

Raspberry Polyphenols: Synergies with Other Fruits

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Presentation Outline

- **Introduction**
- **UCLA In vitro Berry Studies**
- **UCLA In vivo Berry Studies**
- **Raspberry Polyphenol Synergism**

What are Phytochemicals?

- Non-nutrient plant compounds that may provide human health benefits against cancer, heart disease, neurodegenerative diseases etc.
- Produced by plants for defense against harmful UV radiation, herbivorous predators etc. or as attractants for pollination (bright colors) etc.
- Polyphenols are ubiquitous dietary phytochemicals

UCLA Polyphenol Studies

Polyphenols

Tea

Green tea
Black tea
Tea supplements



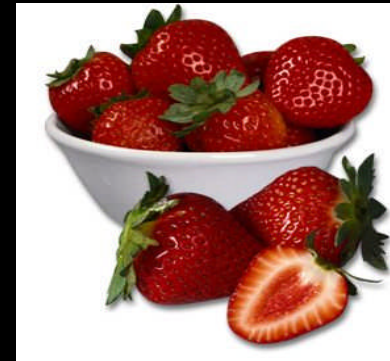
Pomegranates

Juice
Extracts
Pure compounds



Strawberries

Fresh fruits
Extracts



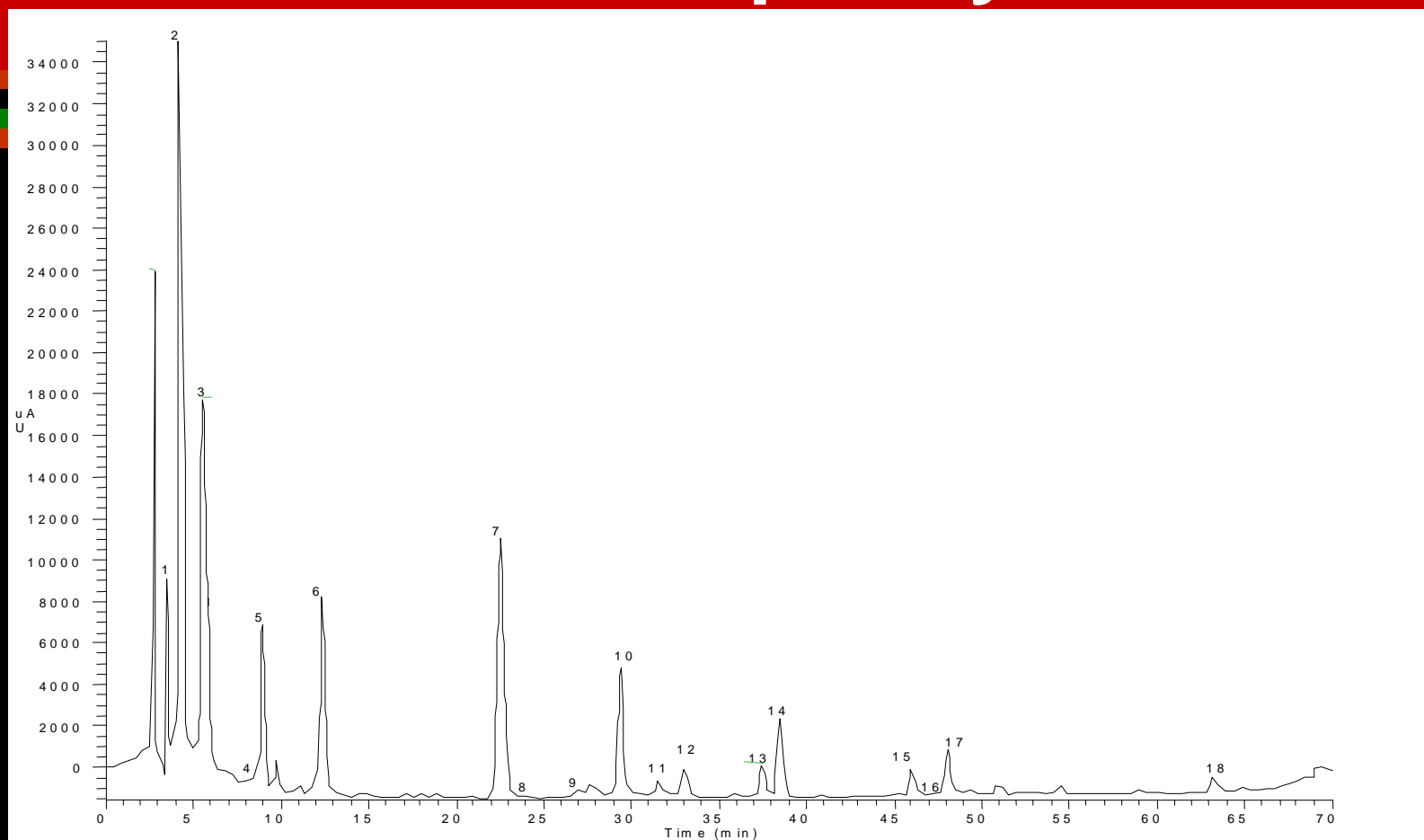
Studies on Other Berries

- **Cranberries**
- **Blueberries**
- **Red & Black Raspberries**
- **Blackberries**
- **Seeds, Seed-oils, Fiber & Other By-Products**

