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The 36th International Vegetable Training Course

From Seed to Table and Beyond

"Module 2: Vegetables: From Harvest to Table"

Bioactive Compounds in Vegetables and Fruits

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Outline

- What are bioactive compounds?
- Types and sources of bioactive compounds and their health benefits
- Factors affect bioactive compound contents during cultivation
- Effect of postharvest handling on bioactive compounds
- Effect of cooking on bioactive compounds

FAO/WHO recommends to consume 400 g of fruits and vegetables per day

Dairy consumption of fruits and vegetables was associated with 50% lower risk of cancers and 33% lower risk of cardiovascular diseases, compared with less frequent fruit consumption.

Lower blood pressure
Control blood glucose
Lower risk of digestive problems, etc.

Eat at least 5 portions of fruits and vegetables

Because

Fruits and vegetables are sources of

- vitamins
- minerals
- fiber
- bioactive components

Dr. Ann Kulze, M.D.

Medical Advisory Board for the Wellness Councils of America and Prevent Cancer Foundation

https://www.youtube.com/watch?v=ZKxwaKk9wG8

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Phytochemicals

- It is found in fruits and vegetables
- Give color in the plants and act as plant protectors
- Maintain and improve health
- Four key features of phytochemicals
  - Anti-inflammatory power: inflammation is the key of chronic diseases
  - Antioxidant power
  - Immune boosting power
  - Detoxify property
- Examples: flavonoids, glucosinolates and n-3 polyunsaturated fatty acid

What is bioactive compounds?

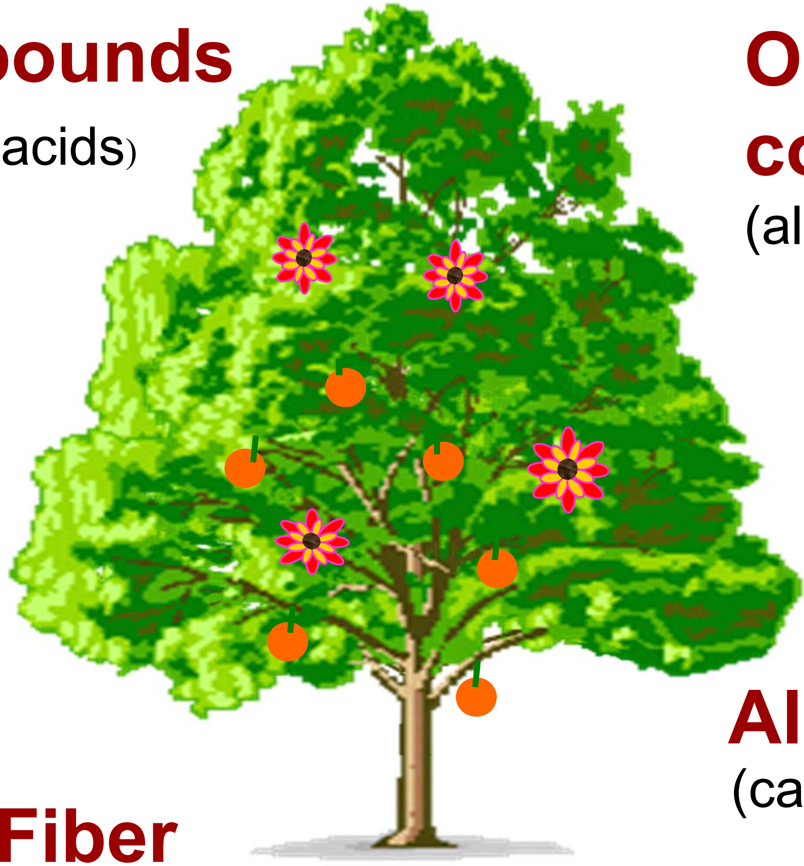
- Extranutritional constituents: occur in small quantities in food
- Plant-based bioactive compounds = "**Phytochemicals**"
  - Phyto means "plant" in Greek
  - Secondary metabolites synthesized by plants
  - Do not provide nutritive value
  - Function of bioactive compounds in plants:
    - Protect against stress
    - Plant hormones
    - Pigments (green, yellow, orange, etc.)
    - Photosensitizing and energy transferring compounds

Where are the bioactive compounds accumulated?

- Leaves
- Flowers
- Fruits

- Roots/Tubers
- Bulb
- Bark/stem/ heart wood

Major classes of bioactive compounds



Phenolic compounds
(flavonoids, phenolic acids)

Phytosterols
(stigmastanol, campasterol)

Terpenoids
(carotenoids)

Fiber
(soluble/insoluble fiber)

Organosulfur compounds
(allicin)

Glucosinolates
(isothiocyanates, indoles)

Alkaloids
(capsaicinoids, caffeine)

Betalains
(betaxanthin, betacyanin)

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Fiber

Sources: grains, wheat bran, oat bran, barley, nuts, seeds, beans , peas, fruits and vegetables

Mechanism of action:

- attracts water and turns to gel during digestion: slows digestion
- adds bulk to the stool and appears to help food pass more quickly through the stomach and intestines

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Fiber

Health benefits:

