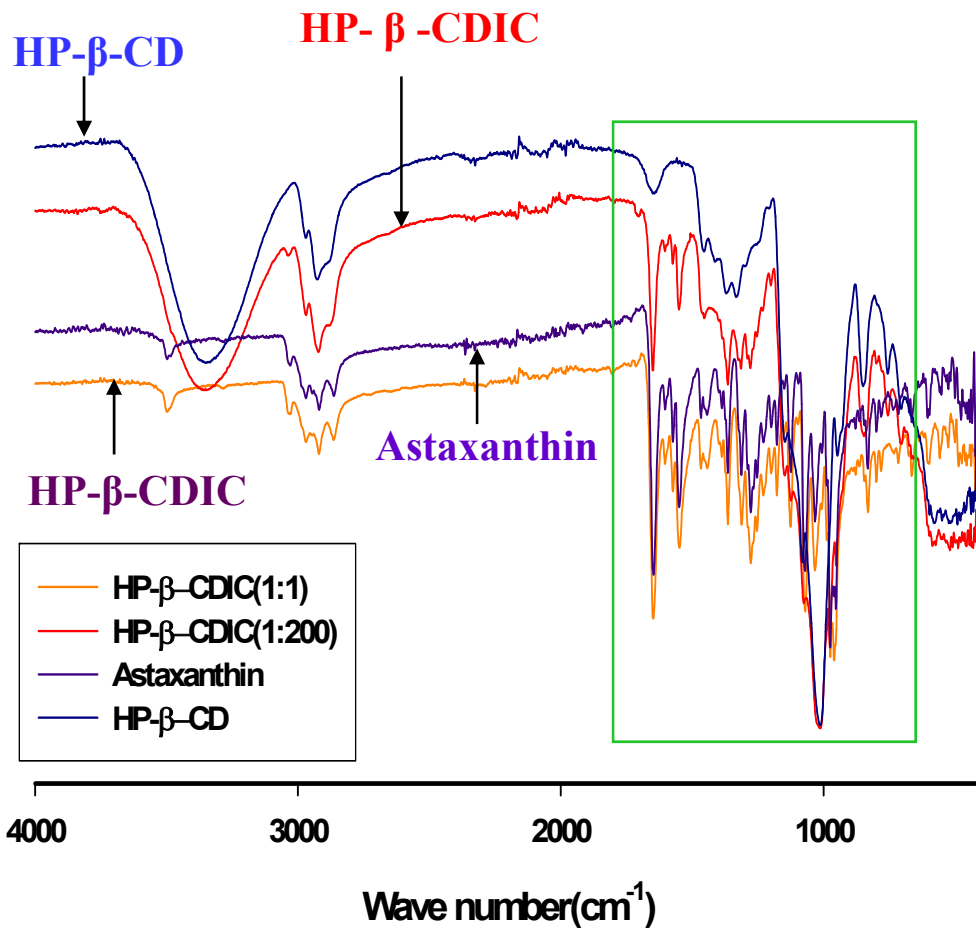


β -CD

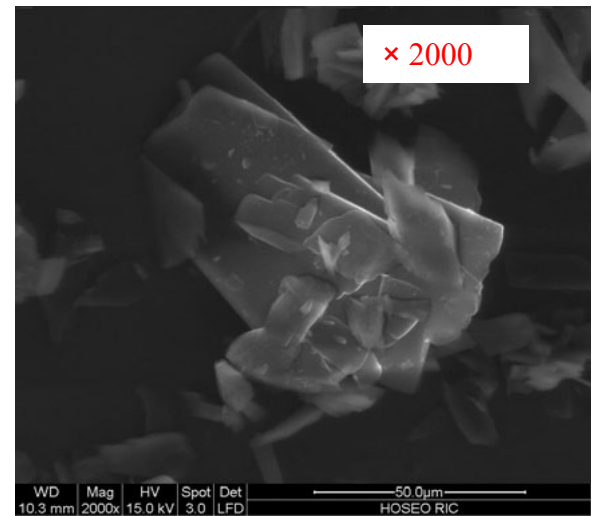


β -CD I

FTIR spectra and SEM : HP- β -CD

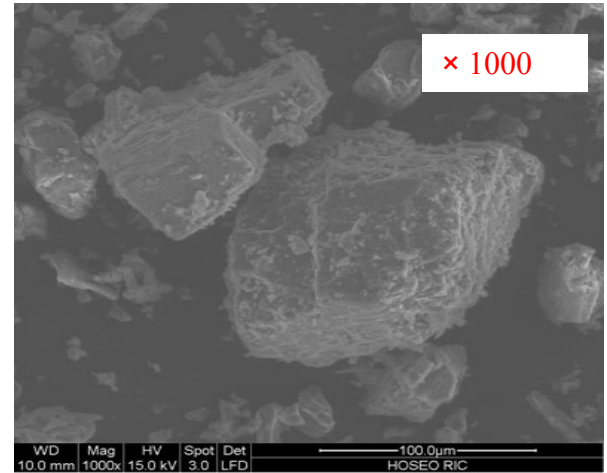