Red Raspberry Polyphenols

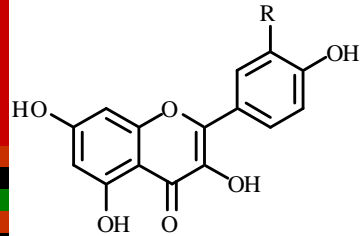
- **Flavonoids**
 - **Anthocyanins**
 - **Flavonols**
- **Ellagitannins (and Ellagic acid)**

HPLC-UV and LC-MS/MS Profiling of Red Raspberry



Seeram NP et al; *Blackberry, Black Raspberry, Blueberry, Cranberry, Red Raspberry and Strawberry extracts inhibit growth and stimulate apoptosis of human cancer cell in vitro*, *J. Agric. Food. Chem.* 2006, 9329-39.

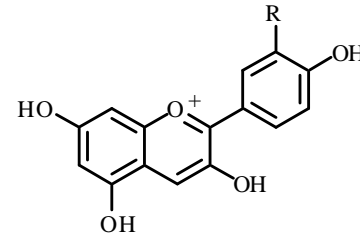
Structures of Raspberry Polyphenols



Flavonols

Quercetin R = OH

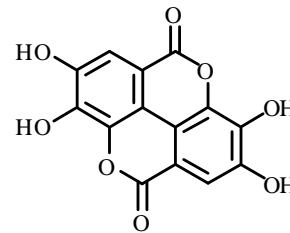
Kaempferol R = H



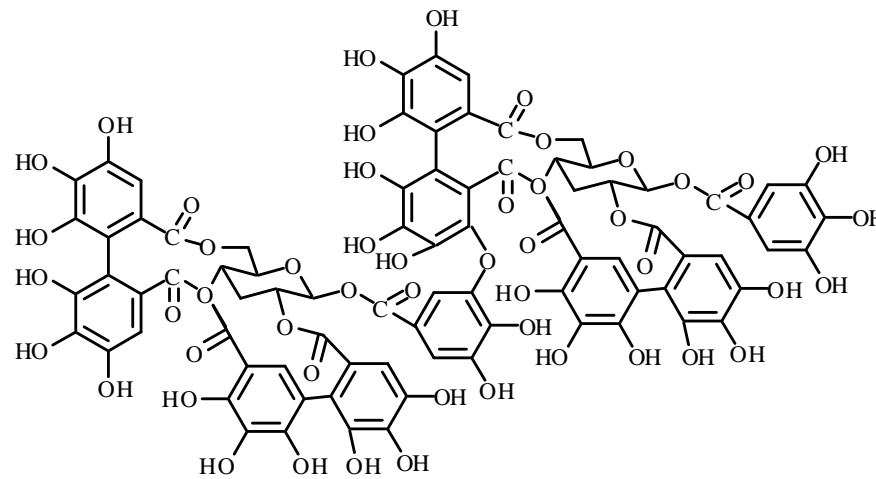
Anthocyanidins

Cyanidin R = OH

Pelargonidin R = H



Ellagic acid



Ellagitannin

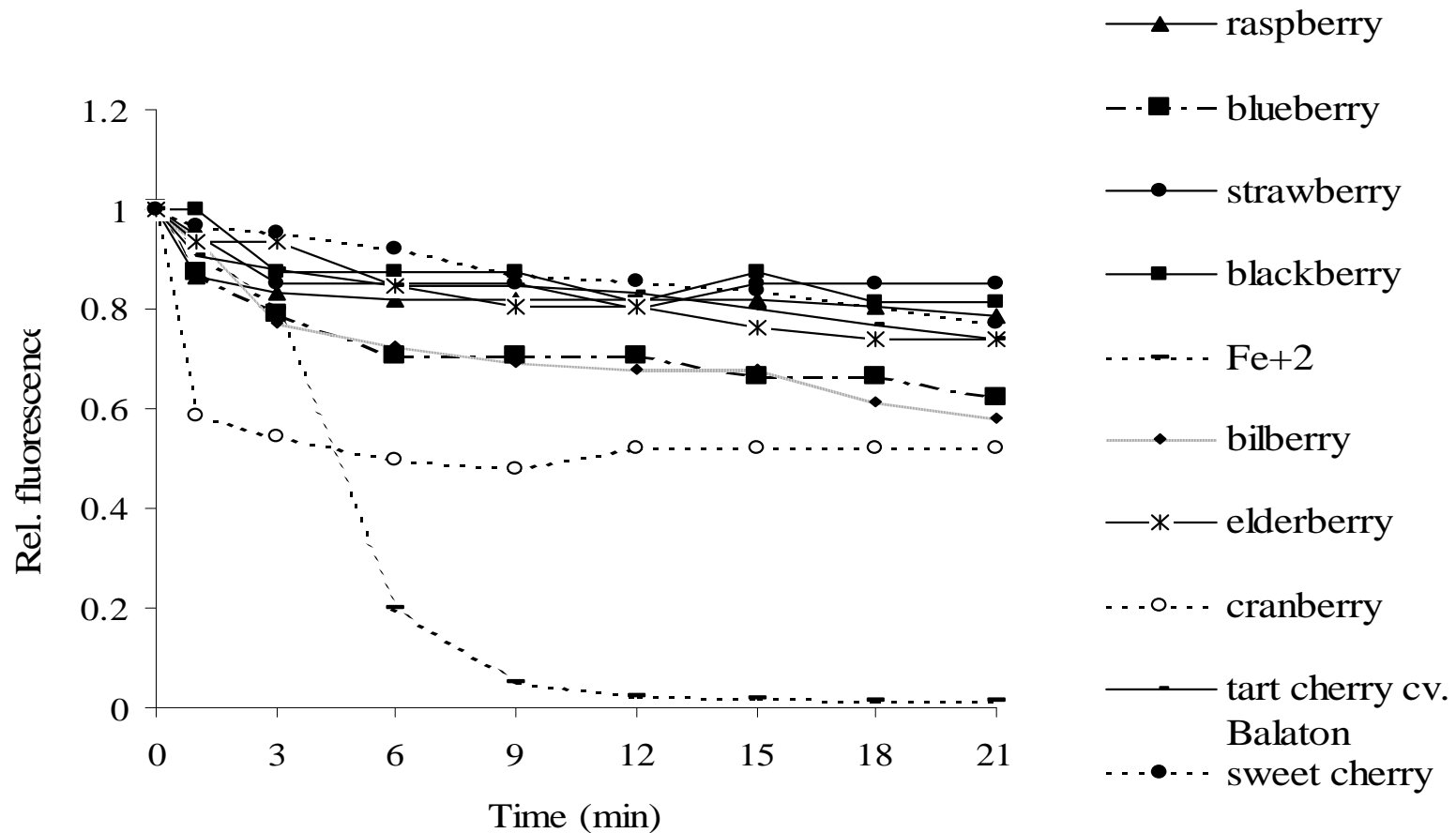
Sanguin H-6

Biological Activities of Berry Polyphenols

- **Antioxidant**
- **Anti-inflammatory**
- **Anti-proliferative & Pro-apoptotic**
- **Anti-neurodegenerative**