- Weight management and lower risk of obesity
- Diabetes prevention and management
- Lower blood cholesterol
- Management of gastrointestinal tract
- Lower risk of colon cancer

Phenolic compounds

Flavonoids

Flavonols

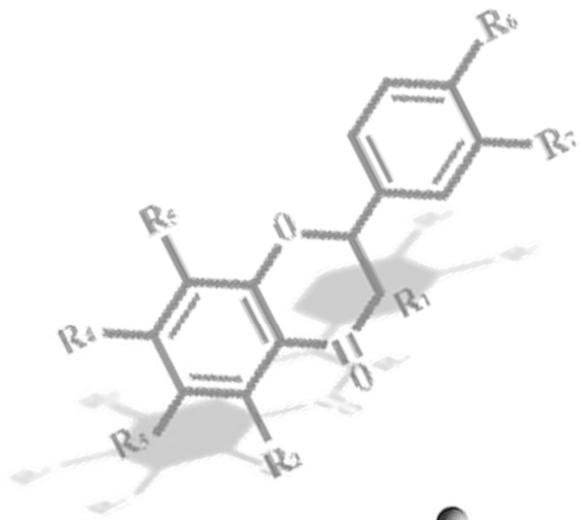
Flavones

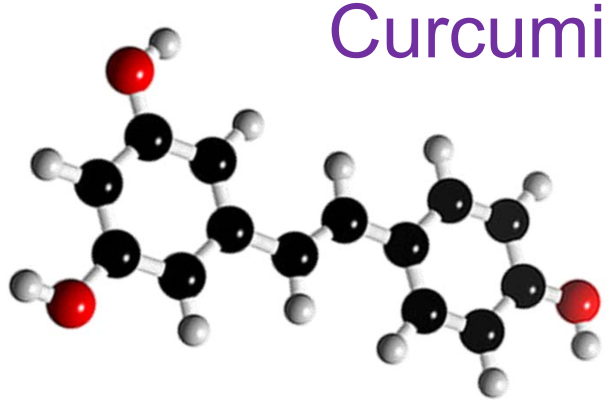
Flavonones

Flavanols

Isoflavones

Anthocyanins





Non-flavonoid compounds

Phenolic acids

Stilbenes

Curcuminoids

Water soluble compounds

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Flavonoids	Sources
Flavonols	Onion, kale, broccoli, apple
Flavones	Parsley, celery, chili/pepper
Flavonones	Orange, grapefruit, lemon
Flavanols	Apple, tea, cocoa
Isoflavones	Soybean
Anthocyanins (pigments: blue, purple, red)	Grape, blue berry, strawberry

Phenolic compounds

Health benefits:

- Prevention disorder of gastric and duodenal ulcers
- Reduce risk of cancers and act as anti-cancer agents
- Lower blood cholesterol
- Heart disease prevention
- Prevention of osteoporosis

Phenolic acids

Two major subclasses:

hydroxybenzoic acids and hydroxycinnamic acids

Sources:

Coffee
Grains
Fruits
Vegetables
Nuts

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Phenolic acids

Health benefits:

- Prevention or treatment of cancers
- Prevention of atherosclerosis
- Lower blood glucose

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Stilbenes

Resveratrol

Sources: Grape, peanut, mulberry, blueberry

Health benefits:

- Increase metabolism: burn fat and calories
- Prevention of coronary heart disease
- Defense against cancers: chemopreventive and chemotherapeutic activity

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Curcumin

Bright yellow pigment

Sources: Turmeric

Health benefits:

- Prevention of cancers (skin and colon cancer)
- Prevention Alzheimer's disease
- Lower risk of cardiovascular diseases
- Reduce risk or treatment of diabetes mellitus

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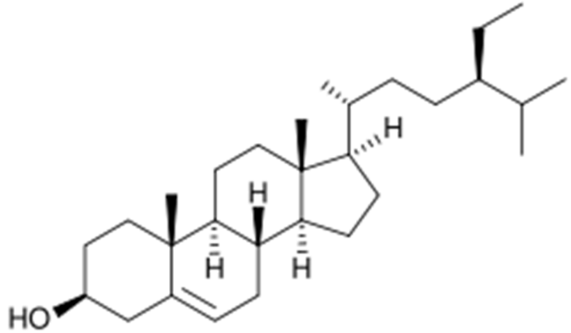
Phytosterols