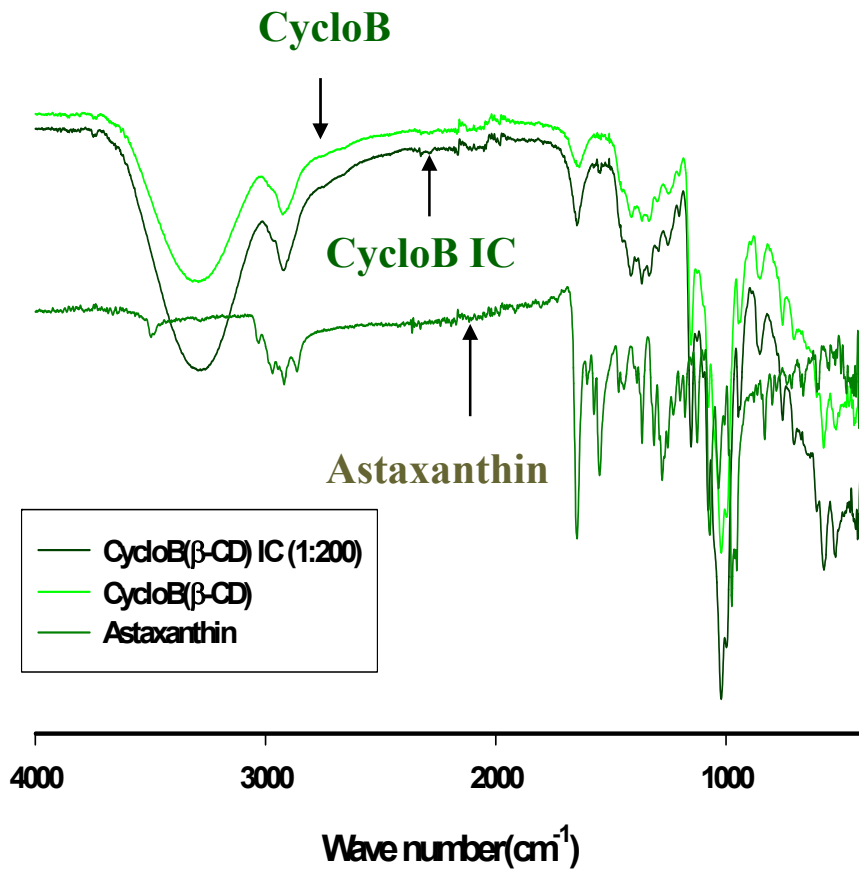


HP- β -CD

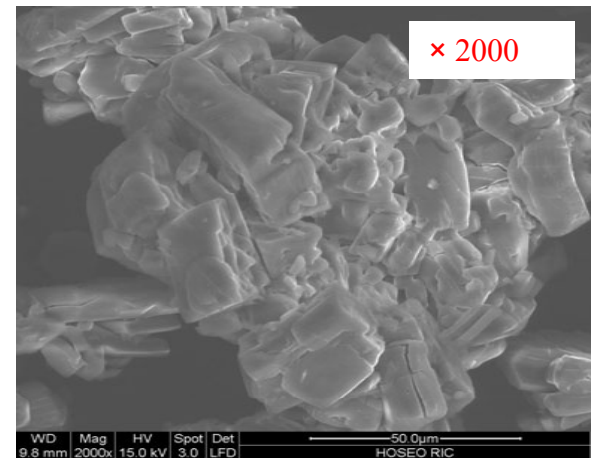


HP- β -CDIC

FTIR spectra and SEM : Cyclo B(β -CD)



CycloB (β -CD)

