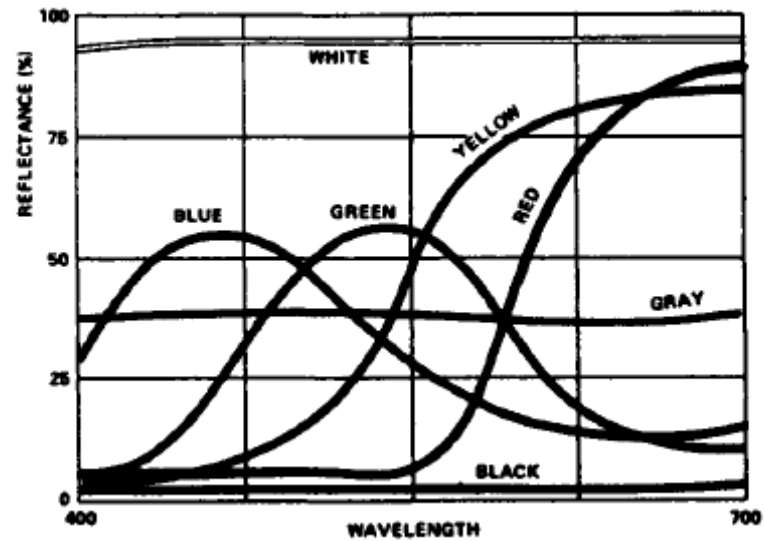
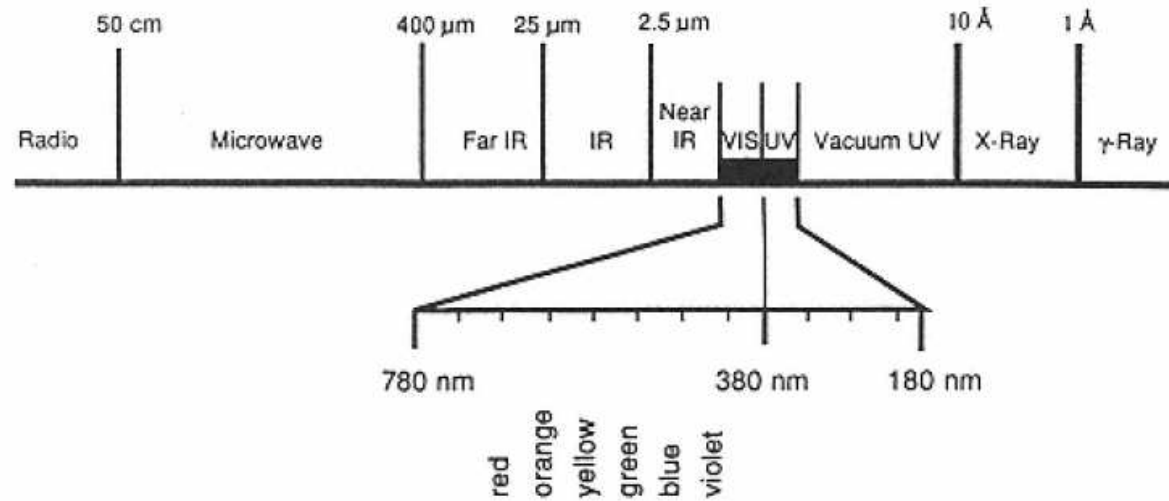


Χρώματα

- Χημικές ενώσεις (φυσικές ή συνθετικές) που προσδίδουν χρώμα στα τρόφιμα
 - Χρωστικές (φυσικές)
 - Βαφές (υδατοδιαλυτές)
 - Λάκες (ελαιοδιαλυτές, σε μίγμα με στερεό)
- Δείκτες ποιότητας των τροφίμων
 - Κόκκινο / φρέσκο κρέας
 - Καφέ / όχι φρέσκο
- Το χρώμα συσχετίζεται με την αναμενόμενη γεύση !

Χρώματα



Κύρια χρώματα, Σύστημα CIE

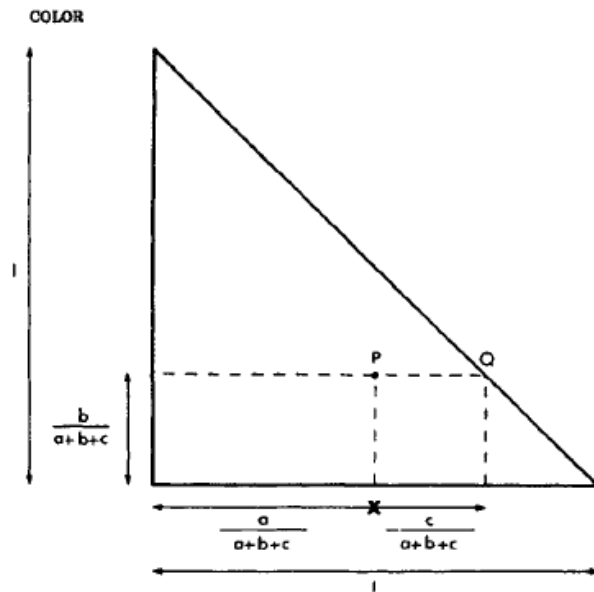


Figure 6-4 Representation of a Color as a Point in a Color Triangle

RED X
GREEN Y
BLUE Z

$$x = \frac{X}{X+Y+Z}$$

$$x = \bar{x}/(\bar{x} + \bar{y} + \bar{z})$$

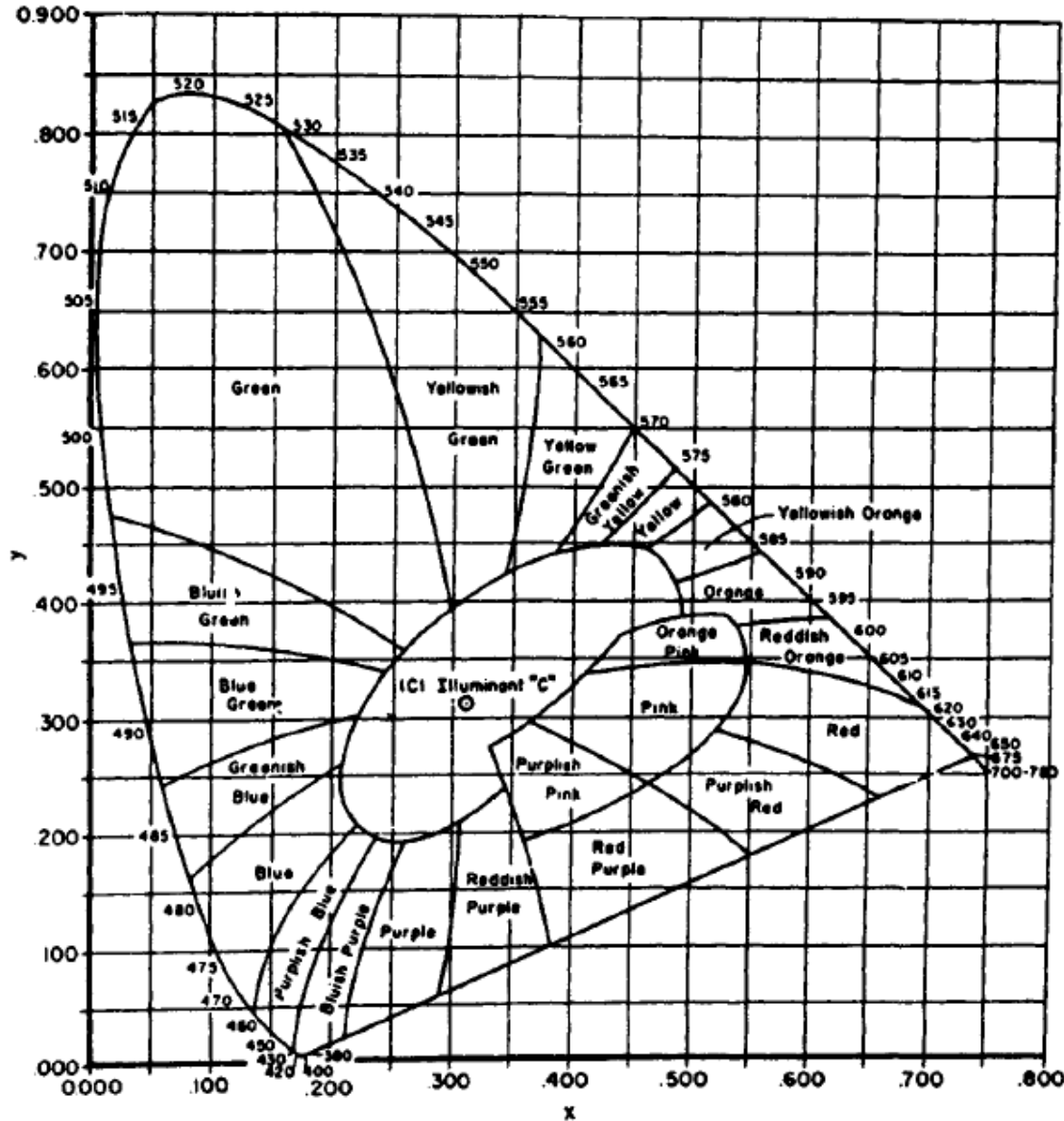
$$y = \frac{Y}{X+Y+Z}$$

$$y = \bar{y}/(\bar{x} + \bar{y} + \bar{z})$$

$$z = 1 - (x + y)$$

$$z = \frac{Z}{X+Y+Z}$$

Χρωμοδιάστημα CIE



$$x = \bar{x} / (\bar{x} + \bar{y} + \bar{z})$$

$$y = \bar{y} / (\bar{x} + \bar{y} + \bar{z})$$

$$z = 1 - (x + y)$$

Χρωστικές

1. tetrapyrrole compounds: chlorophylls, hemes, and bilins
2. isoprenoid derivatives: carotenoids
3. benzopyran derivatives: anthocyanins and flavonoids
4. artefacts: melanoidins, caramels

Χρωστικές κρέατος

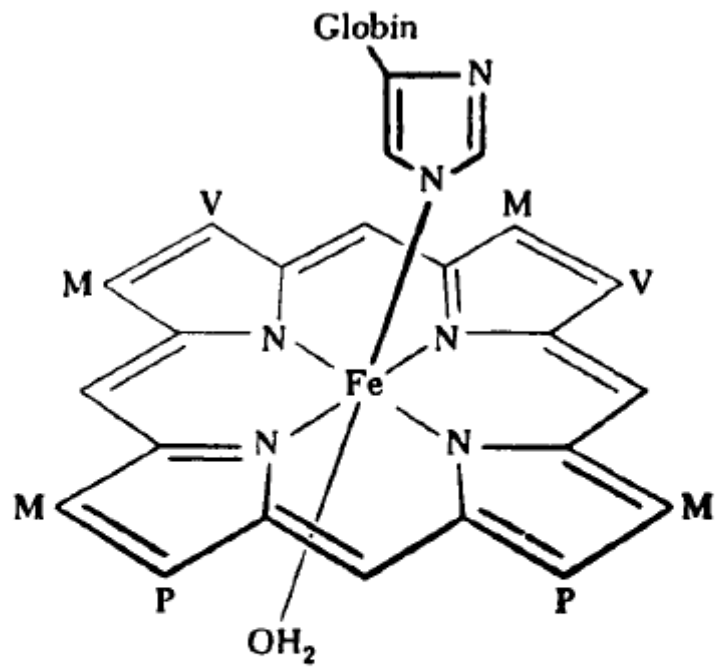
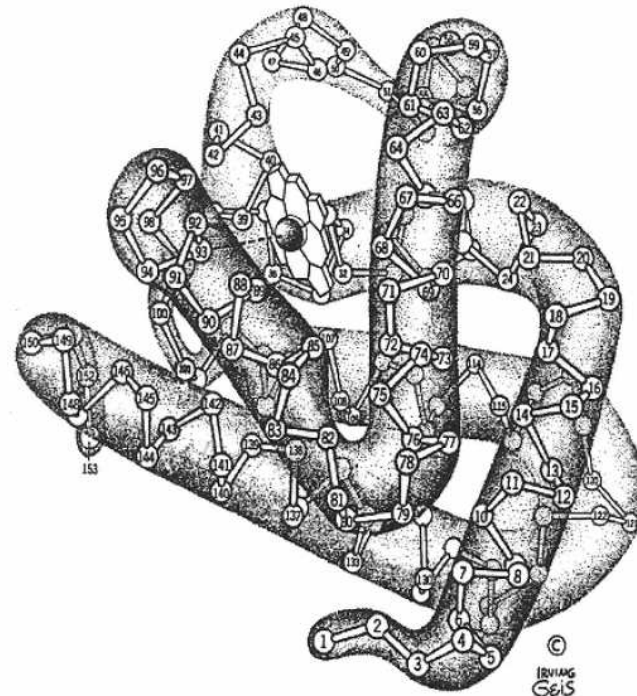


Figure 6-11 Schematic Representation of the Heme Complex of Myoglobin. M = methyl, P = propyl, V = vinyl. *Source:* From C.E. Bodwell and P.E. McClain, Proteins, in *The Sciences of Meat Products*, 2nd ed., J.E. Price and B.S. Schweigert, eds., 1971, W.H. Freeman & Co.