Fat soluble compounds



Sources: Nuts

Seeds

Beans

Vegetable oils

Margarine

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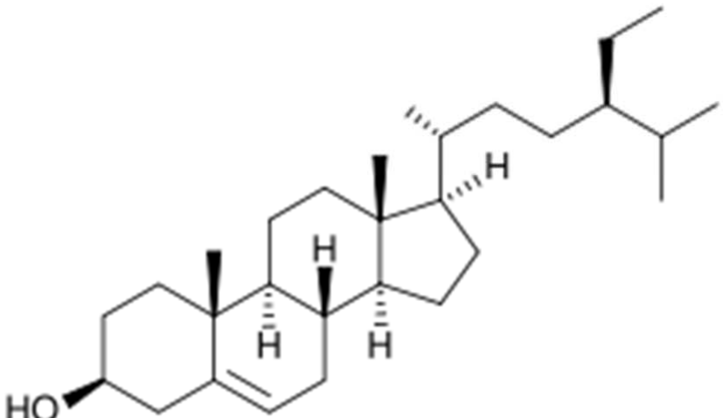
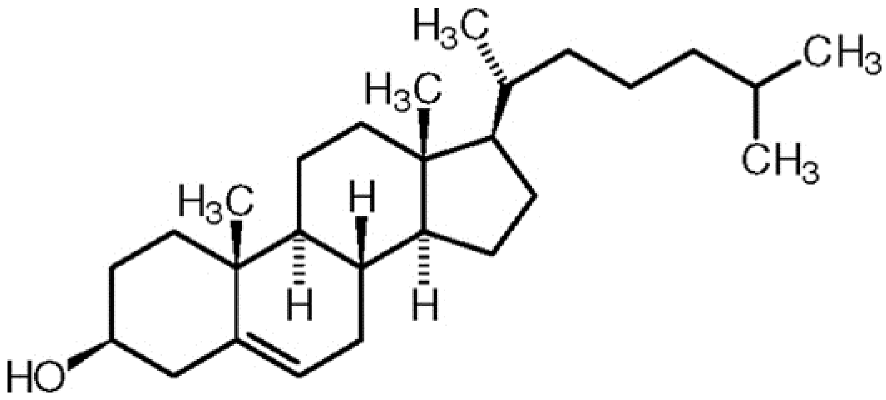
Phytosterol contents in some nuts and seeds

Type of Nut/Seed	Total Phytosterols (mg/100g)
Almonds	89-208
Cashew nut	80-158
Hazelnut	54-121
Macadamia	96-187
Pistachio	279-297
Pumpkin seed	94-265
Sesame seed	**400-404**
Sunflower seed	176-322



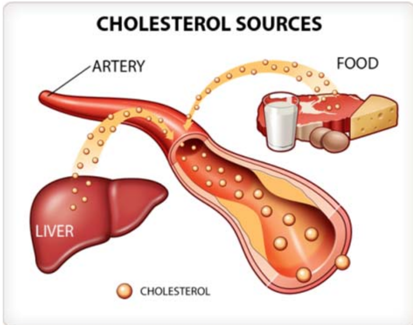
Phytosterols



Cholesterols

Competitively absorption between cholesterols and phytosterols

"Phytosterols are easier to absorb than cholesterols"



Health benefits:

- Lower blood cholesterol
- Reduce the risk of cardiovascular diseases

Carotenoids

Fat soluble compounds

Pigments: yellow-orange-red

Carotenoids

Carotenes

β-carotene

α-carotene

Xanthophylls

Lutein

Zeaxanthin

β-cryptoxanthin

Lycopene

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Carotenoids

Sources: Fruits and vegetables

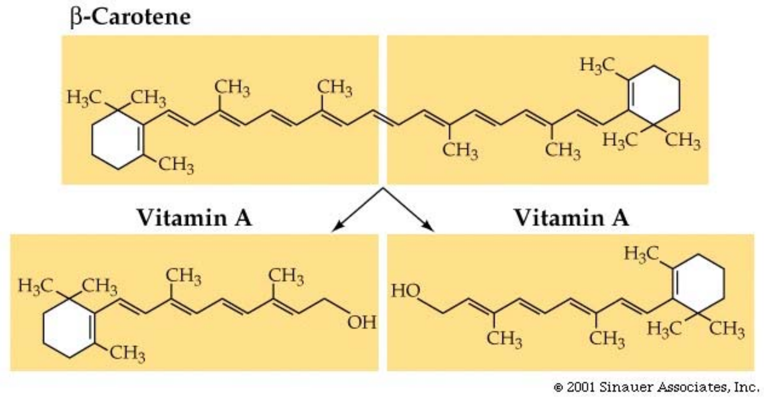
(also green leafy vegetables)

Examples of major contributors of carotenoids in North American diet

Carotenoid	Food source	Amount
β-Carotene	Apricot, dried	17600
	Carrots, cooked	9771
	Spinach, cooked	5300
	Green Collard	5400
	Canteloupe	3000
	Beet Green	2560
	Broccoli, cooked	1300
	Tomato, raw	520
α-Carotene	Carrots, cooked	3723
Lycopene	Tomatoes, raw	3100
	Tomato juice	10000
	Tomato paste	36500
	Tomato ketchup	12390
	Tomato sauce	13060
β-Cryptoxanthin	Tangerine	1060
	Papaya	470
Lutein	Spinach, cooked	12475
	Green collard	16300
	Beet, green	7700
	Broccoli, cooked	1839
	Green peas, cooked	1690

Gac fruit contains lycopene 70 times more than tomato

Carotenoids



Health benefits:

Carotenes: β-carotene & α-carotene

- Convert to vitamin A
- Reduce risk of cardiovascular diseases
- Reduce risk of cancers
- Reduce risk of osteoporosis
- Improve immune function

Xanthophylls: lutein & zeaxanthin

- Pigments in macula and retina (eyes)
- Protect tissues from phototoxic damage
- Prevention of cancers