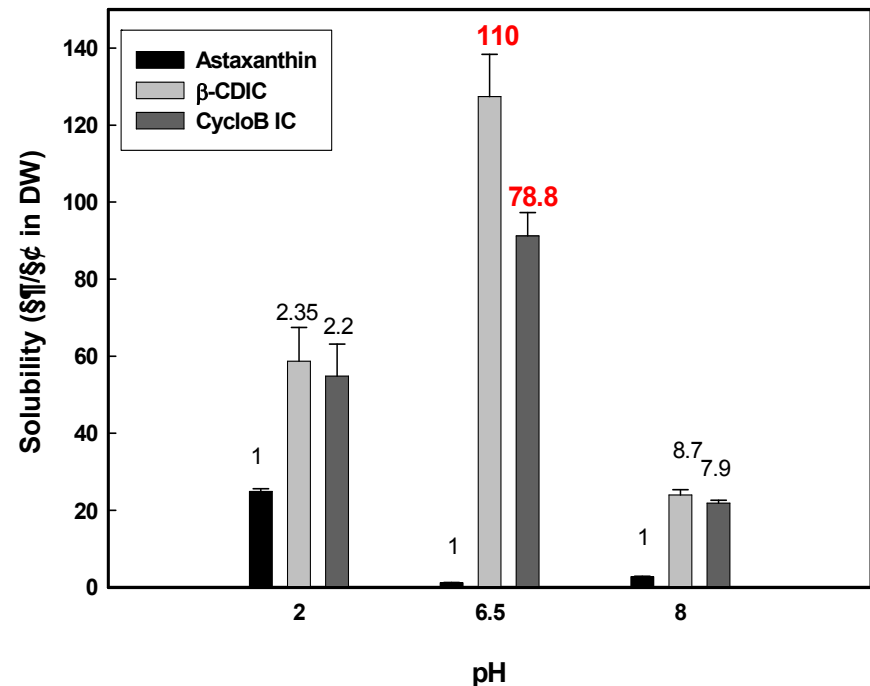
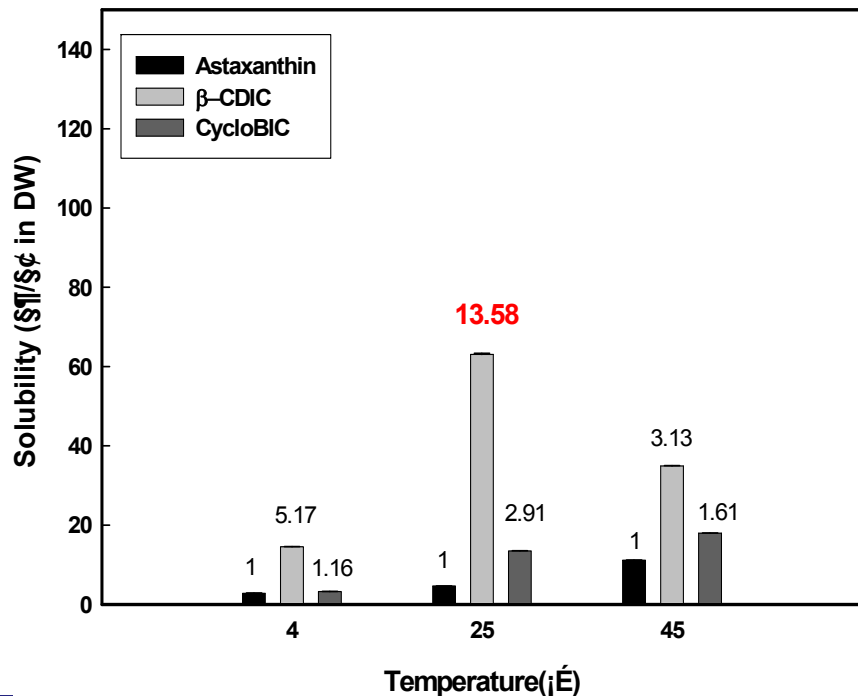
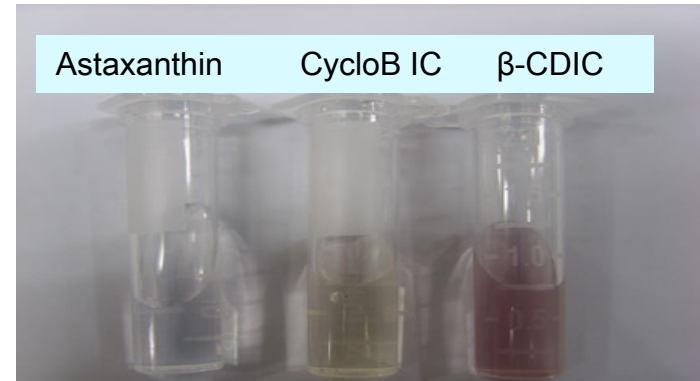