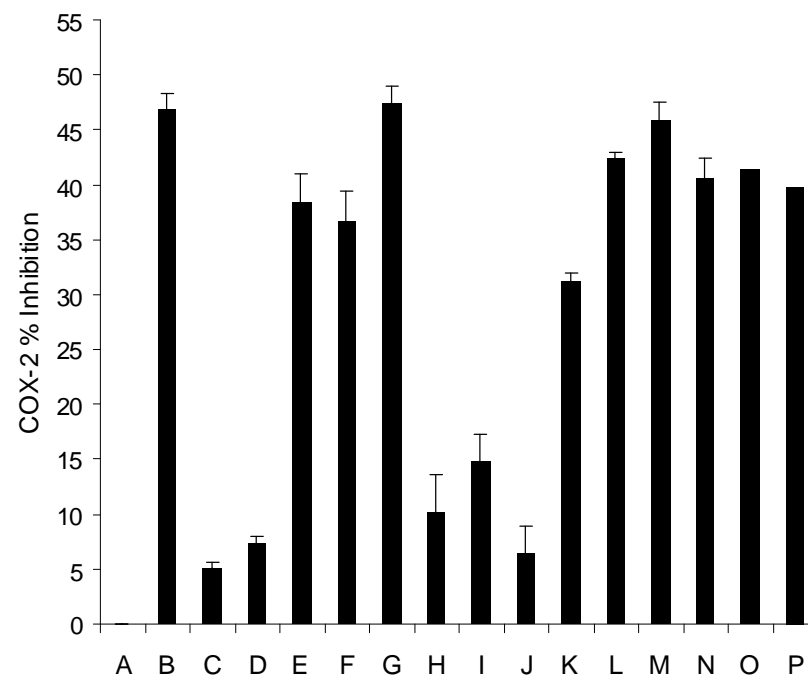
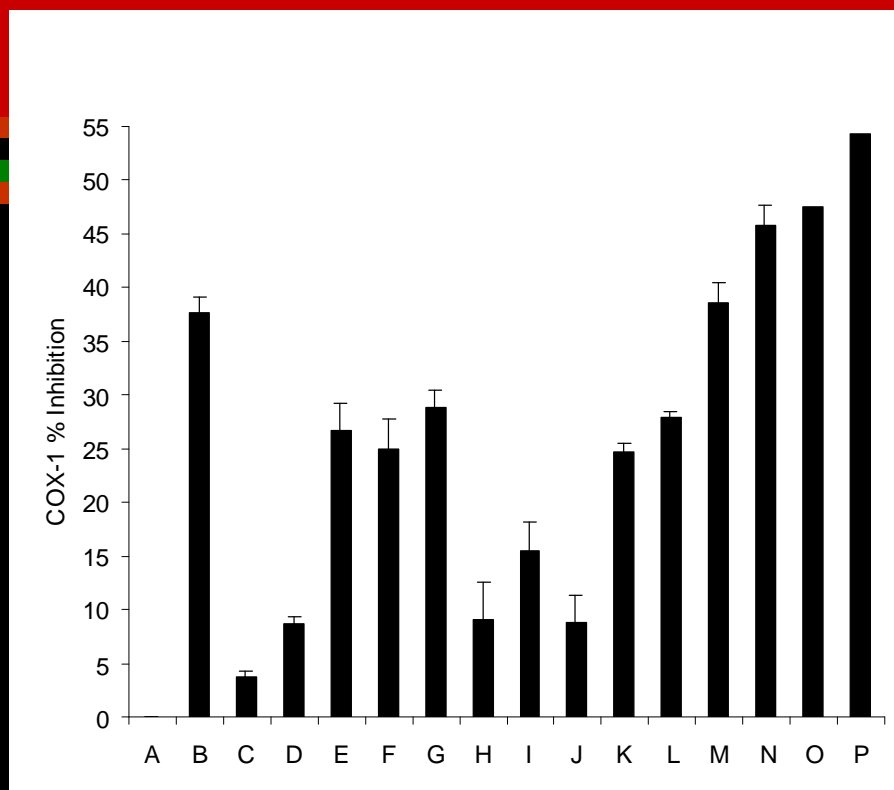
1. Seeram NP et al; *Cyclooxygenase inhibitory and antioxidant cyanidin glycosides from cherries and berries*; *Phytomedicine*, 2001, 362-369.
2. Seeram NP et al; *Inhibition of Proliferation of human tumor cell lines by anthocyanidins and catchins*; *Nutrition and Cancer*, 2003, 10-106.
3. Tall J et al; *Tart cherry anthocyanins suppress inflammation induced pain behavior in the rat*; *Behavioral Brain Research*, 2004, 181-188.
4. Seeram NP et al; *Blackberry, Black Raspberry, Blueberry, Cranberry, Red Raspberry and Strawberry extracts inhibit growth and stimulate apoptosis of human cancer cell in vitro*, *J. Agric. Food. Chem.* 2006, 9329-39.

Inhibition of Lipid Peroxidation



Seeram NP et al; *Cyclo-oxygenase inhibitory and antioxidant cyanidin glycosides from cherries and berries*; *Phytomedicine*, 2001, 362-9.

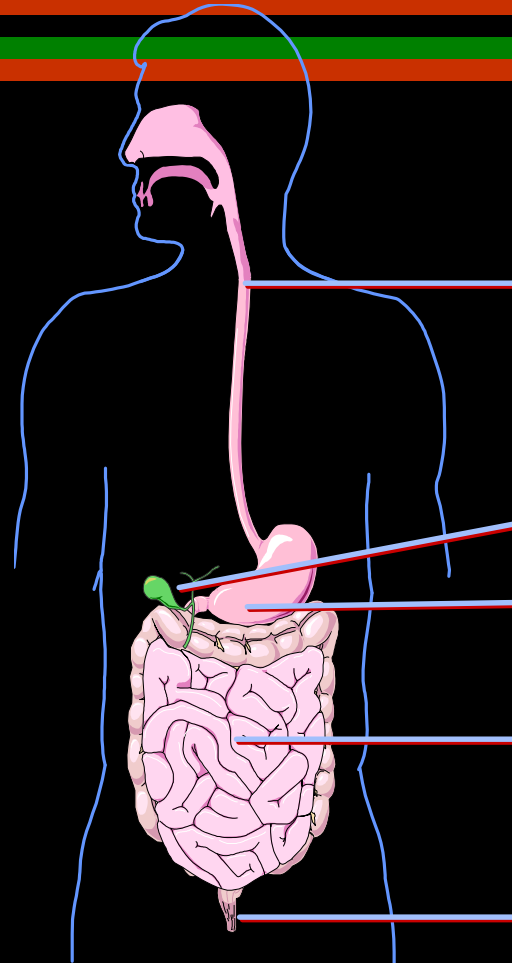
Anti-inflammatory Activity: Inhibition of COX Enzymes