Lycopene

- Reduce risk of cardiovascular diseases
- Reduce risk of cancers, particularly prostate, breast, cervical, ovarian and liver cancers
- Reduce the risk of osteoporosis
- Protective effect in hypertension
- Improvement of sperm motility

Betalains

Water soluble compounds

Pigments: yellow (betaxanthins)

red-violet (betacyanins)

Sources: yellow beet, red beet, dragon fruit, cactus pear, Swiss chard, Amaranth leaves

Betalains

Health benefits:

Reduce risk of cancers and act as chemopreventive agent

Allicin

Organosulfur compoun

Sources: Garlic

Shallot

Onion

Scallion

Leek

Chinese leek

Chinese chive

Spring onion

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Allicin

Health benefits:

- Prevention and treatment of cancers
- Reduce risk of atherosclerosis
- Reduce blood cholesterol
- Reduce fat deposition
- Decrease blood pressure

Isothiocyanates

Sulforaphane

Sources: Cruciferous vegetables (broccoli, cauliflower, kale, turnips, collards, brussels sprouts, cabbage, radish, watercress)
Mustard, Wasabi

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Isothiocyanates

Health benefits:

Potential compounds which can inhibit carcinogenesis and tumorigenesis

Capsaicinoids

Fat soluble compounds

Give pungent taste (hot)

Sources: pepper and chili

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Capsaicinoids

Health benefits:

- Reduce pain sensation
- Cancer prevention
- Weight reduction (increase energy expenditure)
- Inhibit platelet aggregation
- Reduce the incidence of cardiovascular diseases

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Example:
Bioactive compounds in plants

Rice



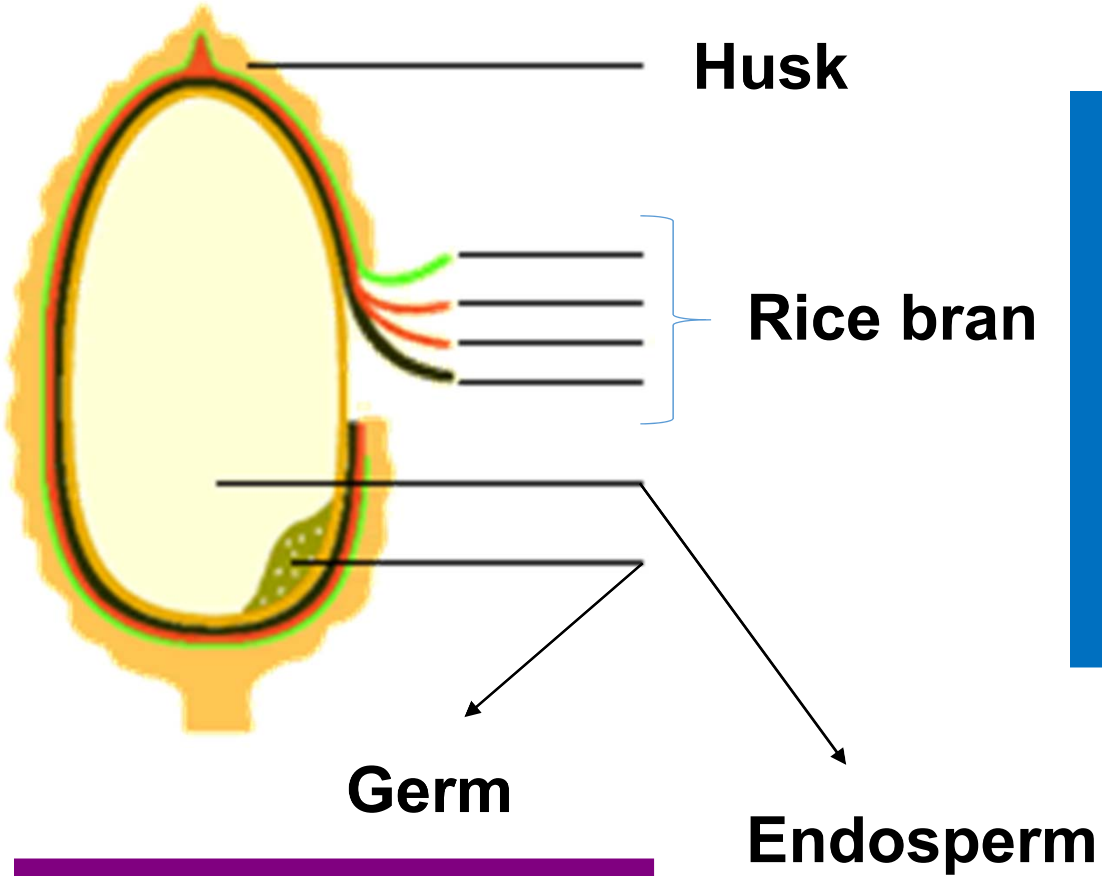



Japonica rice

Indica rice

Basmati rice

Dehusking and milling



γ-aminobutyric acid
Vitamin E
γ-Oryzanols
Phenolic acids
Anthocyanins

γ-aminobutyric acid (GABA)

Carbohydrate
Anthocyanin

Comparison of bioactive components and antioxidant activities in different rice

Red rice VS White rice

- **Dehusked**
- **Under-milled**
- **Milled**

(Finocchiaro et al., 2007)