CycloB IC (β -CD)

Water-solubility of inclusion complex in various pH and temperature

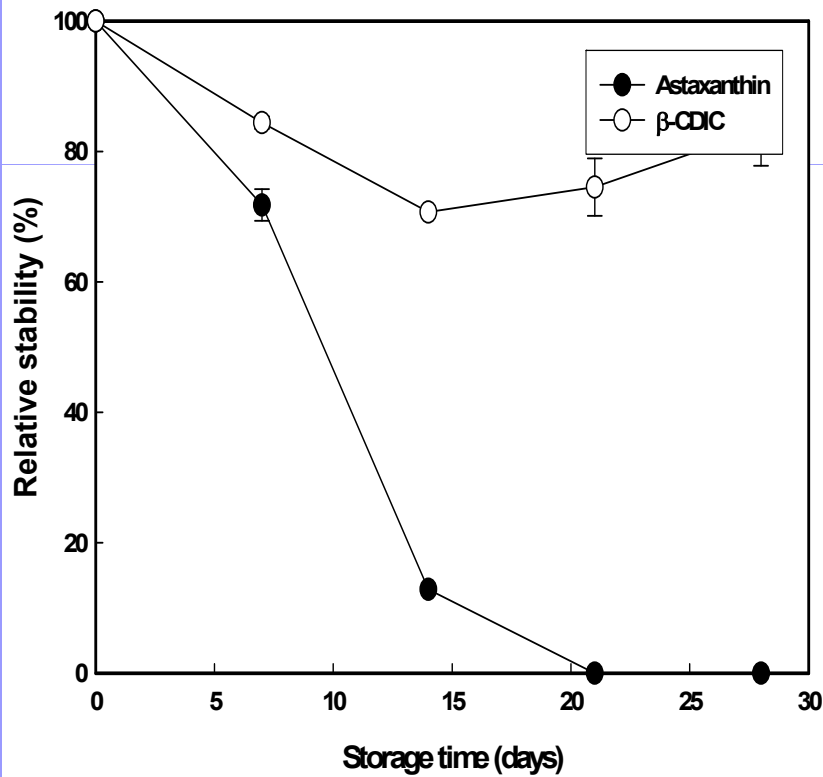
⇒ β -CDIC is 13.6 times of free astaxanthin at 25°C

⇒ β -CDIC is 110 times of free astaxanthin at pH 6.5



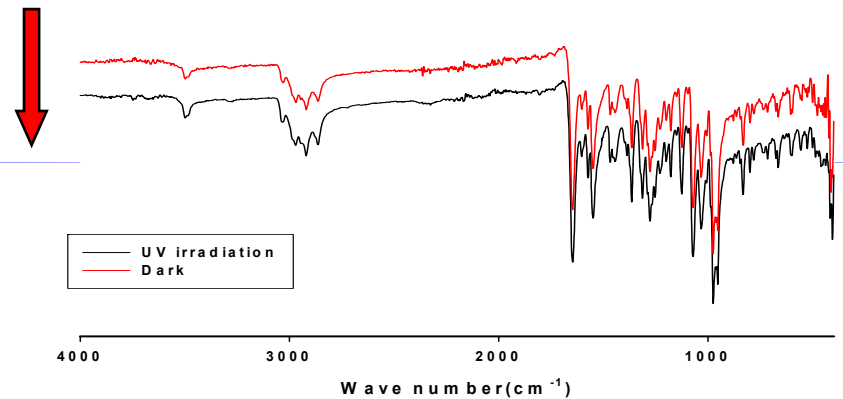
Effects of UV irradiation on the long-term stability of synthetic astaxanthin and inclusion complex