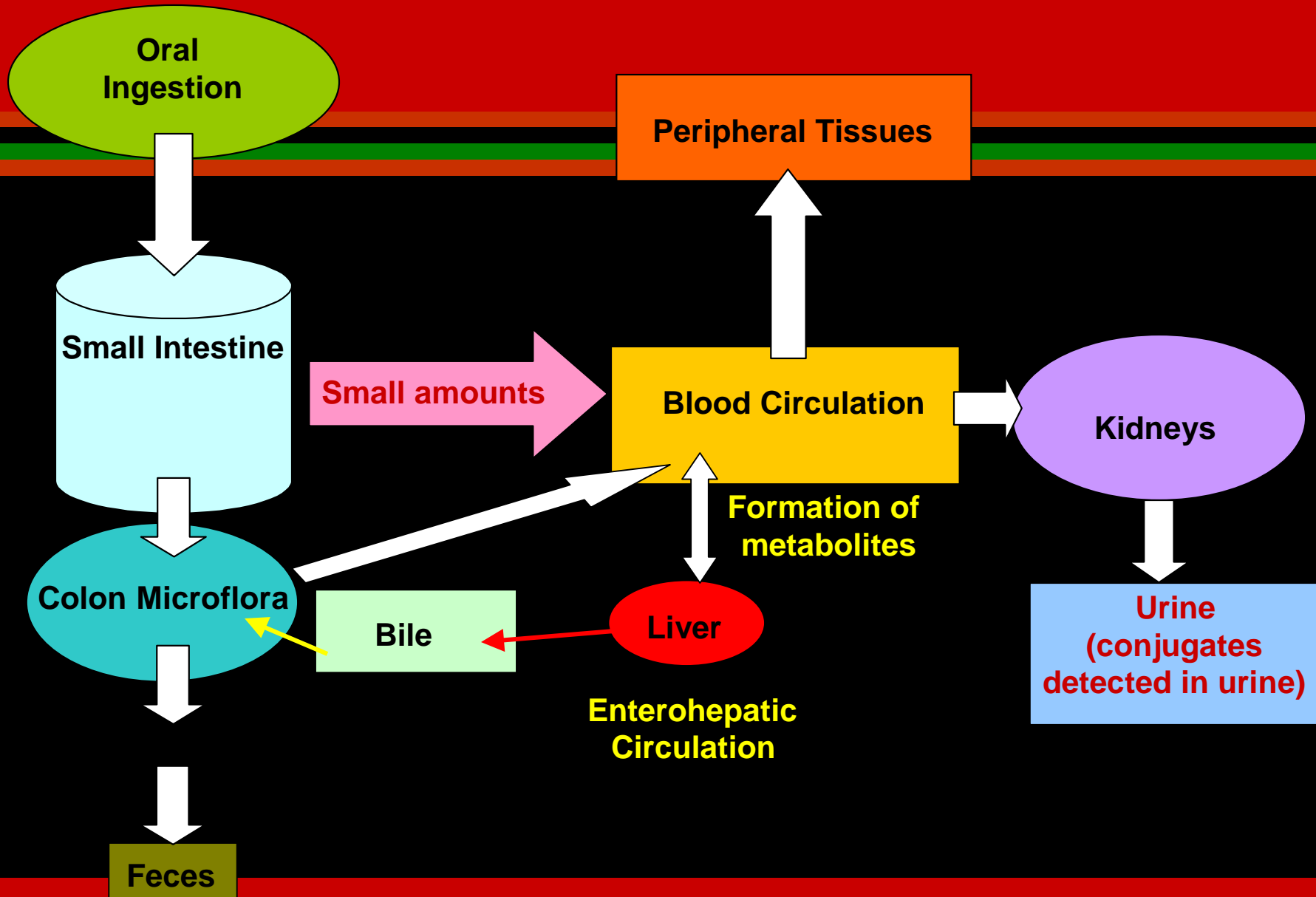
A = DMSO; B = cyanidin 4; C = anthocyanin 1; D = anthocyanin 2; E = tart cherry cv. Balaton™; F = tart cherry cv. Montmorency; G = sweet cherry; H = blueberry var. Jersey; I = cranberry var. Early Black; J = bilberry; K = elderberry; L = strawberry var. Honeoye; M = blackberry; N = raspberry; O = naproxen; P = ibuprofen.