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Bioactive components and antioxidant activities in different rice

Rice	Ferulic acid[1]	Anthocyanin[1]	Vitamin E[1]	γ-Oryzanol[1]	AA[2]
Red rice					
Dehusked	120.8	76.00	50.4	470	12.33
Under-milled	52.9	17.95	30.7	255	2.53
Milled	25.6	2.47	14.7	90	2.34
White rice					
Dehusked	66.2	Not detected (nd)	43.4	744	1.01
Under-milled	11.1	nd	10.1	191	0.88
Milled	5.9	nd	10.2	58	0.83

[1] unit in mg/kg,
[2] antioxidant activity unit in mmolTrolox/kg

(Finocchiaro et al., 2007)

Bioactive compounds in Chinese kale

Isothiocyanates

- Phenolic compounds (Flavonoids)
- Carotenoids

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Bioactive compounds in bitter gourd

- Charantin
- Vicine

} Lower blood glucose

- Cucurbitacins: Induce appotosis
- Phenolic compounds

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Bioactive compounds in pumpkin

- **Carotenoids (lutein, β-carotene)**
- Phenolic compounds (flavonoids, phenolic acid)
- Cucurbitacins
- Vitamin C

Bioactive compounds in tomato

- **Carotenoids (lycopene)**
- Vitamin C
- Phenolic compounds (flavonoids)

Bioactive compounds in pepper/chili

Capsaicinoids: pungent taste

anthocyanin

Carotenoids

capsanthin
β-cryptoxanthin,
antheraxanthin,
violaxanthin

lutein & violaxanthin

Chlorophyll

capsanthin &
capsorubin

Flavonoids: high flavonoid content

Phenolic acids

Vitamin C

Vitamin E

Combination of carotenoids &
chlorophyll

Bioactive compounds in *Allium* species (e.g. garlic, shallot, onion)

- Organosulfur compound: Allicin
- Flavonoids (flavanols, anthocyanins)
- Phenolic acids
- Saponins (terpene/steroid + sugar)

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Bioactive compounds in turmeric

Curcumin

- Carotenoids (β-carotene)
- Phenolic acids
- Phytostrols
- Vitamin C

Bioactive compounds in black pepper

Piperine:

Alkaloids (antitumor activity)

Flavonoids

Phenolic acids

Phytosterols

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Bioactive compounds in berry

- Phenolic compounds (flavonoids, phenolic acid)
- Vitamin C
- Carotenoids (Goji berry)

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Bioactive compounds in guava

- Vitamin C
- Phenolic compounds (flavonoids, catechin)
- Carotenoids (lycopene)

Bioactive compounds in pineapple

- Carotenoids (lutein and zeaxanthin)
- Phenolic compounds (phenolic acids, catechin)
- Saponins
- Phytosterols

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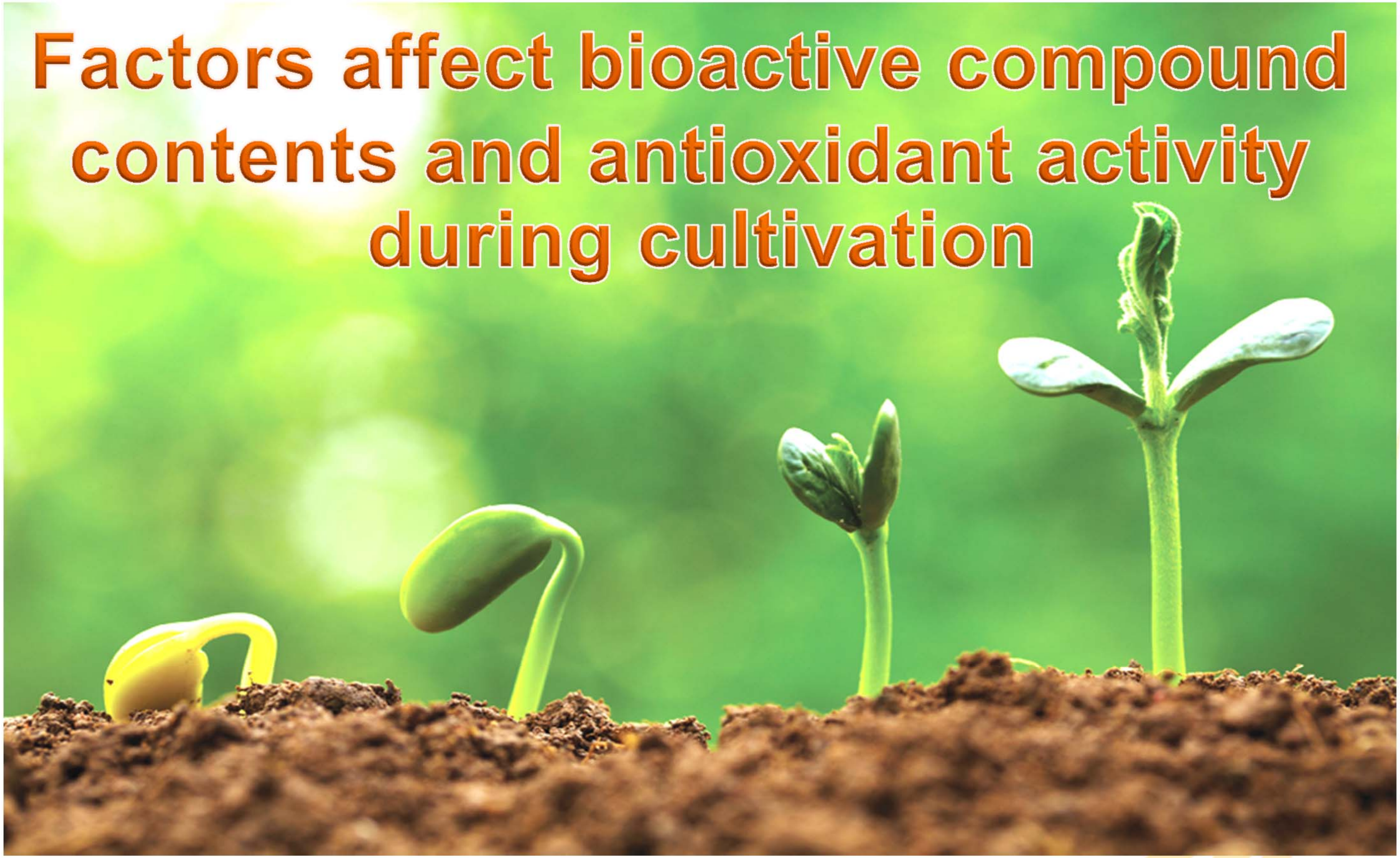
Bioactive compounds in mango