Μυοσφαιρίνη



Χρωστικές κρέατος

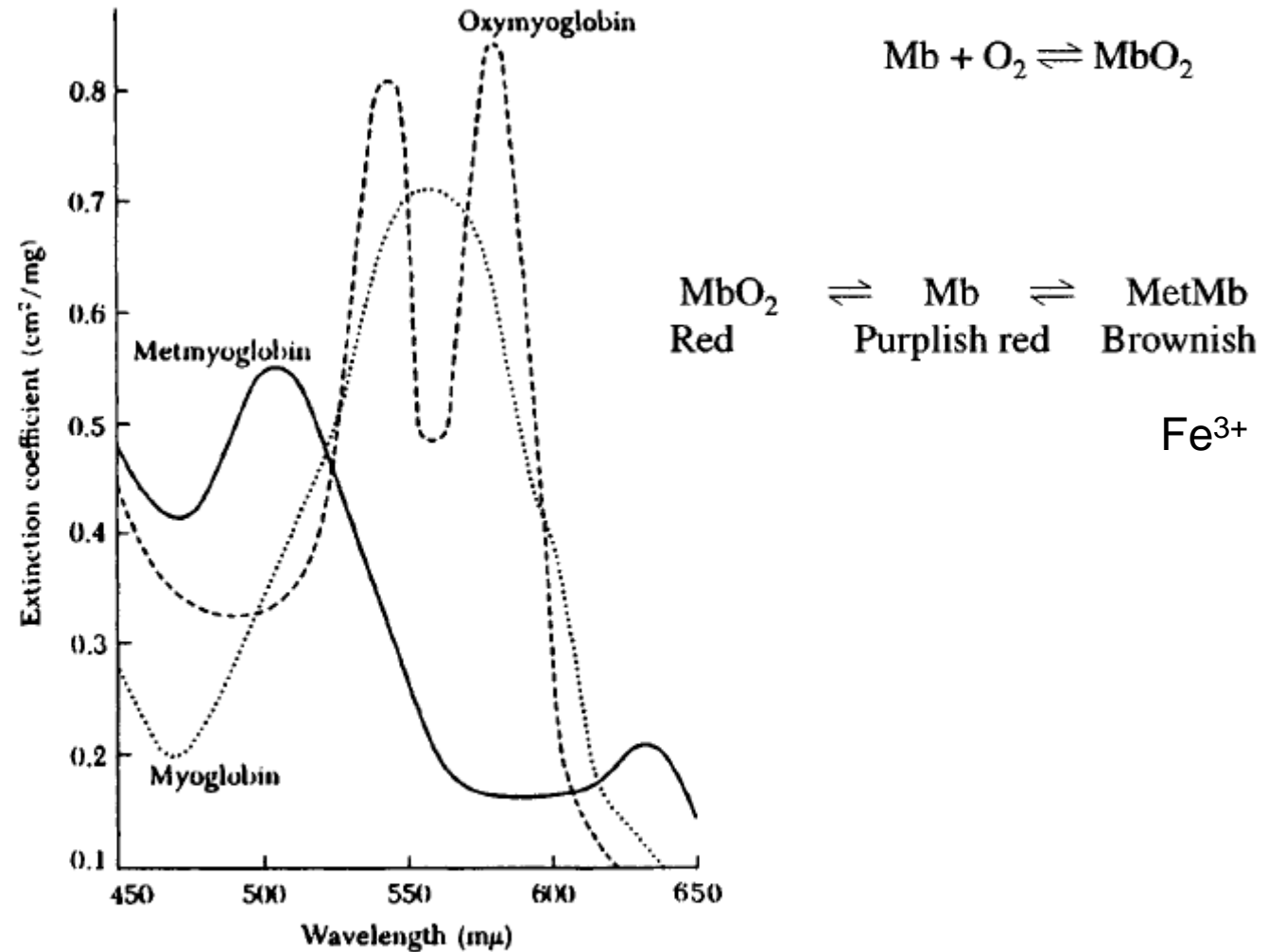


Figure 6-12 Absorption Spectra of Myoglobin, Oxymyoglobin, and Metmyoglobin. *Source:* From C.E. Bodwell and P.E. McClain, Proteins, in *The Sciences of Meat Products*, 2nd ed., J.E. Price and B.S. Schweigert, eds., 1971, W.H. Freeman & Co.

Επεξεργασμένο κρέας

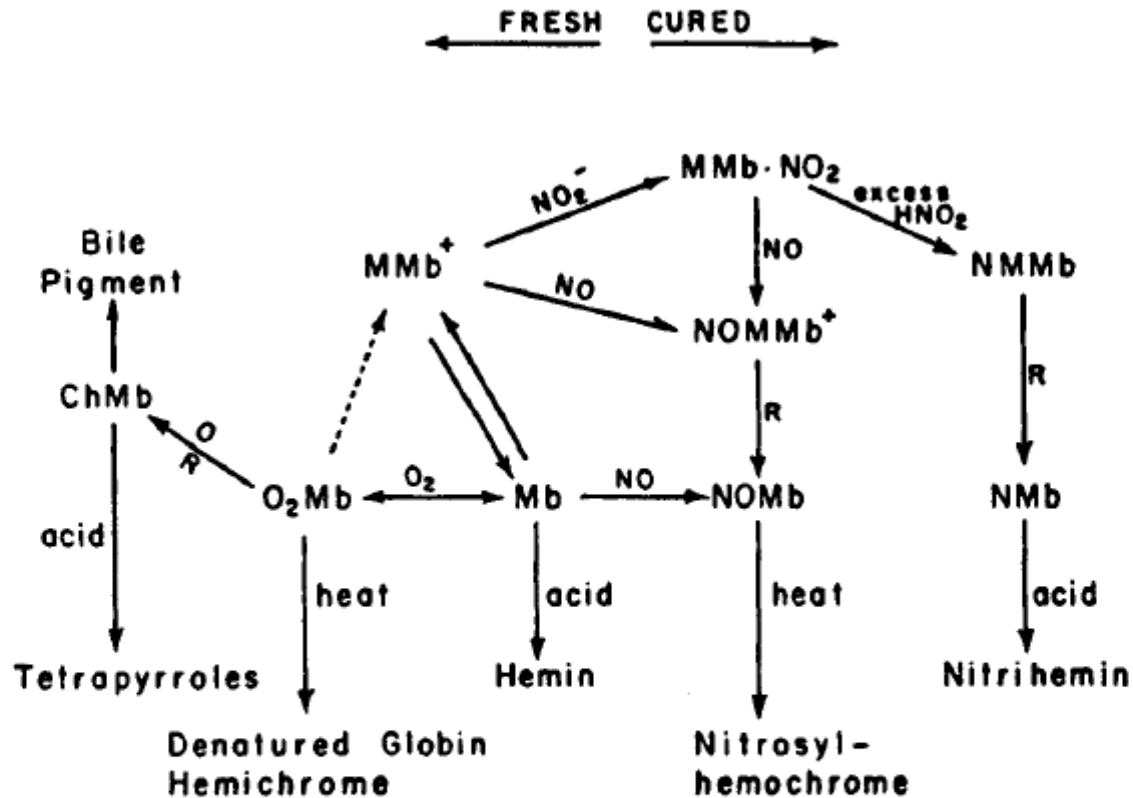


Figure 6-13 Heme Pigment Reactions in Meat and Meat Products. ChMb, cholemyoglobin (oxidized porphyrin ring); O₂Mb, oxymyoglobin (Fe⁺²); MMB metmyoglobin (Fe⁺³); Mb, myoglobin (Fe⁺²); MMB·NO₂, metmyoglobin nitrate; NOMMb, nitrosylmetmyoglobin; NOMb, nitrosylmyoglobin; NMMb, nitrimetmyoglobin; NMb, nitrimyoglobin, the latter two being reaction products of nitrous acid and the heme portion of the molecule; R, reductants; O, strong oxidizing conditions. *Source:* From J.B. Fox, *The Chemistry of Meat Pigments*, *J. Agr. Food Chem.*, Vol. 14, no. 3, pp. 207-210, 1966, American Chemical Society.

Χλωροφύλλες

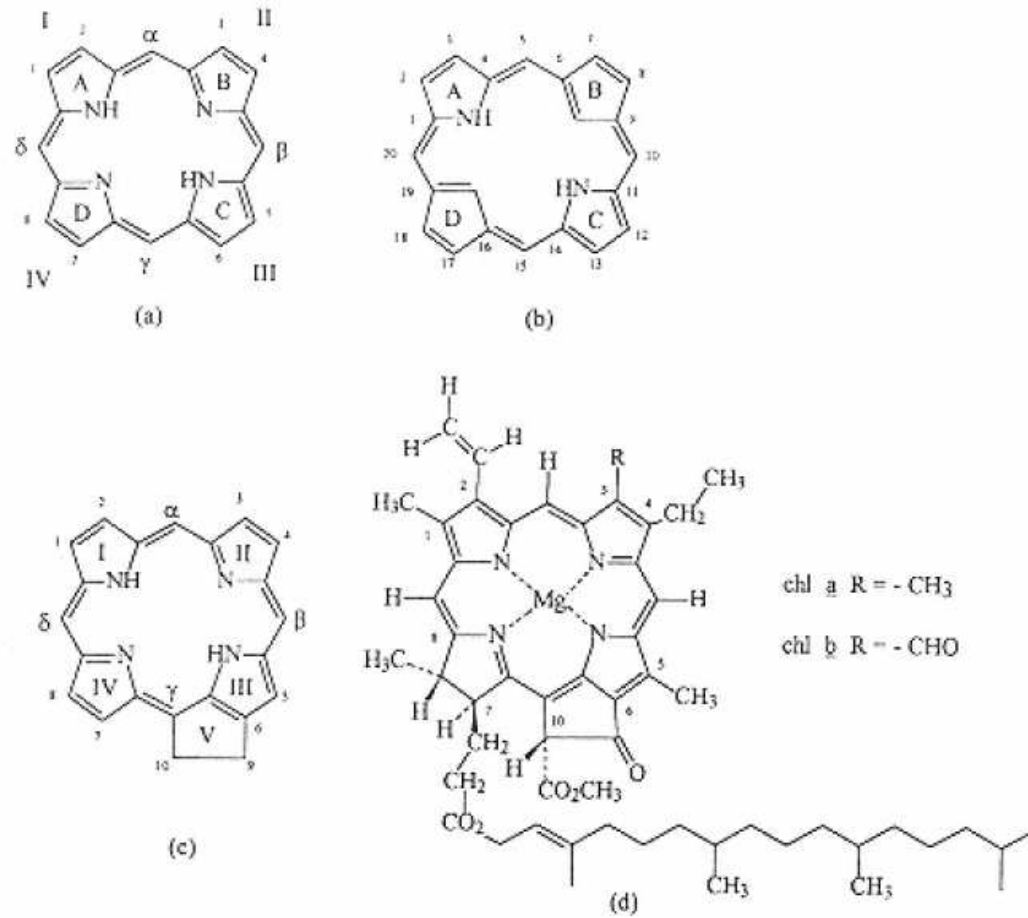


FIGURE 5
Structure of porphin (a,b), phorbins (c), and chlorophyll [chl] (d).

Χλωροφύλλες

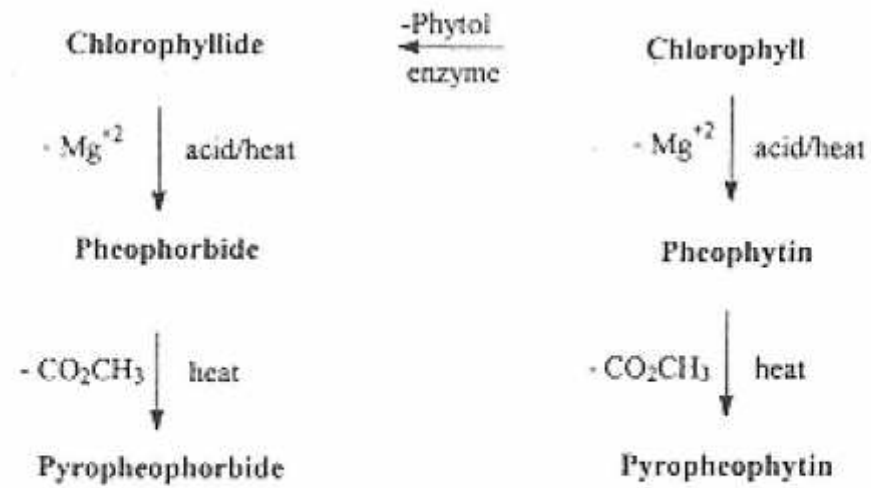


FIGURE 6
Chlorophyll and its derivatives.