What happens when we consume Polyphenols?

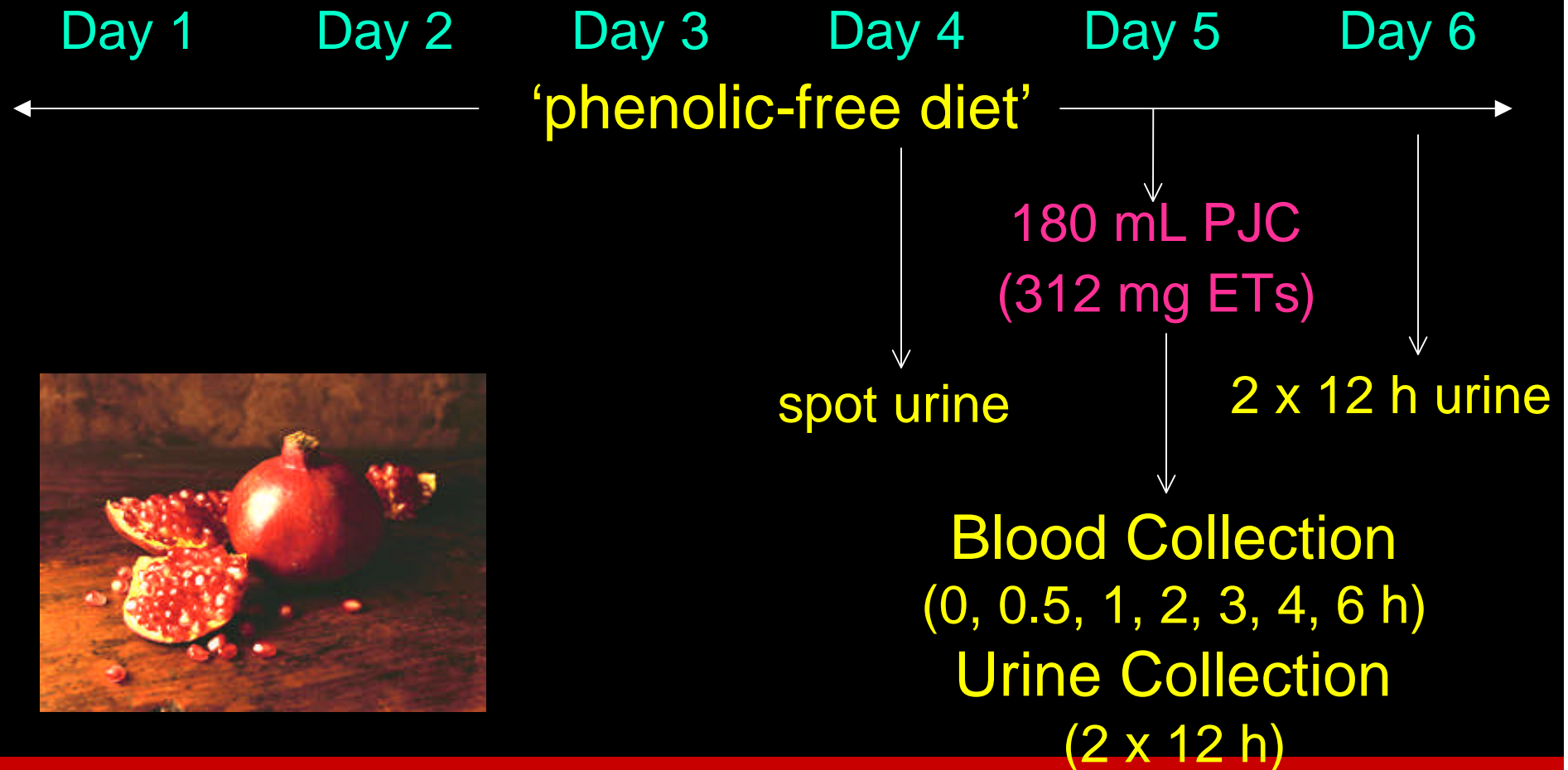
- Absorption
- Distribution
- Metabolism
- Excretion