Effect of light

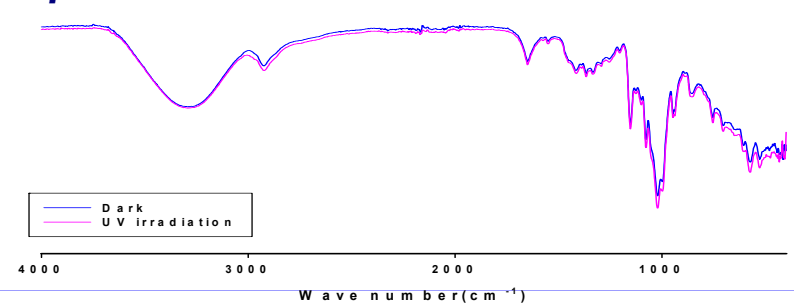


FTIR spectra

Astaxanthin



β -CDIC



\Rightarrow β -CDIC is 7 times compared with free astaxanthin(10%) after 14 days

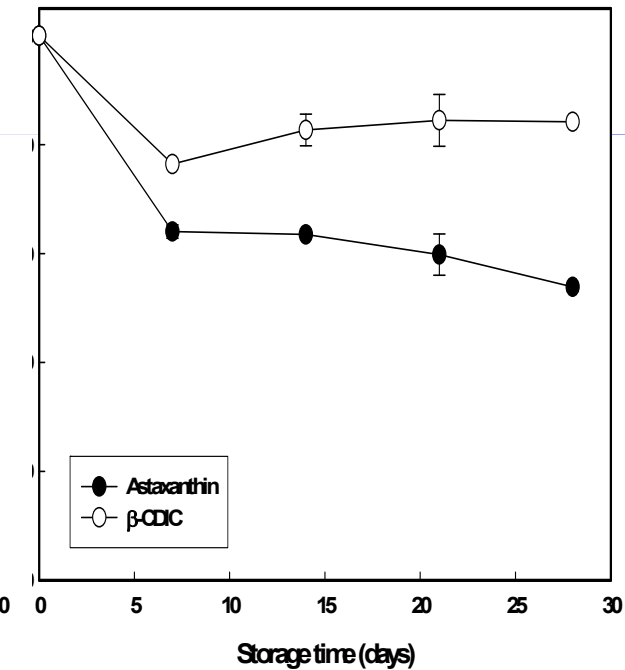
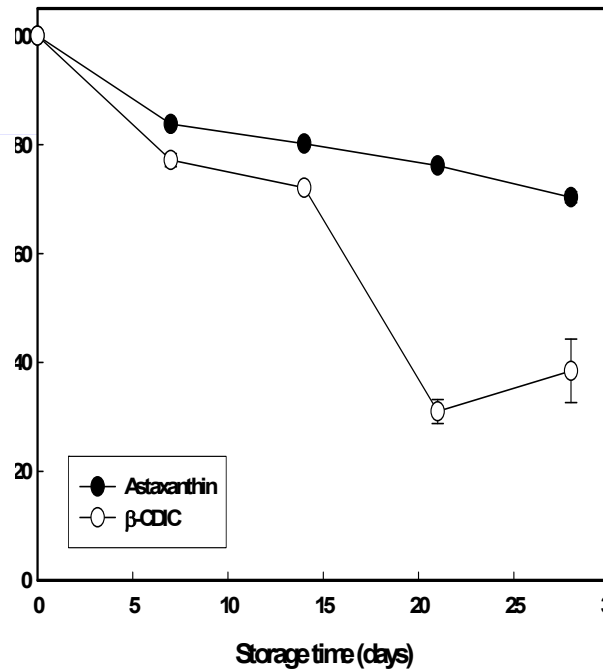
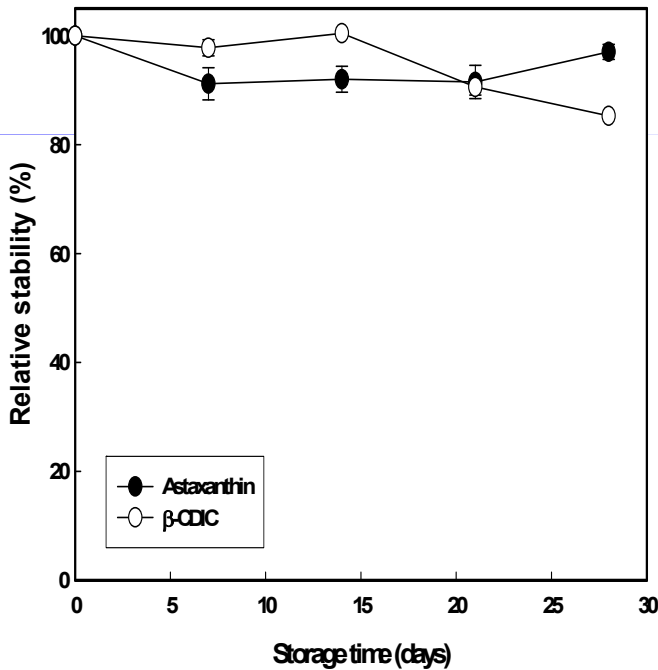
Effects of temperature on the long-term stability of synthetic astaxanthin and inclusion complex