Χλωροφύλλες

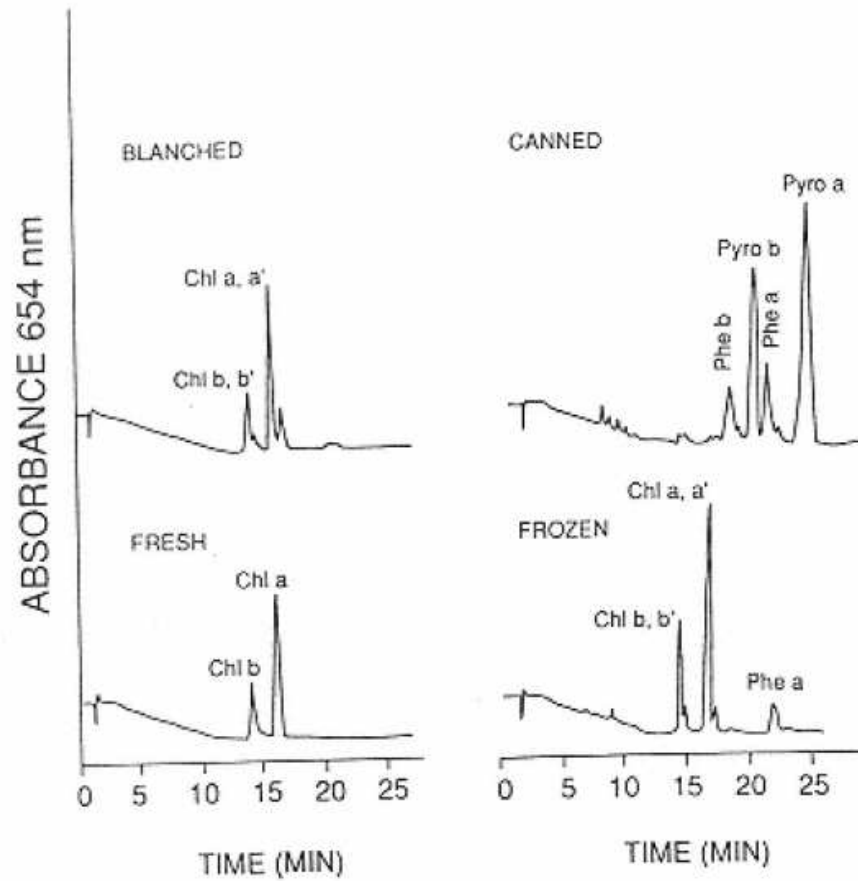
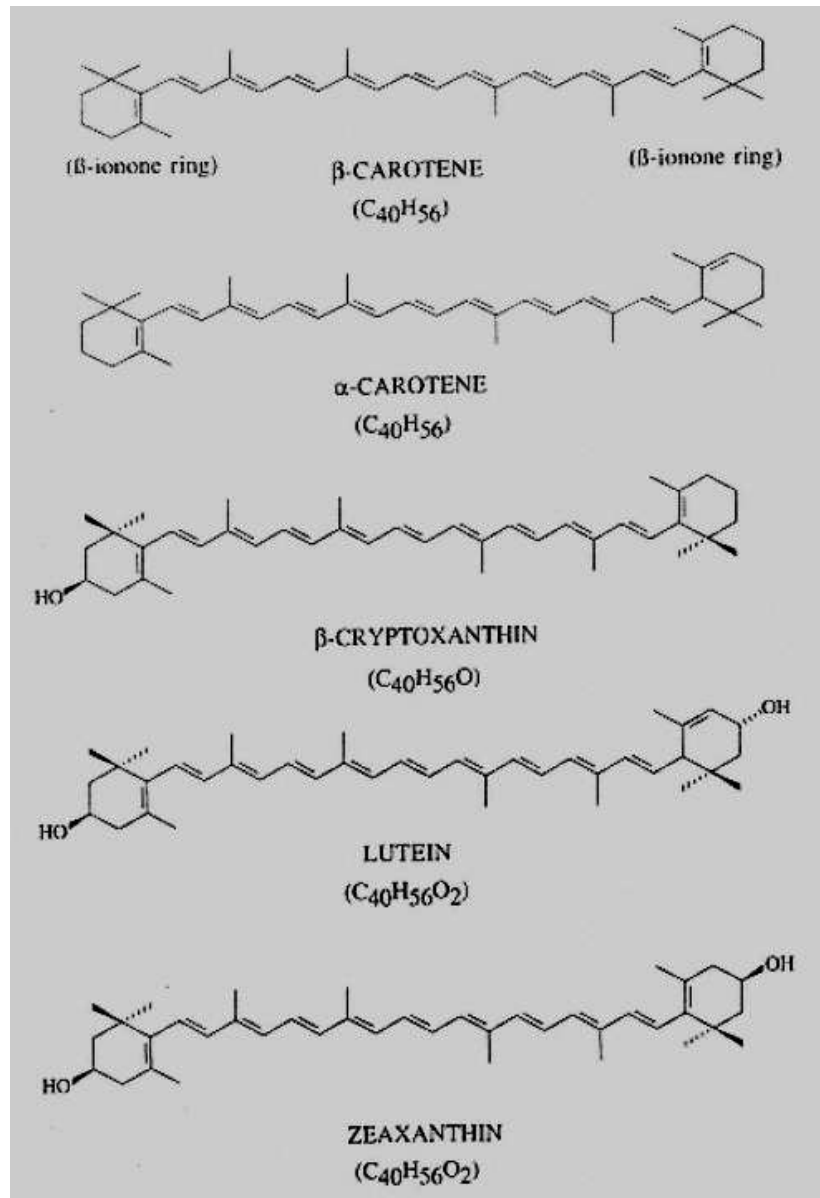


FIGURE 8
High-performance liquid chromatography (HPLC)
chromatograms of chlorophylls (chl) and derivatives in fresh,
blanched, frozen, and canned spinach. Phe = pheophytin, Pyro
= pyropheophytin. (From Ref. 92.)

Καροτένια



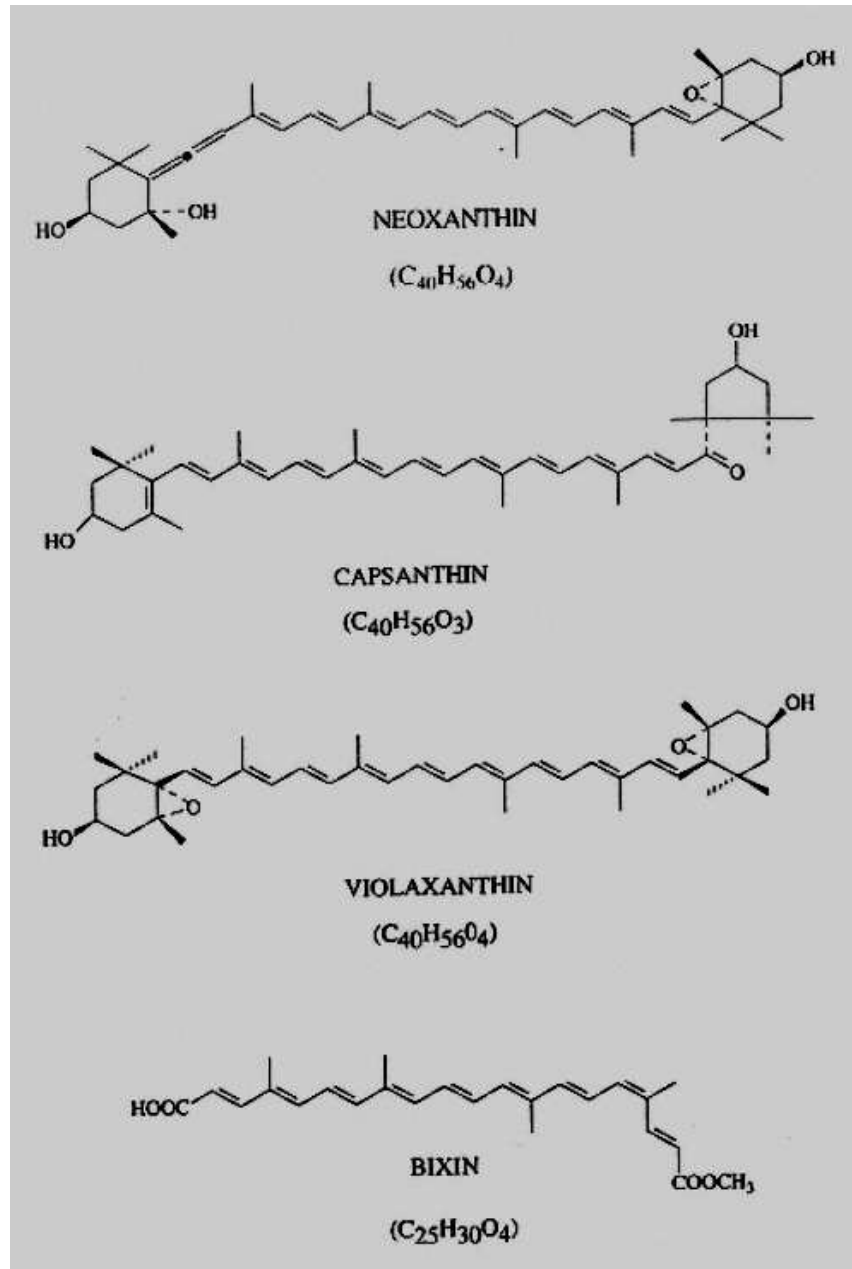
Κίτρινη (καρότο, γλυκοπατάτα)

Κίτρινη (καρότο)

Κίτρινη (καλαμπόκι)

Κίτρινη (πράσινα φύλλα, καλαμπόκι)

Κίτρινη (κρόκος, καλαμπόκι)



Κίτρινη (πράσινα φύλλα)

Κόκκινη (κόκκινη πιπεριά)

Κίτρινη (πράσινα φύλλα)

Κίτρινοκόκκινη
(σπόροι ανάτο)



Καροτένια

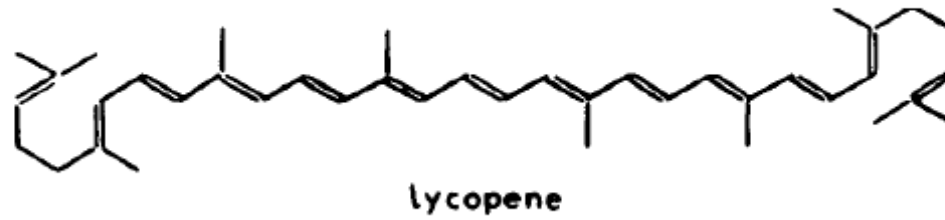
- Κύρια πηγή βιταμίνης Α για τα ζώα
- Συνυπάρχουν με τις χλωροφύλλες στα φυτά στους χλωροπλάστες, αλλά καλύπτονται χρωματικά
- Συμμετέχουν στην φωτοσύνθεση και προσφέρουν φωτοπροστασία
- Το φθινόπωρο με τη γήρανση, οι χλωροπλάστες αποσυντίθενται, και



CD BANK

© Canada-Photos.com

Λυκοπένιο



Ροδάκινο – Βερούκοκο - Ντομάτα

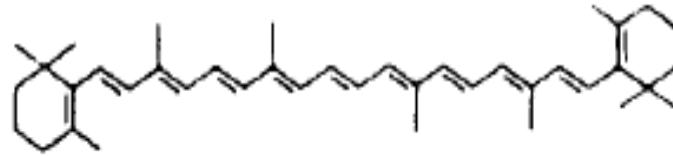
10%

90%

<i>Pigment</i>	<i>Green</i> (mg/100 g)	<i>Half-ripe</i> (mg/100 g)	<i>Ripe</i> (mg/100 g)
Lycopene	0.11	0.84	7.85
Carotene	0.16	0.43	0.73
Xanthophyll	0.02	0.03	0.06
Xanthophyll ester	0	0.02	0.10

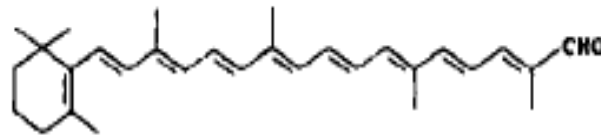
Συνθετικά καροτενοειδή χρώματα

β-Carotene



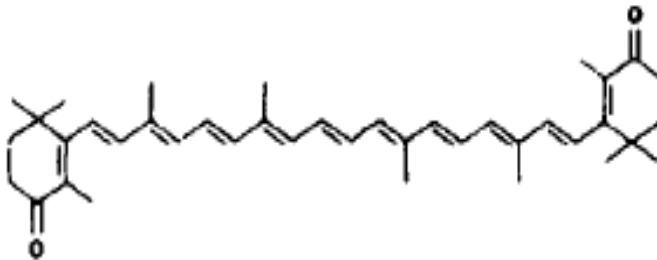
Κίτρινο

β-Apo-8'-
carotenal



Πορτοκαλί

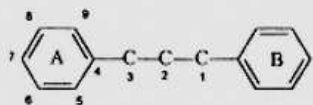
Canthaxanthin



Κόκκινο

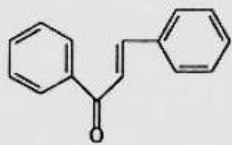
Φυσικά χρώματα : ανάτο, κόκκινη πιπεριά, παρθένο φοινικέλαιο

Ανθοκυανίνες

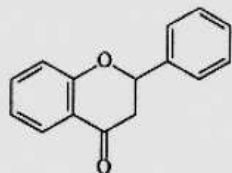


Basic C₆C₃C₆ Structure

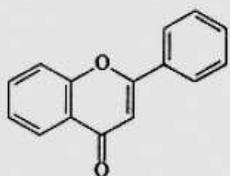
FLAVANONES



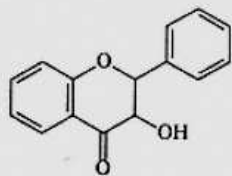
Chalcone



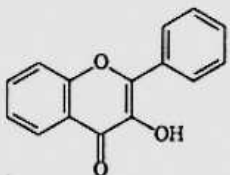
Flavanones



Flavones

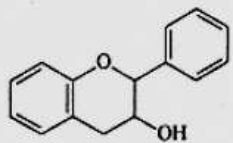


Flavanonols

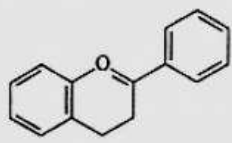


Flavonols

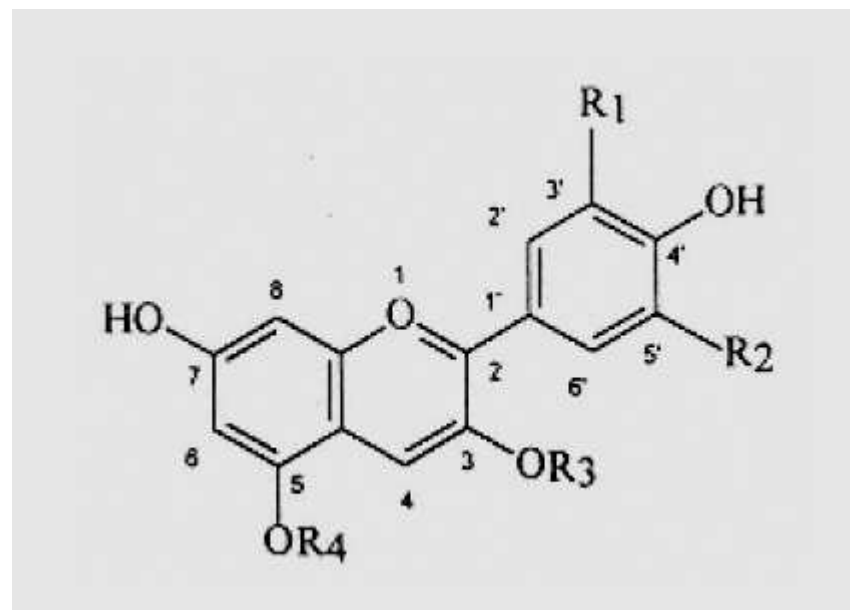
FLAVANS



Catechins



Anthocyanidins

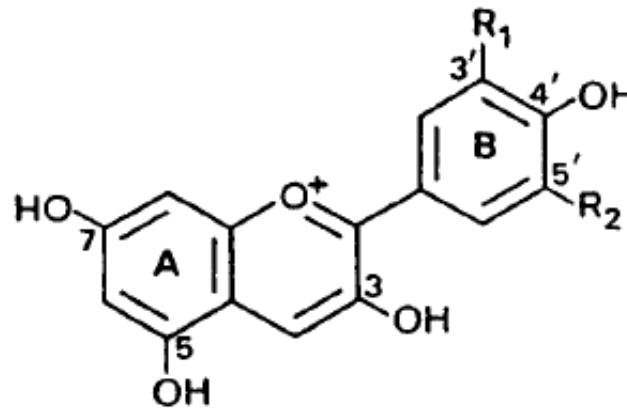


$R_1, R_2 = -H, -OH, -OCH_3$

$R_3 = -\text{σάκχαρο}$

$R_4 = -H, -\text{σάκχαρο}$

Ανθοκυανιδίνες (άγλυκο ανθοκυανινών)