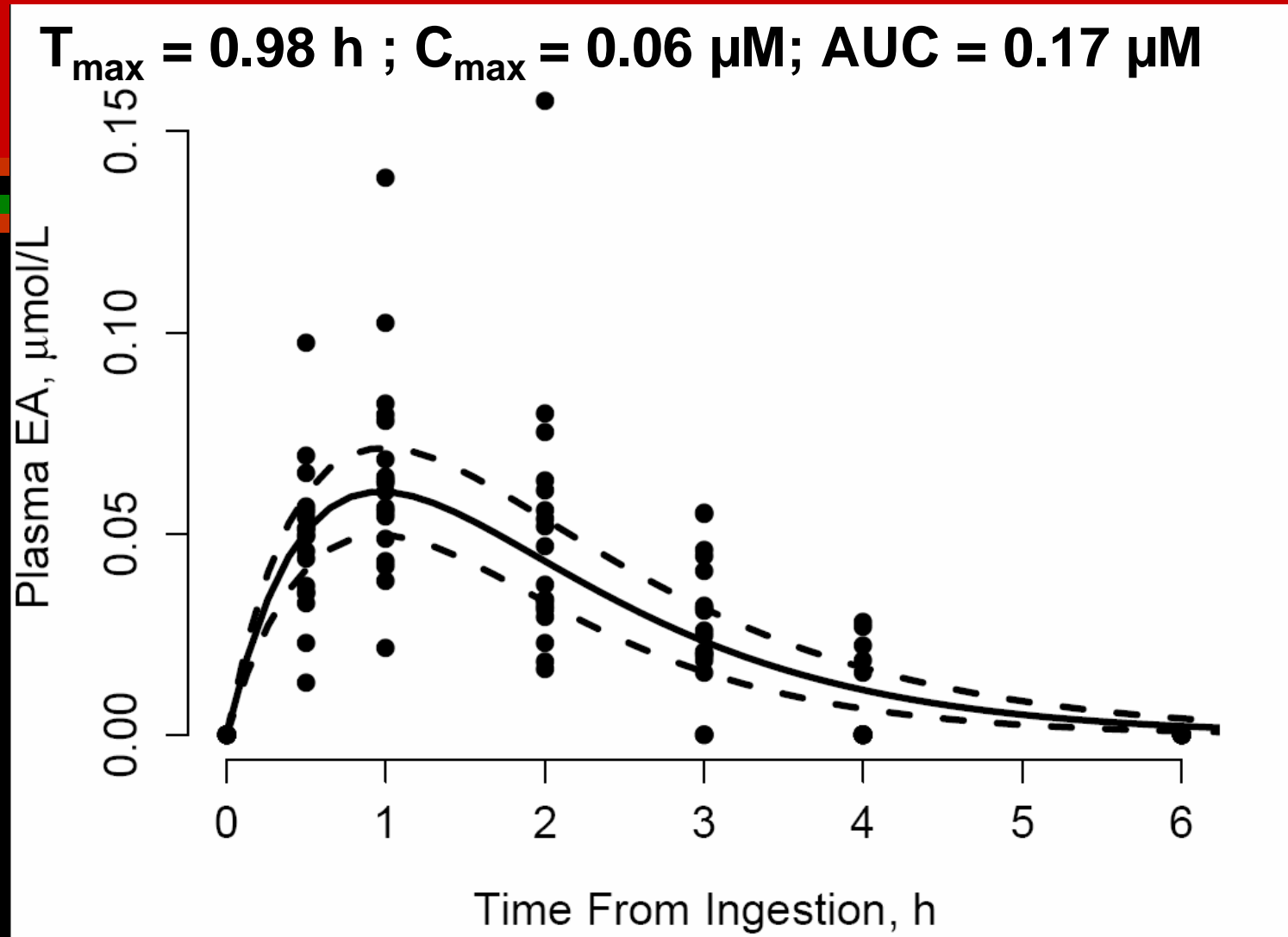
Metabolism of Polyphenols



Pharmacokinetics and Metabolism of Ellagitannins (n = 18)