- Carotenoids (lutein, zeaxanthin, β-carotene)
- Phenolic compounds (flavonoids, tannin, phenolic acids)
- Vitamin C

Factors affect bioactive compound contents and antioxidant activity during cultivation



Effect of genotypes with varying flesh color on bioactive components and antioxidant activities in sweet potato

Orange

Light orange

Yellow

Purple

Light purple

White

(Teow et al., 2007)

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Bioactive components in different sweet potato genotypes

Sample	Phenols (mg/g)	Total anthocyanin (mg/g)	β-carotene (μg/g)
Xushu 18	0.003	ND (Not detected)	0.2
11-12	0.011	ND	1.5
13-1	0.033	ND	2.3
11-16	0.118	ND	13.0
12-7	0.130	ND	29.8
12-17	0.108	ND	11.8
Beauregard	0.211	ND	**92.3**
Hernandez	0.517	ND	**167**
Covington	0.183	0.038	**120**
11-5	0.168	0.017	**77.1**
11-20	0.472	ND	**226**
13-14	0.130	ND	**44.9**
13-15	0.140	ND	**127**
12-9	0.248	0.030	22.3
13-6	0.257	0.069	56.6
NC415	**0.792**	**0.430**	6.3
12-5	**0.477**	**0.246**	46.9
13-17	**0.571**	**0.322**	31.3
13-18	**0.949**	**0.531**	5.4