$R_1 = H$

$R_1 = OH$

$R_1 = OH$

$R_1 = OCH_3$

$R_1 = OCH_3$

$R_1 = OCH_3$

$R_2 = H$

$R_2 = H$

$R_2 = OH$

$R_2 = H$

$R_2 = OH$

$R_2 = OCH_3$

PELARGONIDIN

CYANIDIN

DELPHINIDIN

PEONIDIN

PETUNIDIN

MALVIDIN

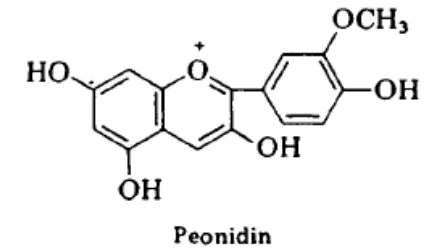
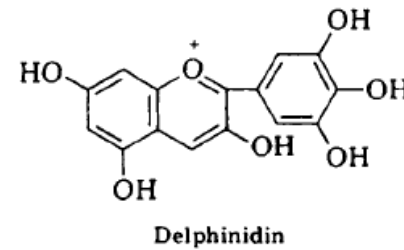
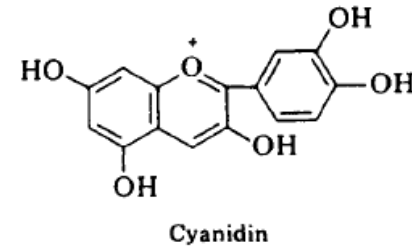
Figure 6–23 Chemical Structure of Fruit Anthocyanidins

Ανθοκυανιδίνες

- Κύριες χρωστικές στο φυτικό βασίλειο
- Κόκκινο, μπλέ, μώβ χρώματα
- Αποικοδομούνται κατά την αποθήκευση
- Ευαίσθητες σε pH, θερμοκρασία, οξύτητα

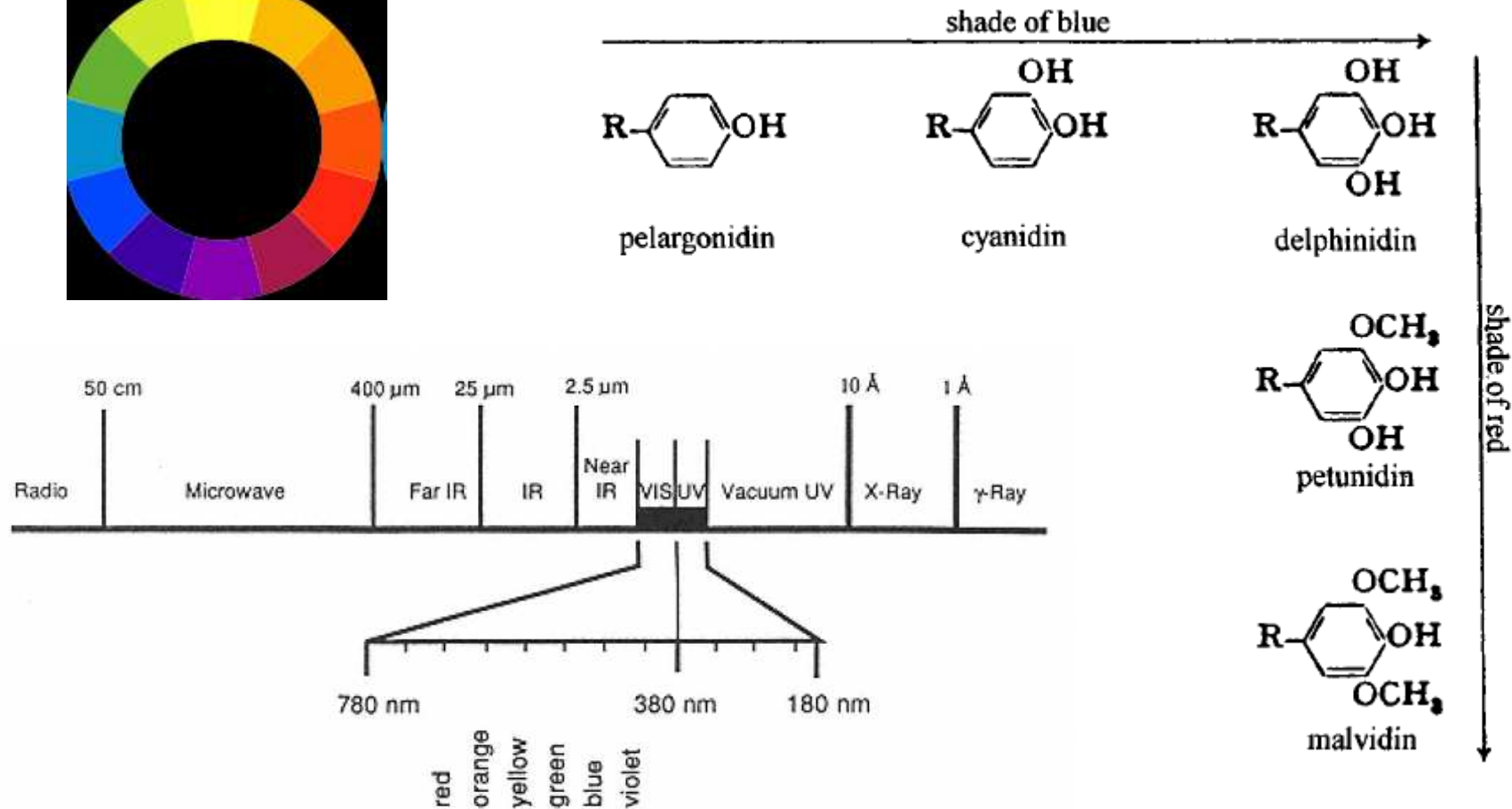
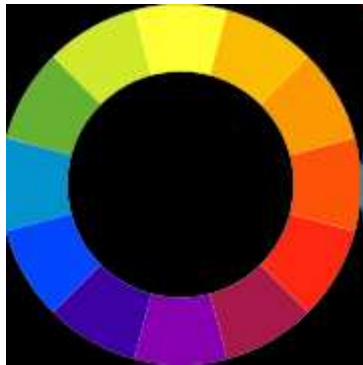
Ανθοκυανιδίνες φρούτων

<i>Fruit or Vegetable</i>	<i>Anthocyanidin</i>
Apple	Cyanidin
Black currant	Cyanidin and delphinidin
Blueberry	Cyanidin, delphinidin, malvidin, petunidin, and peonidin
Cabbage (red)	Cyanidin
Cherry	Cyanidin and peonidin
Grape	Malvidin, peonidin, delphinidin, cyanidin, petunidin, and pelargonidin
Orange	Cyanidin and delphinidin
Peach	Cyanidin
Plum	Cyanidin and peonidin
Radish	Pelargonidin
Raspberry	Cyanidin
Strawberry	Pelargonidin and a little cyanidin



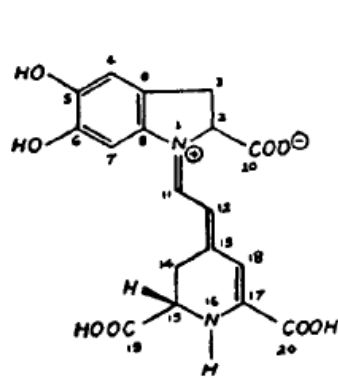
Υποκαταστάτες και χρώμα

Βαθυχρωμία (μεγαλύτερα λ) : $-\text{OCH}_3$ καλύτεροι δότες από $-\text{OH}$

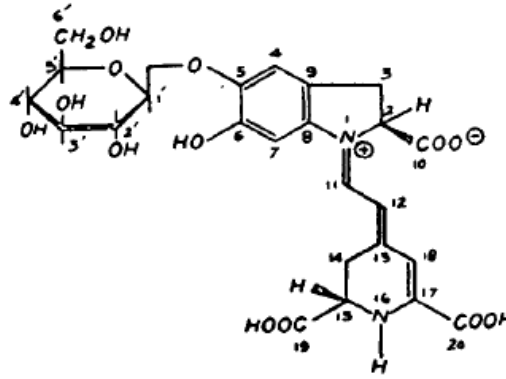


Βεταλαΐνες: χρωστικές τεύτλου

Κόκκινες



I BETANIDIN
II ISOBETANIDIN, C-15
EPIMER OF BETANIDIN

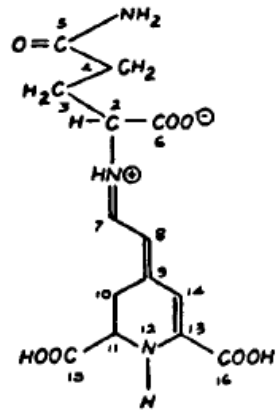


III BETANIN
IV ISOBETANIN, C-15
EPIMER OF BETANIN

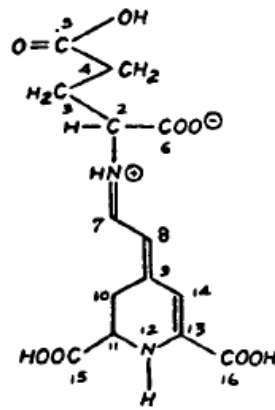
75-95%



Κίτρινες



V VULGAXANTHIN-I



VI VULGAXANTHIN-II

Ανάλυση ανθοκυανιδινών

1. Εκχύλιση με ακετόνη / ακετόνη-νερό 30% / χλωροφόρμιο
 - Πλήρης διαχωρισμός λιπιδίων, χλωροφύλλης
2. Εκχύλιση με μεθανόλη
 - Εύκολη συμπύκνωση
 - Περιέχει χαμηλής πολικότητας ουσίες
 - Αποικοδομούνται κατά την αποθήκευση
 - Ευαίσθητες σε pH, θερμοκρασία, οξύτητα

Καθαρισμός ανθοκυανινών με εκχύλιση στερεάς φάσης (SPE)

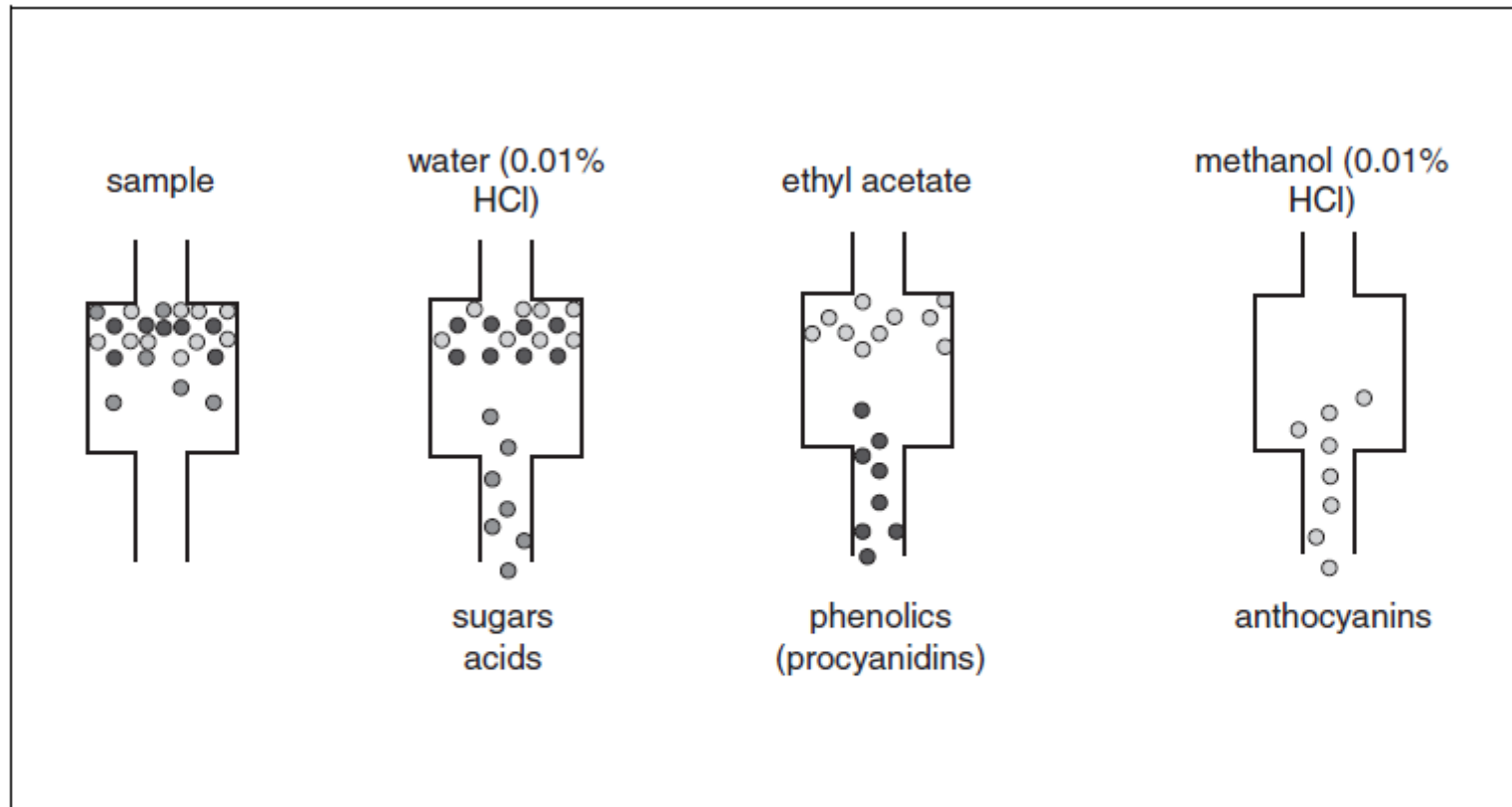


Figure F1.1.1 Solid-phase (C18) purification of anthocyanins. The sample components (represented by differentially shaded circles) are resolved by subsequent wash steps as indicated. The last wash, with acidified methanol, elutes anthocyanins. Acidified methanol and/or water should be used as solvents if electrospray mass spectrometry is to be carried out subsequently.