4

°C

25°C

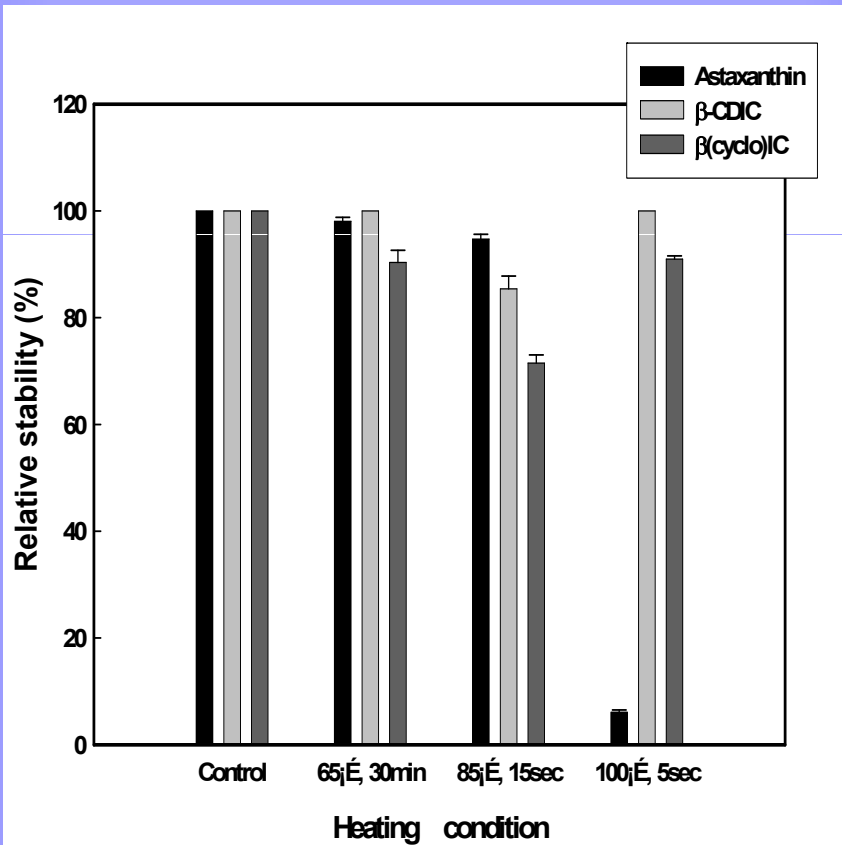
45°C



=> β -CDIC is stable than free astaxanthin at 45°C

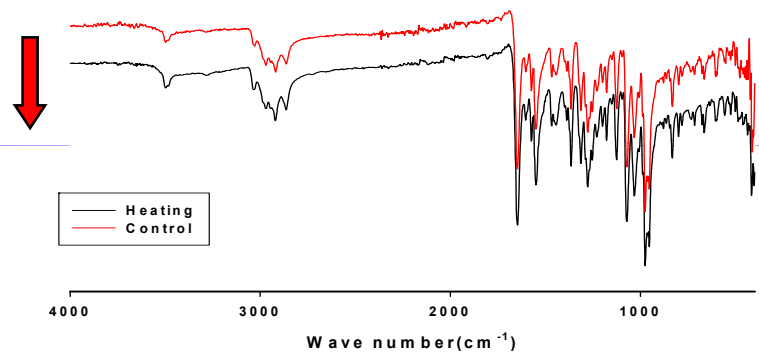
Effect of heating on the stability of synthetic astaxanthin and inclusion complexes