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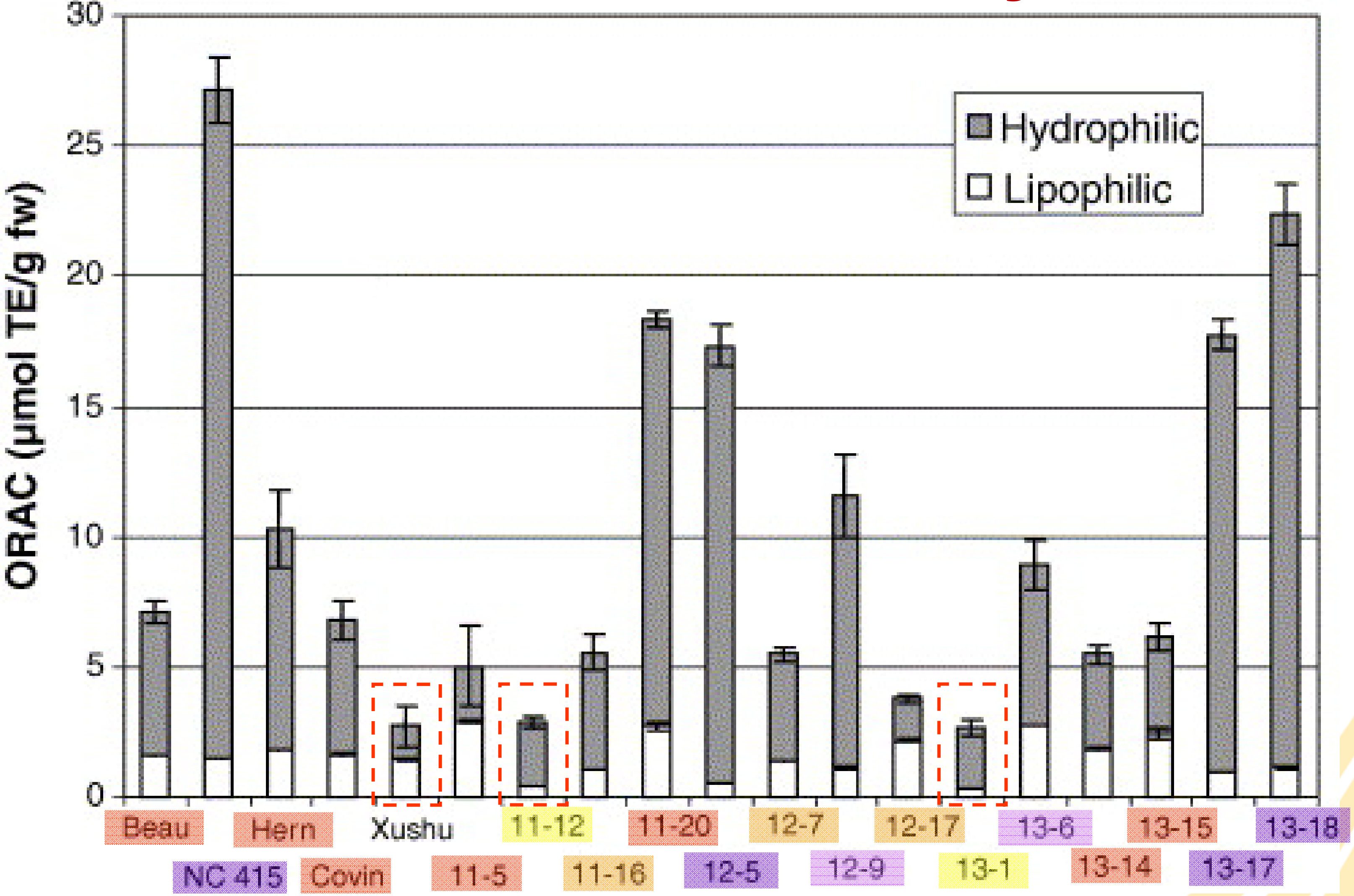
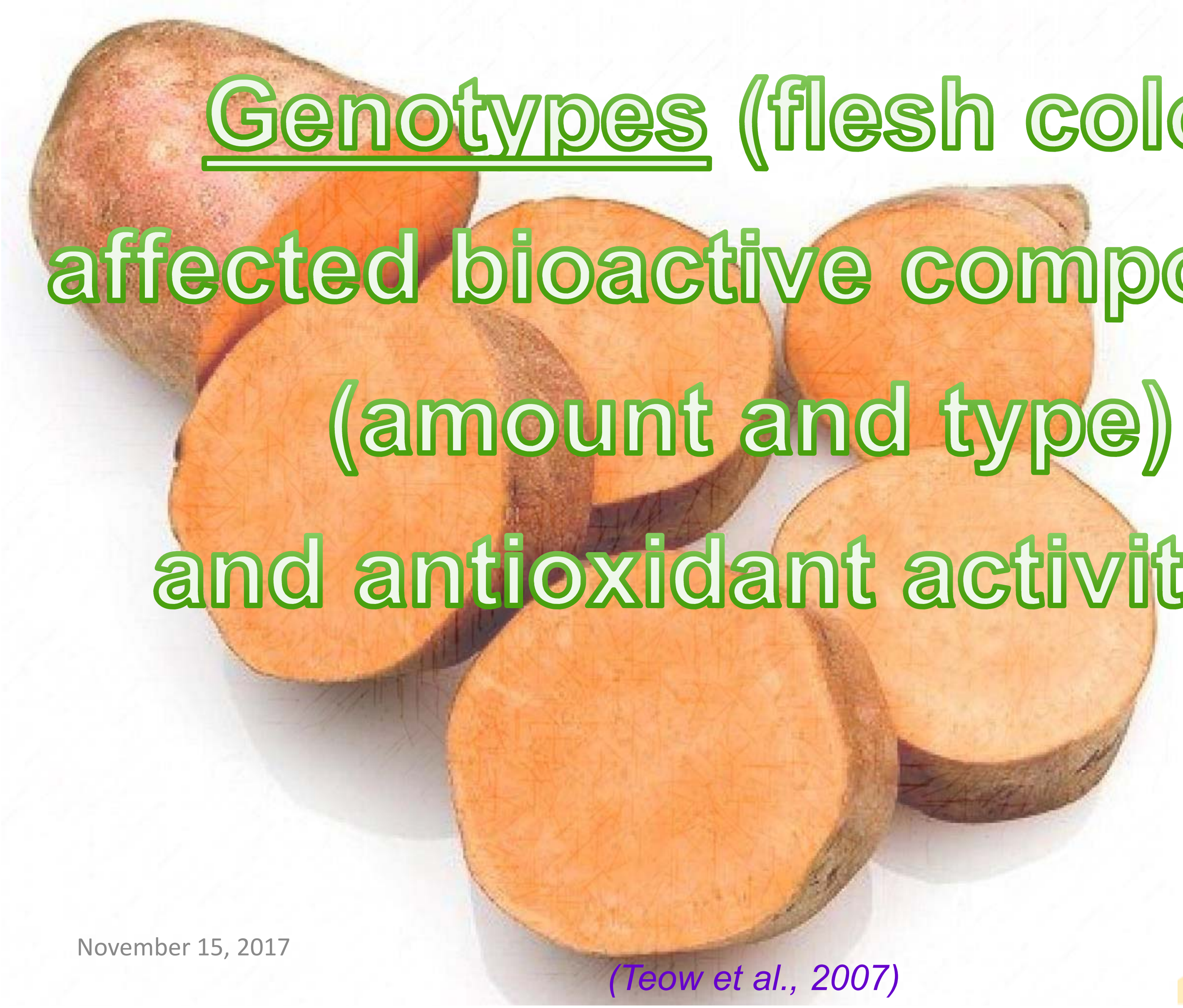
Antioxidant activity



(Teow et al., 2007)



Genotypes (flesh color) affected bioactive compounds (amount and type) and antioxidant activities.