Προσδιορισμός ανθοκυανινών με φασματομετρία UV-Vis

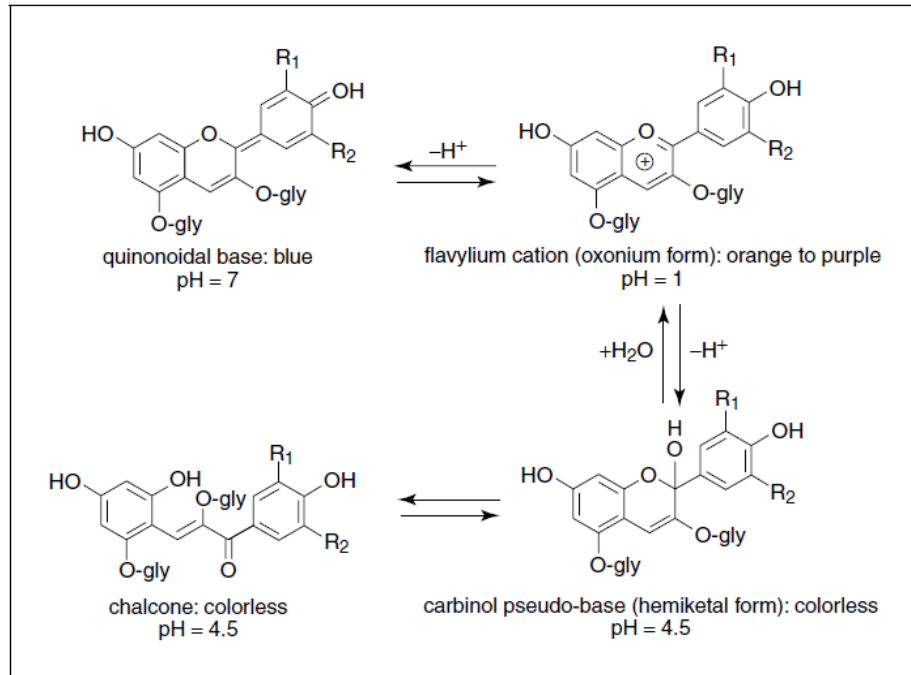


Figure F1.2.2 Predominant structural forms of anthocyanins present at different pH levels.

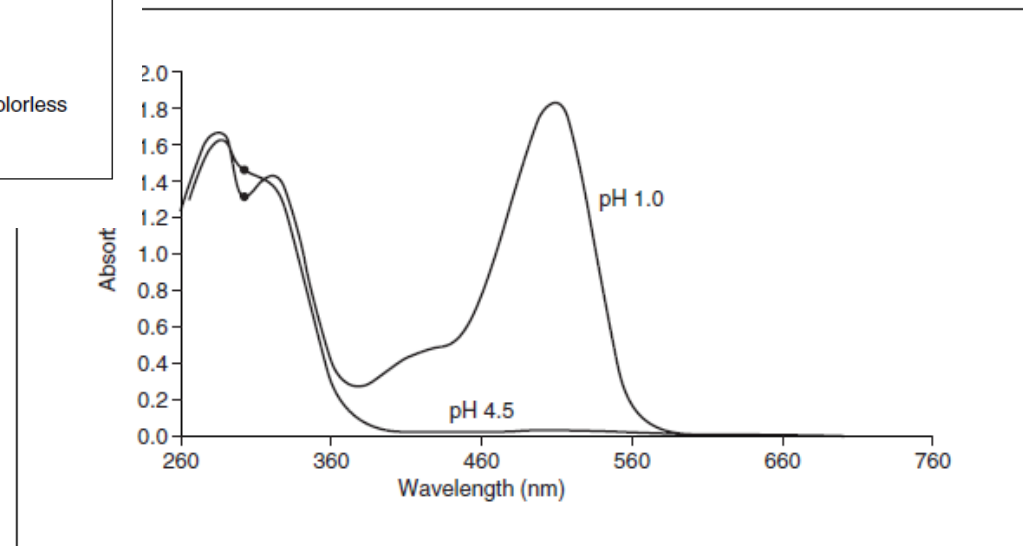


Figure F1.2.1 Spectral characteristics of purified radish anthocyanins (acylated pelargonidin-3-sophoroside-5-glucoside derivatives) in pH 1.0 and pH 4.5 buffers.

Προσδιορισμός πολυμερισμένων ανθοκυανινών με φασματομετρία UV-Vis

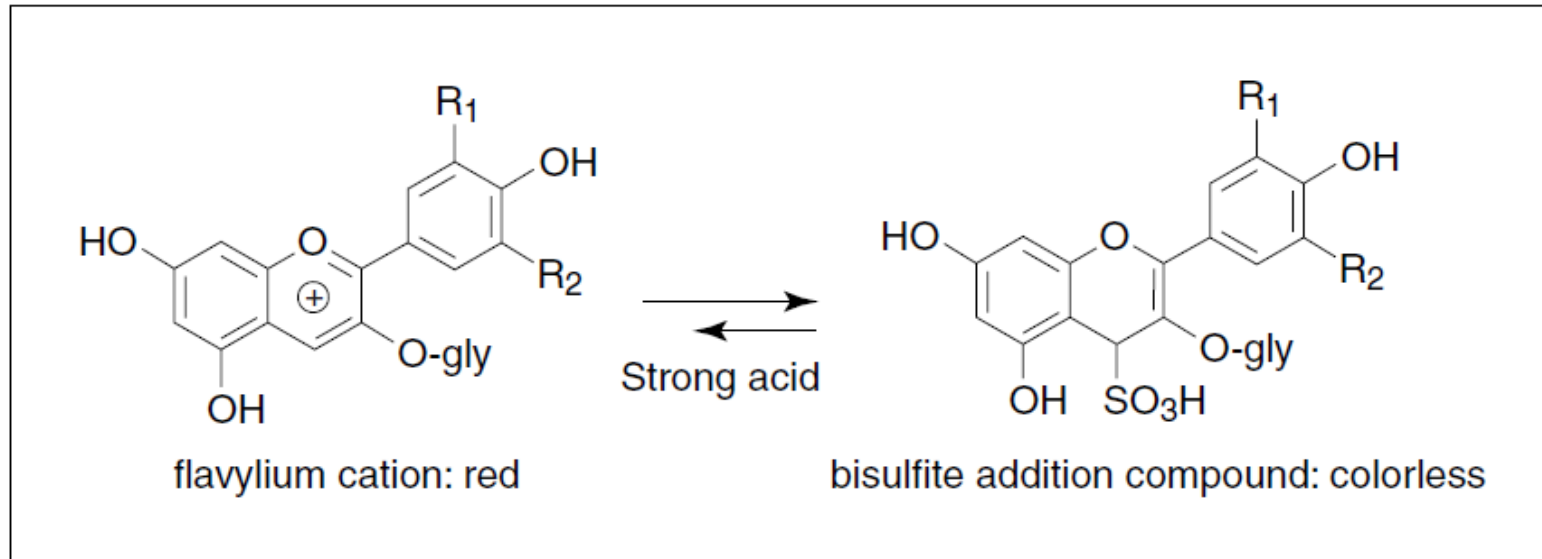


Figure F1.2.3 Formation of colorless anthocyanin-sulfonic acid adducts.

Προσδιορισμός ανθοκυανινών με χρωματογραφία HPLC

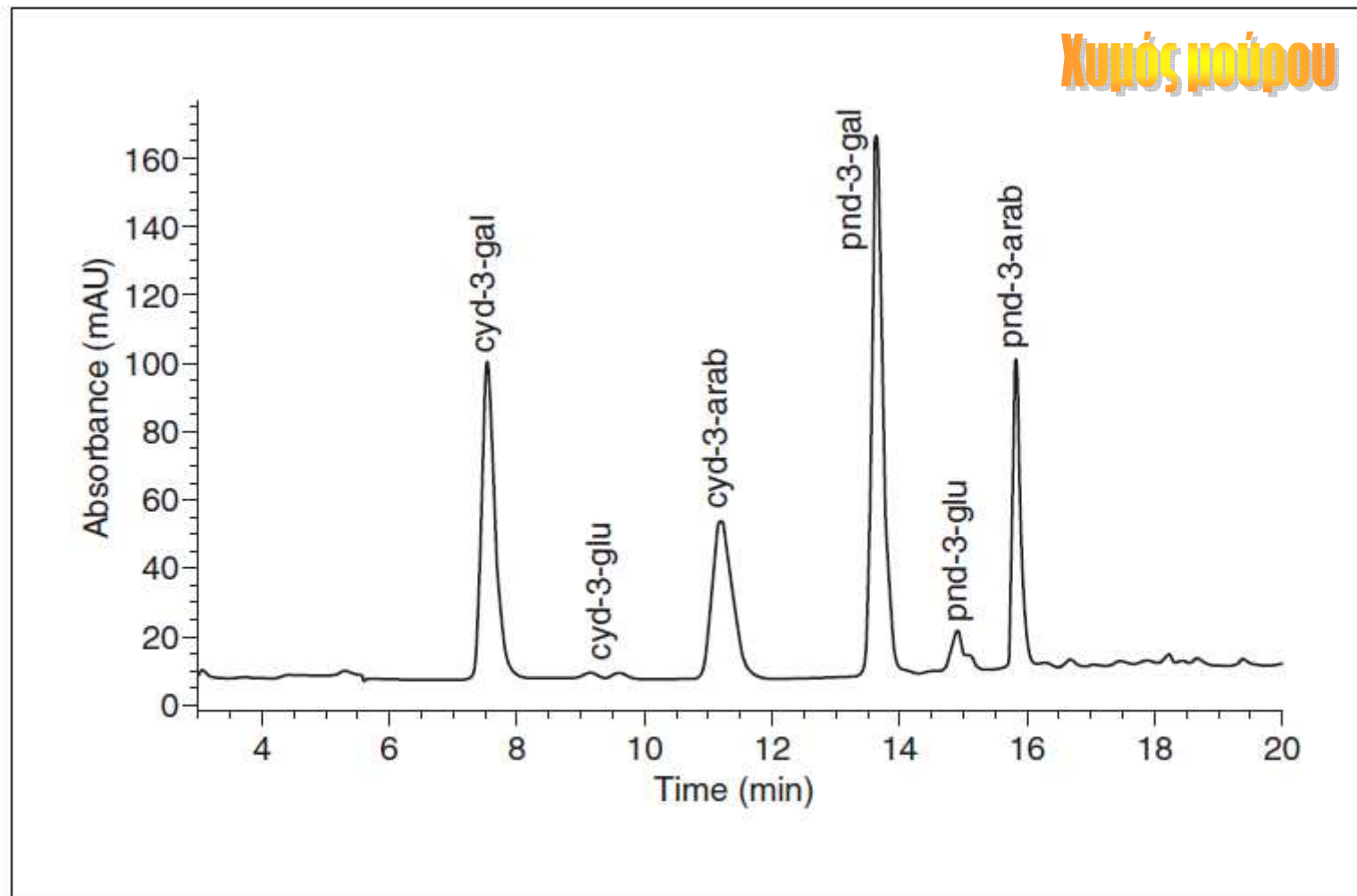


Figure F1.3.2 HPLC chromatogram of cranberry juice. Peaks identified on figure.