Effect of heating

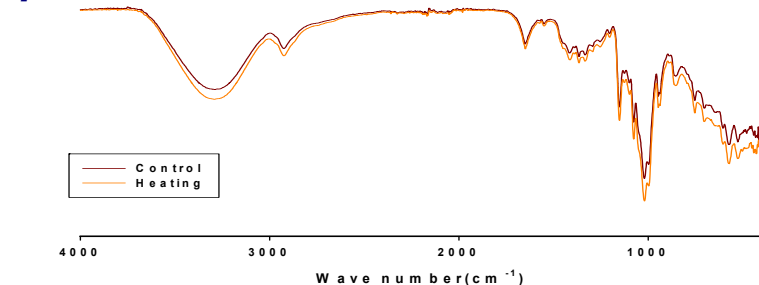


FTIR spectra

Astaxanthin

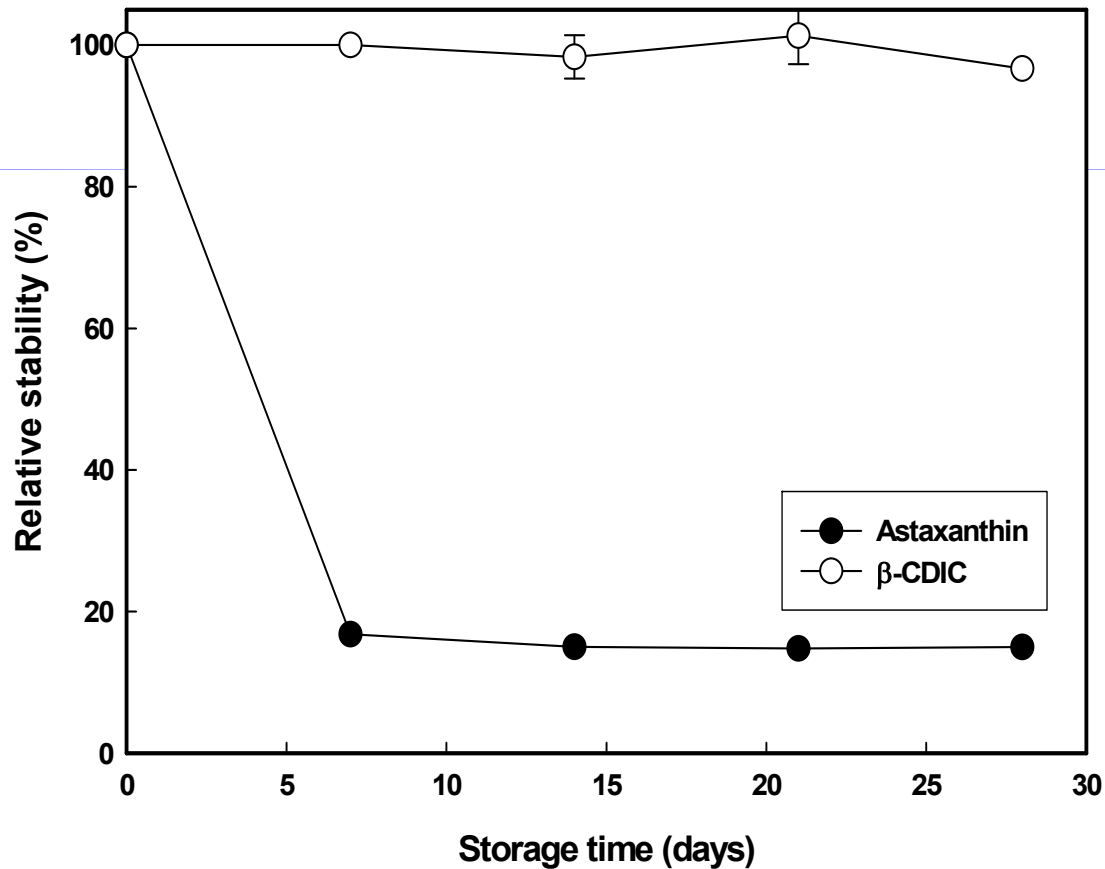


β-CDIC



⇒ β-CDIC is 9 times compared with free astaxanthin after heating(100°C, 5sec)

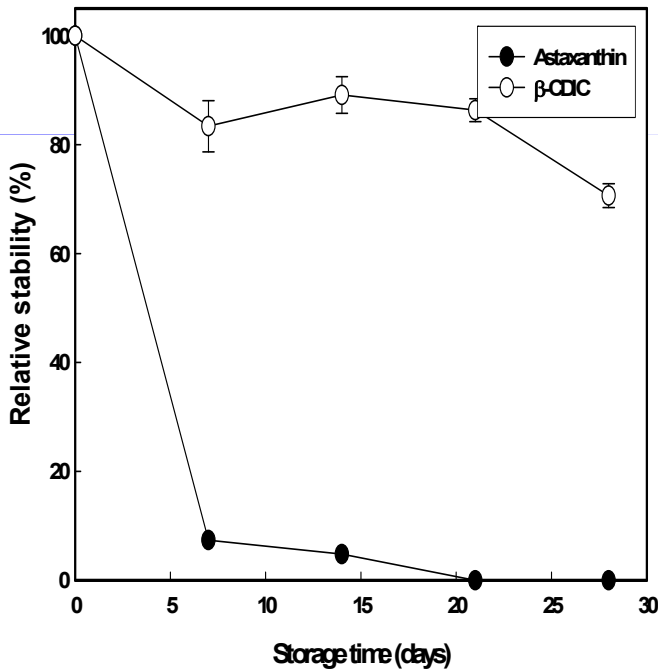
Effects of oxygen on the long-term stability of synthetic astaxanthin and inclusion complex