Ellagic Acid (EA) Pharmacokinetics

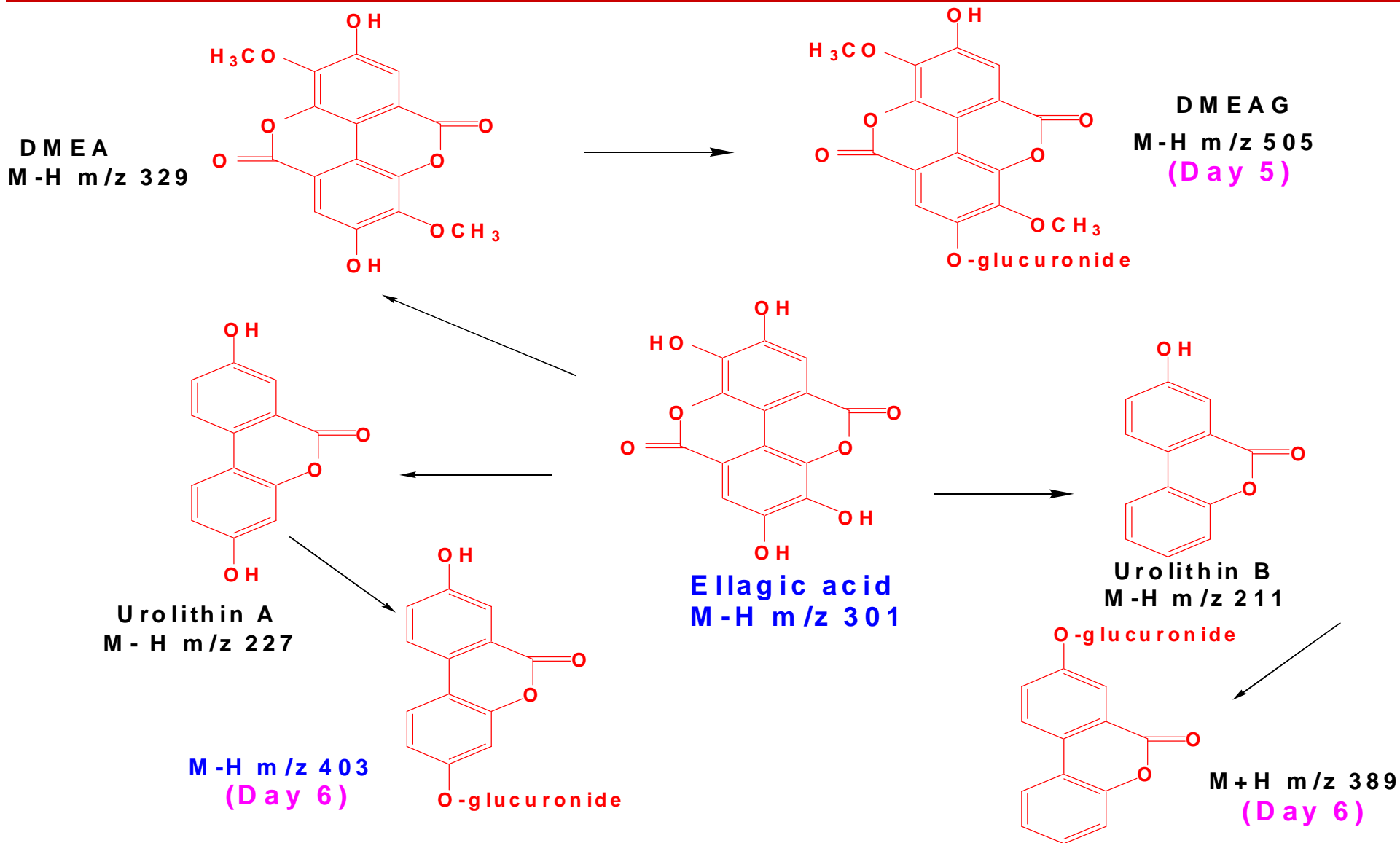


1) Seeram N.; Lee, R.; Heber, D. *Clin. Chim. Acta.* 2004, 348, 63-68.

2) Seeram N.; Henning, S.; Zhang, Y.; Suchard, M.; Li, Z.; Heber, D. *J. Nutrition.*, 2006, 136, 2481-5.

EA Urinary Metabolites Persist for 48 h

(observed Inter-individual variability in metabolite formation)



Berry Polyphenol Synergy Hypothesis

Multiple compounds (in a food or extract matrix) interact synergistically and/or additively to potentiate the bioactivity of major active ingredient (s)

Published Studies

- **Seeram N.P. et al.** Total Cranberry Extract vs. its Phytochemical Constituents : Antiproliferative and synergistic effects against human tumor cell lines. **J. Agric. Food Chem. 2004, 52, 2517-7.**
- **Seeram N.P. et al.** In vitro antiproliferative, apoptotic and antioxidant activities of punicalagin, ellagic acid and a total pomegranate tannin extract are enhanced in combination with other polyphenols as found in pomegranate juice. **J. Nutr. Biochem. 2005, 16, 360-7.**

Red Raspberry Combined with Other Berries: (e.g.Pomegranates)

- **Additivity of ellagitannin-rich berries**
- **Enhanced taste profile of foods and beverages.**
- **Enhanced bioactivities in extracts**
- **Commercial Impact on Taste, Appearance, Health Appeal**