Προσδιορισμός ανθοκυανινών με χρωματογραφία HPLC

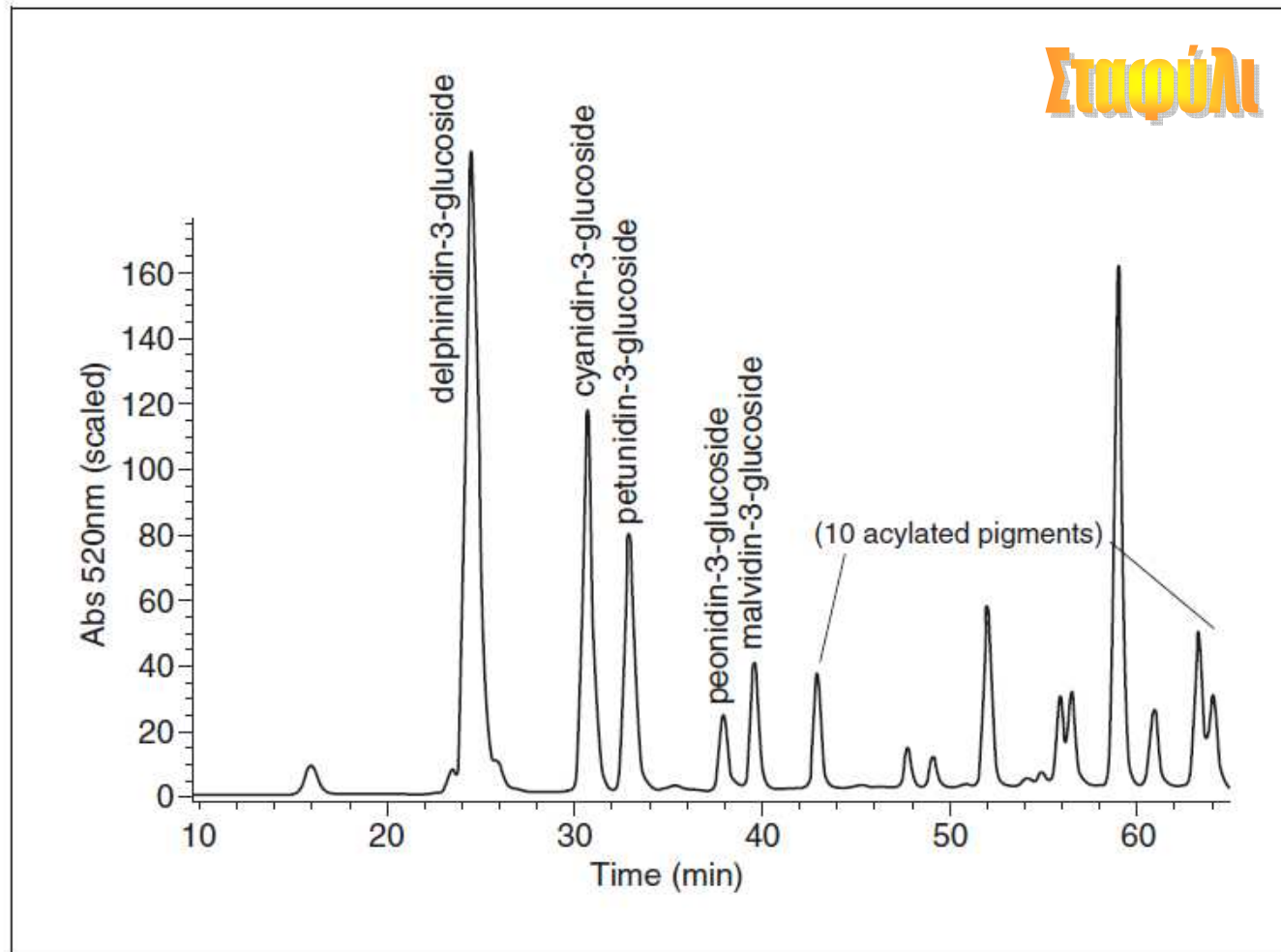


Figure F1.3.3 HPLC chromatogram of concord grape juice. Peaks identified on figure.

Προσδιορισμός ανθοκυανινών με φασματοσκοπία NMR

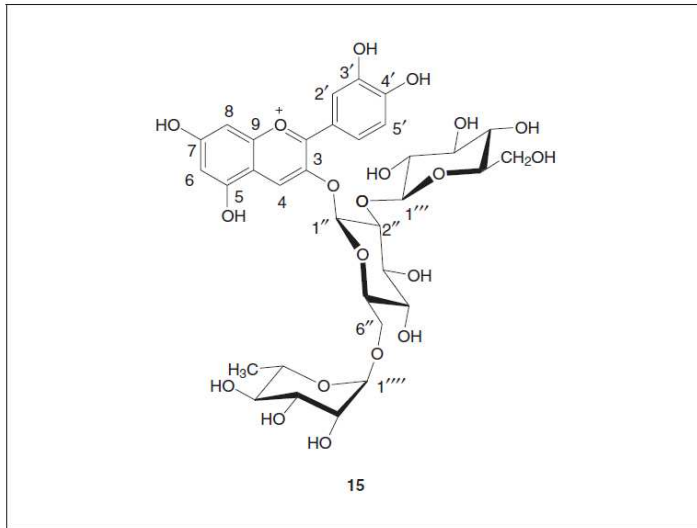


Figure F1.4.1 The structure of the major anthocyanin, cyanidin 3-O-(2''-O-β-glucopyranosyl-6''-O-α-rhamnopyranosyl-β-glucopyranoside), isolated from tart cherries, *Prunus cerasus*. Structure number 15 corresponds to ^1H and ^{13}C NMR data in Tables F1.4.4 and F.1.4.5.

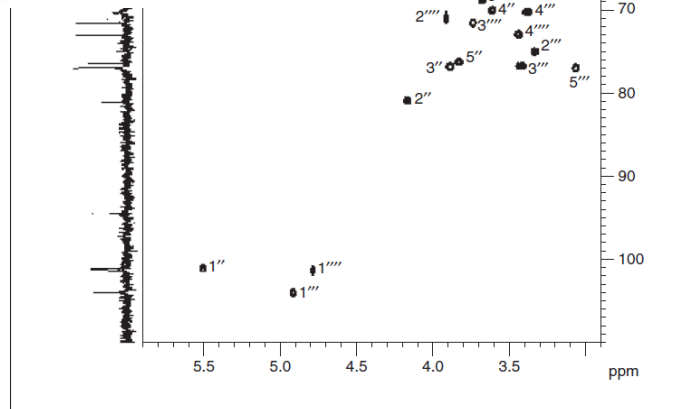


Figure F1.4.6 ^1H - ^{13}C HSQC spectrum of the sugar region of 15 showing all the $^1J_{\text{CH}}$ correlations, and thus all the ^1H and ^{13}C chemical shifts of the three sugar units, but the cross-peak of the methyl group of rhamnose (H6''''/C6''') at 1.2/17.1 ppm, which occurs beyond the presented region. The HSQC was obtained within 38 min.

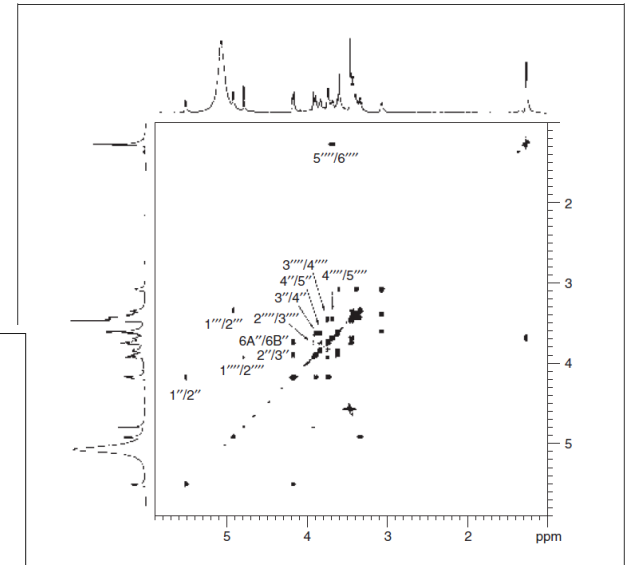


Figure F1.4.3 ^1H - ^1H DQF-COSY spectrum of the sugar region of 15 (Fig. F1.4.1) showing assignments of the individual ^1H resonances of the anthocyanin sugar units by $^3J_{\text{HH}}$ and $^2J_{\text{HH}}$ actions. The cross-peaks involving the rhamnose and one of the glucose units are labeled. The Y spectrum was obtained within 39 min.

Προσδιορισμός καροτενίων με φασματομετρία UV-Vis

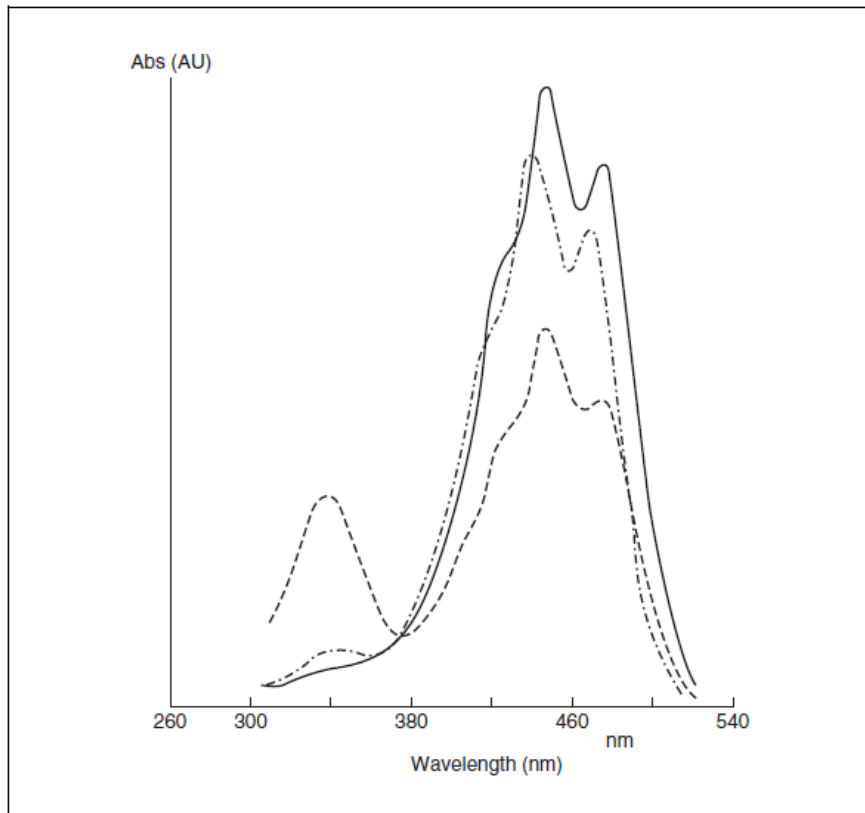


Figure F2.2.1 The spectral characteristics of *all-trans* β -carotene (solid line), *9-cis* β -carotene (dashed and dotted line) and *15-cis* β -carotene (dashed line).

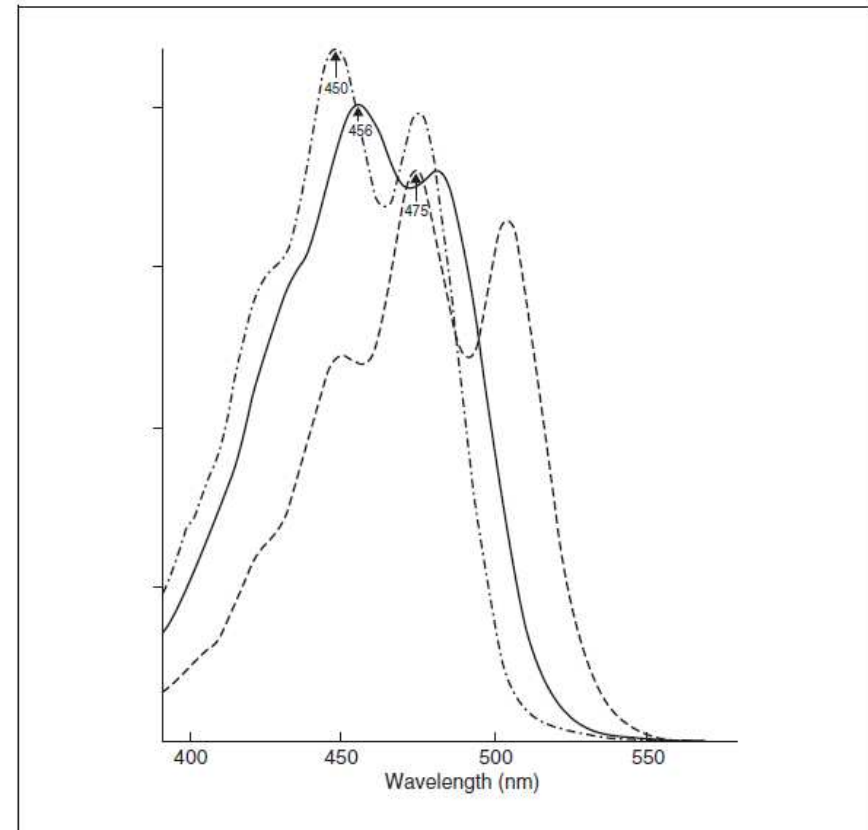


Figure F2.2.4 The spectral characteristics of β -carotene (solid line), lutein (long-dashed line), and lycopene (short-dashed line) in an acetonitrile-based HPLC solvent (75:25:5 v/v/v acetonitrile/methanol/dichloromethane).