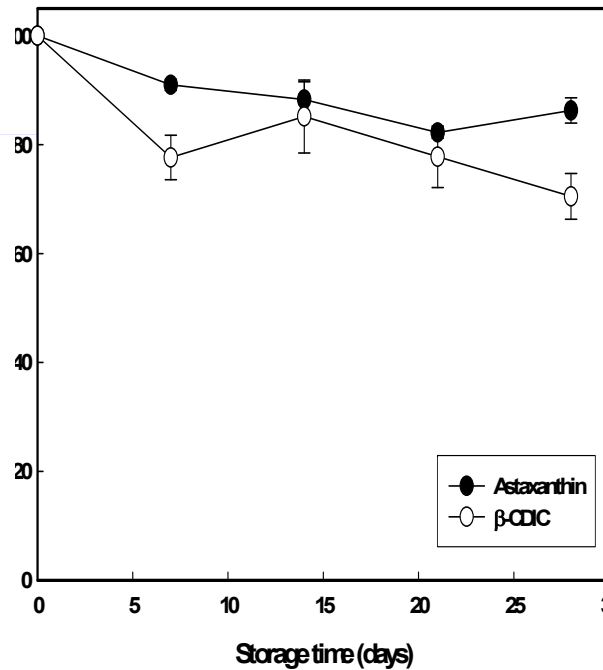
⇒ **β-CDIC is very stable than free astaxanthin after 28 days**

Effects of pH on the long-term stability of synthetic astaxanthin and inclusion complex

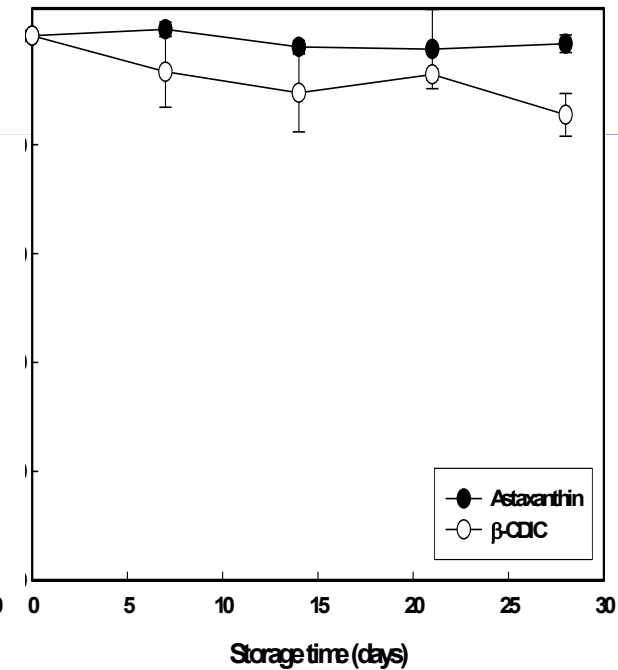
pH 3



pH 5



pH 8



\Rightarrow β -CDIC is stable than free astaxanthin in acidic condition

Summary

▣ FTIR spectrum, SEM

- Best host material for inclusion of astaxanthin \Rightarrow β -CD
- Reaction ratio between astaxanthin and host molecule \Rightarrow 1 : 200

▣ Water-solubility of inclusion complex (β -CDIC & CycloB IC)

- at 25°C : 63.08 & 34.9 ug/ml \Rightarrow 13.6 & 2.9 times of free astaxanthin
- at pH 6.5 : 127.4 & 91.2 ug/ml \Rightarrow 110 & 78.7 times of free astaxanthin

▣ Stability of inclusion complex (β -CDIC)

- light : 7 times compared with free astaxanthin(10%) after 14 days
- Oxidation : very stable within 21 days
- heating : 9 times compared with free astaxanthin after heating(100°C, 5sec)
- Storage temperature : stable than free astaxanthin at 45°C