Προσδιορισμός καροτενοειδών με χρωματογραφία HPLC

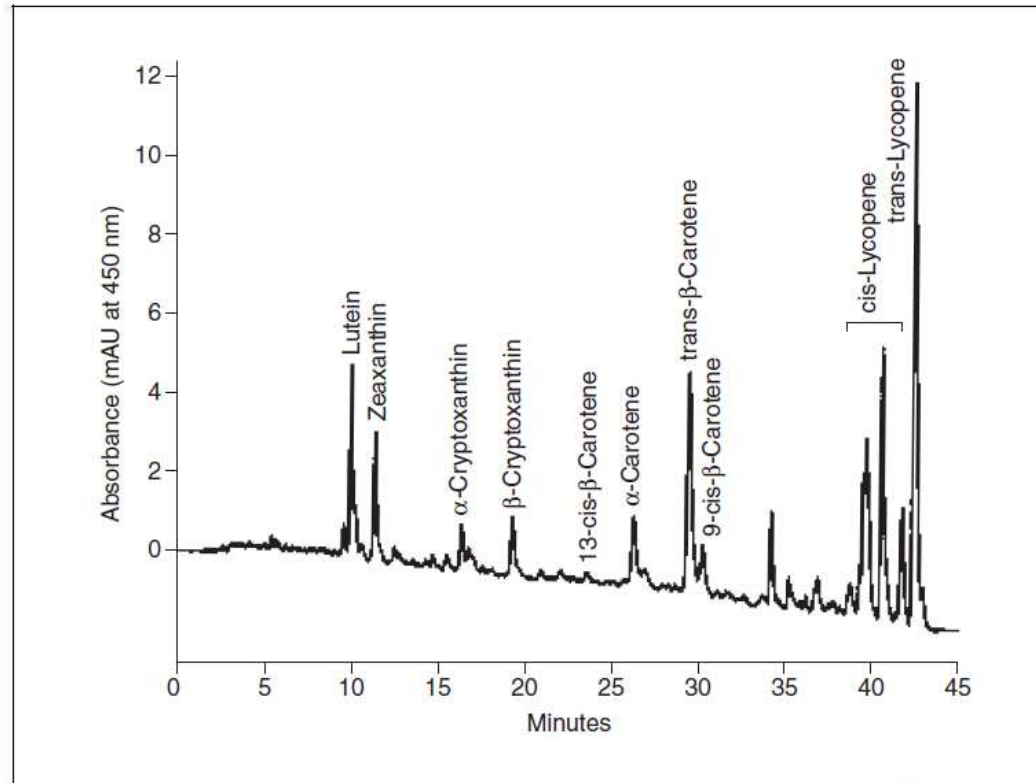
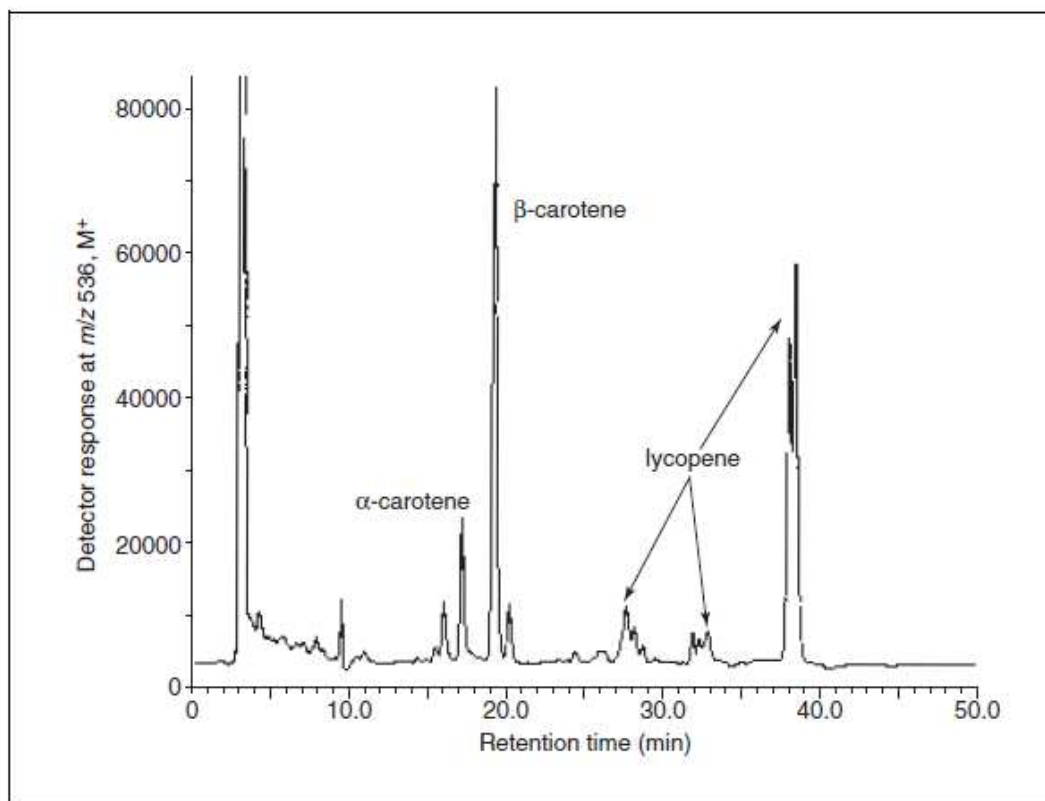


Figure F2.3.3 Gradient HPLC separation of the food reference material carotenoids using Protocol 3. Conditions: 3- μ m \times 250-mm \times 4.6-mm Waters C30, column, 1.0 ml/min flow rate, visible detection at 450 nm, column temperature 35°C, solvent A = 50 mM ammonium acetate in methanol, B = isopropyl alcohol, C = tetrahydrofuran (all solvents contain 0.1% TEA). Flow program: 90% A/10% B linear gradient, 54% A/35% B/11% C over 24 min, linear gradient to 30% A/35% B/35% C over 11 min, hold 8 min, then return to initial conditions over 10 min.

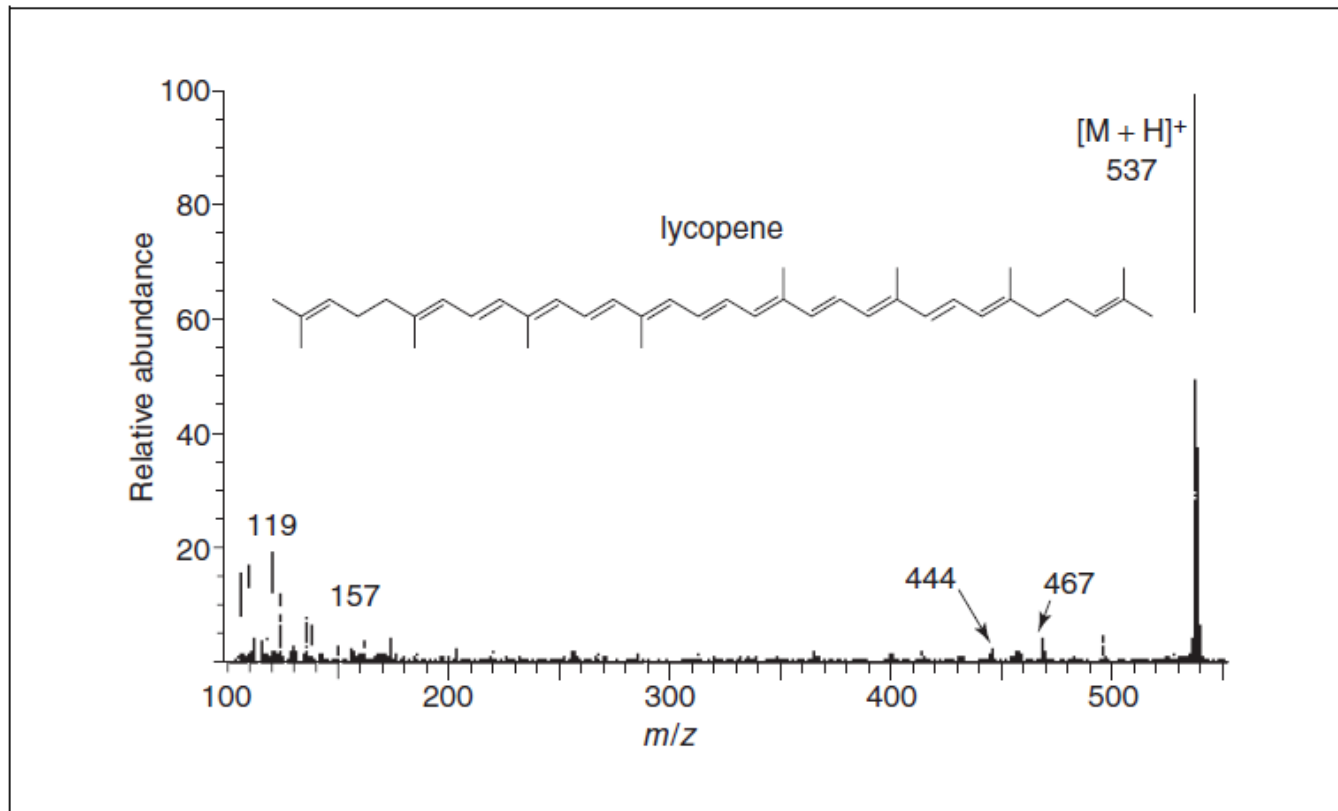
Προσδιορισμός καροτενοειδών με φασματομετρία μαζών



ESI-MS

Figure F2.4.1 Liquid chromatography/mass spectrometry (LC/MS) analysis of isomeric carotenes in a hexane extract from 0.5 ml human serum. Positive ion electrospray ionization MS was used on a quadrupole mass spectrometer with selected ion monitoring to record the molecular ions of lycopene, β -carotene, and α -carotene at m/z (mass-to-charge ratio) 536. A C30 HPLC column was used for separation with a gradient from methanol to methyl-*tert*-butyl ether. The all-*trans* isomer of lycopene was detected at a retention time of 38.1 min and various *cis* isomers of lycopene eluted between 27 and 39 min. The all-*trans* isomers of α -carotene and β -carotene were detected at 17.3 and 19.3 min, respectively.

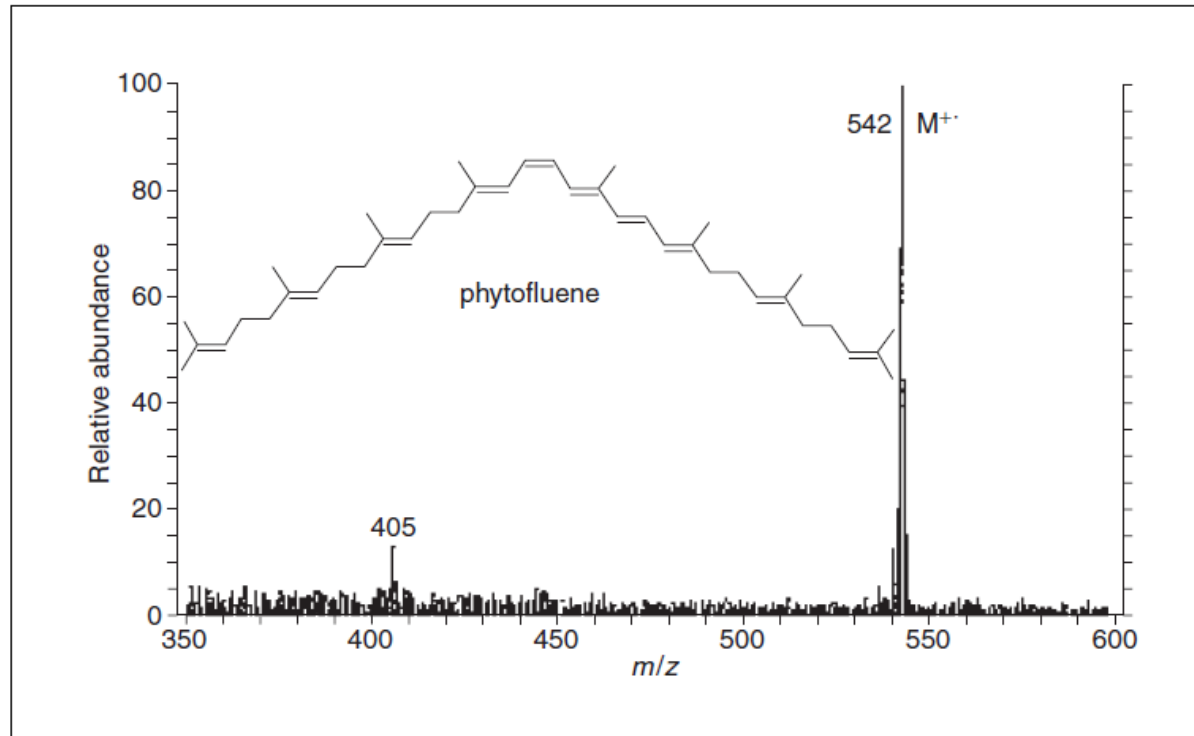
Προσδιορισμός καροτενοειδών με φασματομετρία μαζών



APCI-MS

Figure F2.4.3 Flow-injection positive ion atmospheric pressure chemical ionization (APCI) mass spectrum of ~1 pmol lycopene. The carrier solvent for flow injection analysis consisted of methanol/methyl-*tert*-butyl ether (50:50; v/v) at a flow rate of 200 μ l/min. The lycopene standard was isolated from tomatoes. The all-*trans* isomer of lycopene is shown, which is the most abundant isomer found in the tomato. This carotene is the familiar red pigment of the tomato.

Προσδιορισμός καροτενοειδών με φασματομετρία μαζών



FAB-MS

Figure F2.4.2 Positive ion fast atom bombardment (FAB-MS) mass spectrum of phytofluene isolated from blueberries. The base peak of m/z (mass-to-charge ratio) 542 corresponds to the molecular ion. Characteristic of FAB-MS, background signals are observed at every m/z value. The mass spectrum was obtained during continuous-flow FAB-MS LC/MS using a magnetic sector mass spectrometer. Although the 16-*cis* isomer of phytofluene is shown, the FAB mass spectra of the all-*trans* and other *cis* isomers are indistinguishable.

Προσδιορισμός χρωστικών φρέσκου κρέατος με UV-Vis

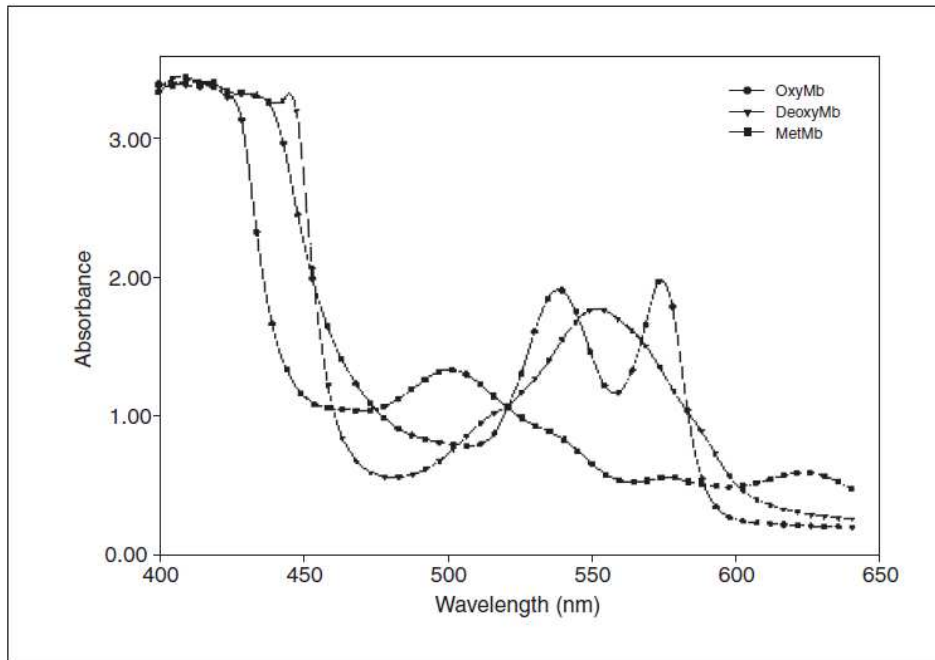


Figure F3.3.1 Absorbance spectra for deoxy-, oxy-, and metmyoglobin.

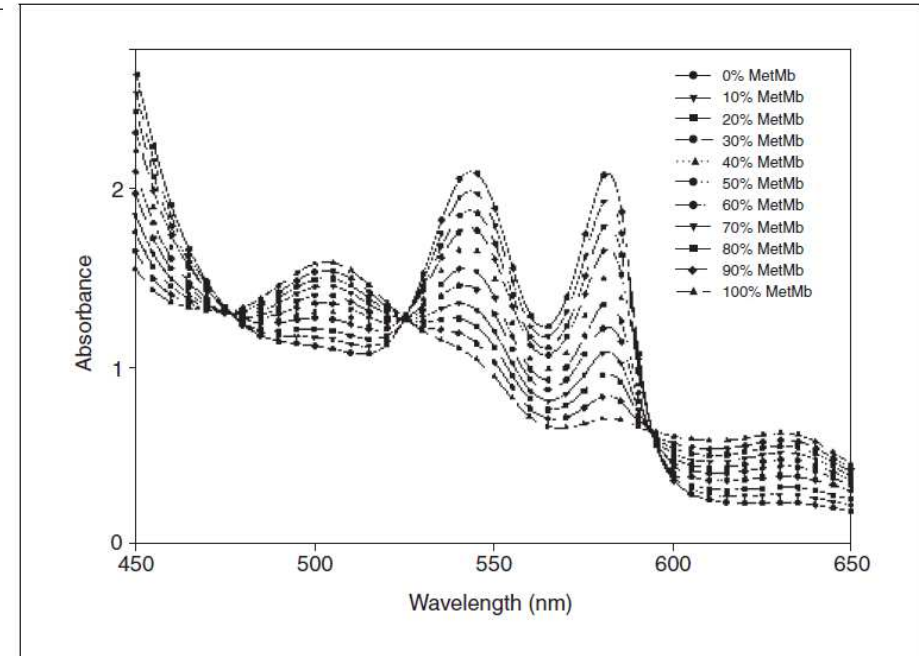
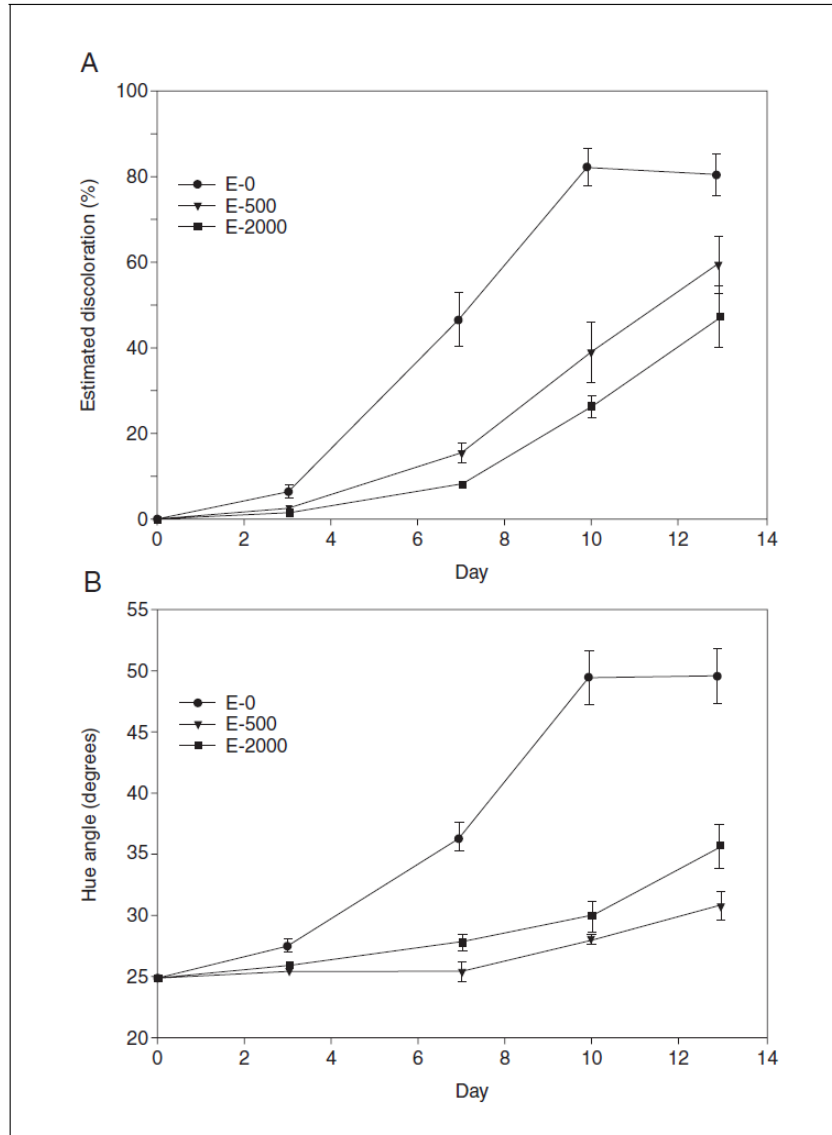


Figure F3.3.2 Absorbance spectra for myoglobin solutions containing different proportions of oxy- and metmyoglobin.

Επίδραση διαίτας εμπλουτισμένης με αντιοξειδωτικά το χρώμα του κρέατος

Πάνελ



UV-Vis

Figure F3.3.3 Comparison of subjective sensory assessment (A; percent discoloration) and objective colorimetric evaluation (B; hue angle). Beef was obtained from cattle supplemented with 0 (E-0), 500 (E-500) or 2000 (E-2000) IU α -tocopherol acetate per head per day. The α -tocopherol demonstrated a color preservation effect. Hue angle was calculated as $[\tan^{-1}(b^*/a^*)] \cdot (360^\circ/2\pi)$. Standard error bars are indicated. Adapted from Chan et al. (1995), with permission from the Institute of Food Technologists.

Προσδιορισμός χλωροφύλλης με UV-Vis

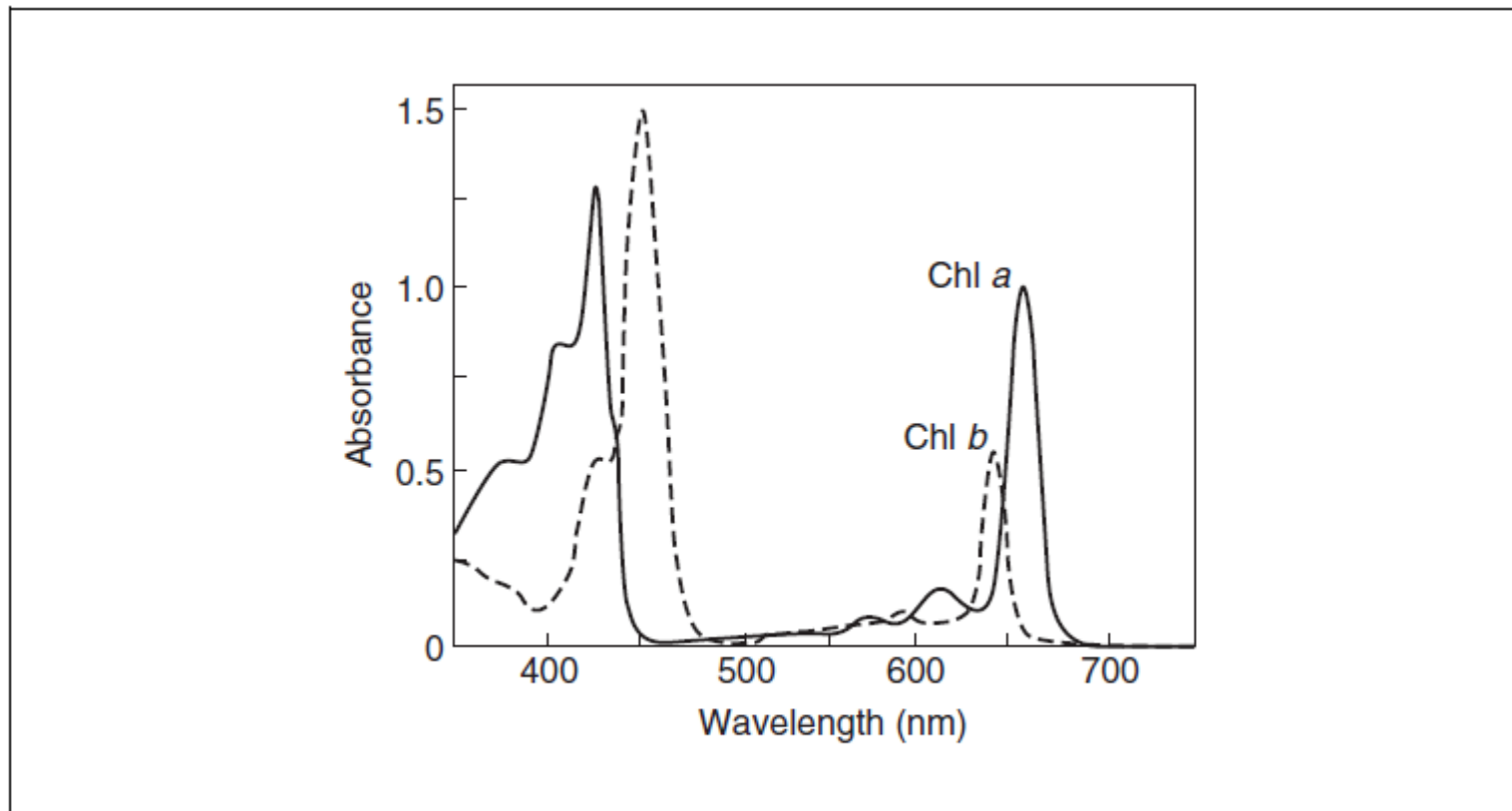


Figure F4.3.1 Absorption spectra of freshly isolated Chl *a* and Chl *b* in diethyl ether (pure solvent). The spectra were measured 40 min after extraction of pigments from leaves and 3 min after eluting the two Chls with diethyl ether from a TLC plate.

Προσδιορισμός χλωροφύλλης με φασματομετρία μαζών

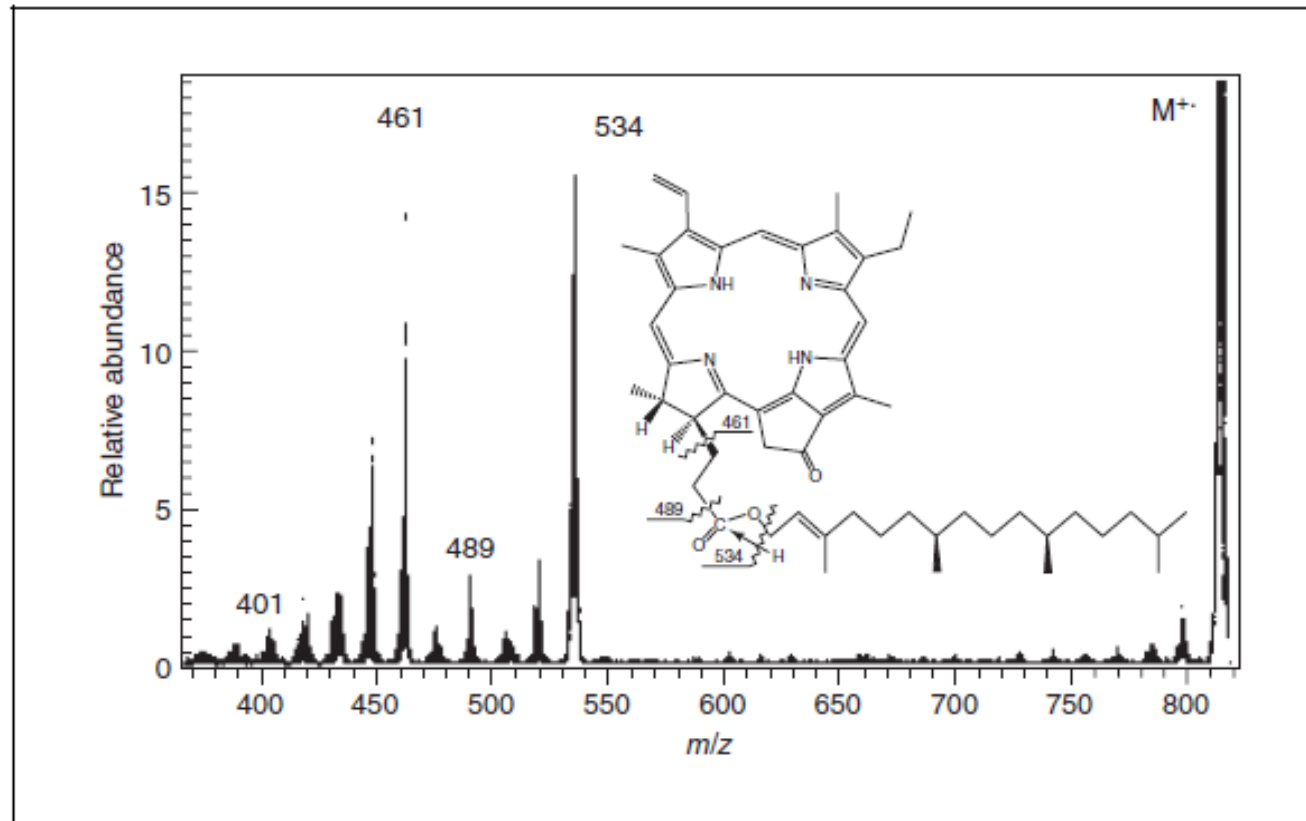


Figure F4.5.1 Positive ion fast atom bombardment (FAB) with collision-induced dissociation (CID) tandem mass spectrum of pyropheophytin *a* isolated from spinach leaves. The FAB matrix was 3-nitrobenzyl alcohol.