(Teow et al., 2007)

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Effect of genotype, cultivated area and year on bioactive components in chickpea

Three different genotypes

Three different areas

Two different years of cultivation (2003 and 2004)

(Nikolopoulou et al., 2006)

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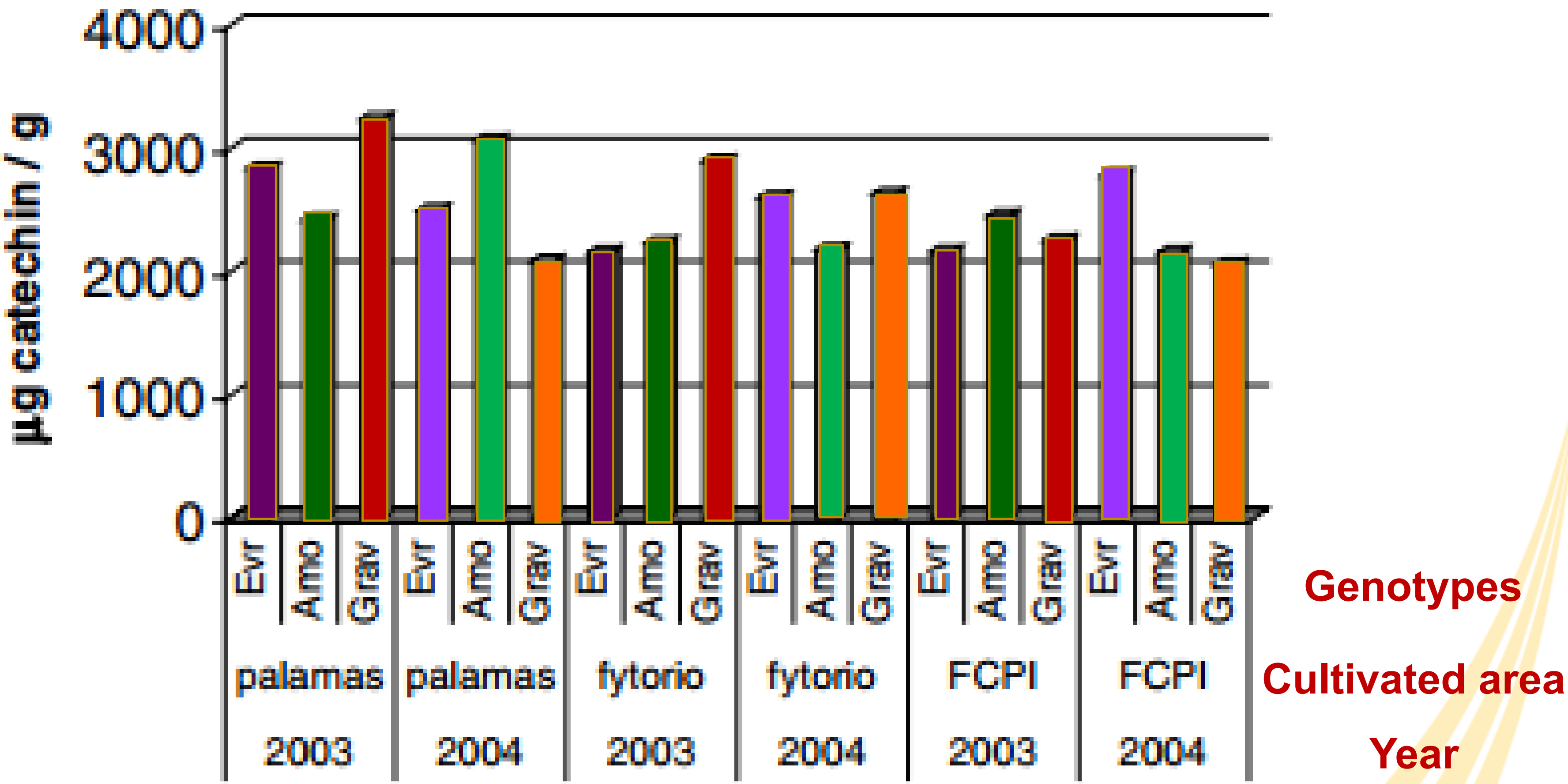
Tannin contents in chickpeas



Evr = Evros, Amo = Amorgos, Grav = Gravia

(Nikolopoulou et al., 2006)

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Genotypes, cultivated areas and years of cultivation affected tannin contents.

Effect of maturity and season on bioactive components and antioxidant activities in strawberry

Maturity: 10 stages

Season: Summer vs Winter

(Ferreyra et al., 2007)

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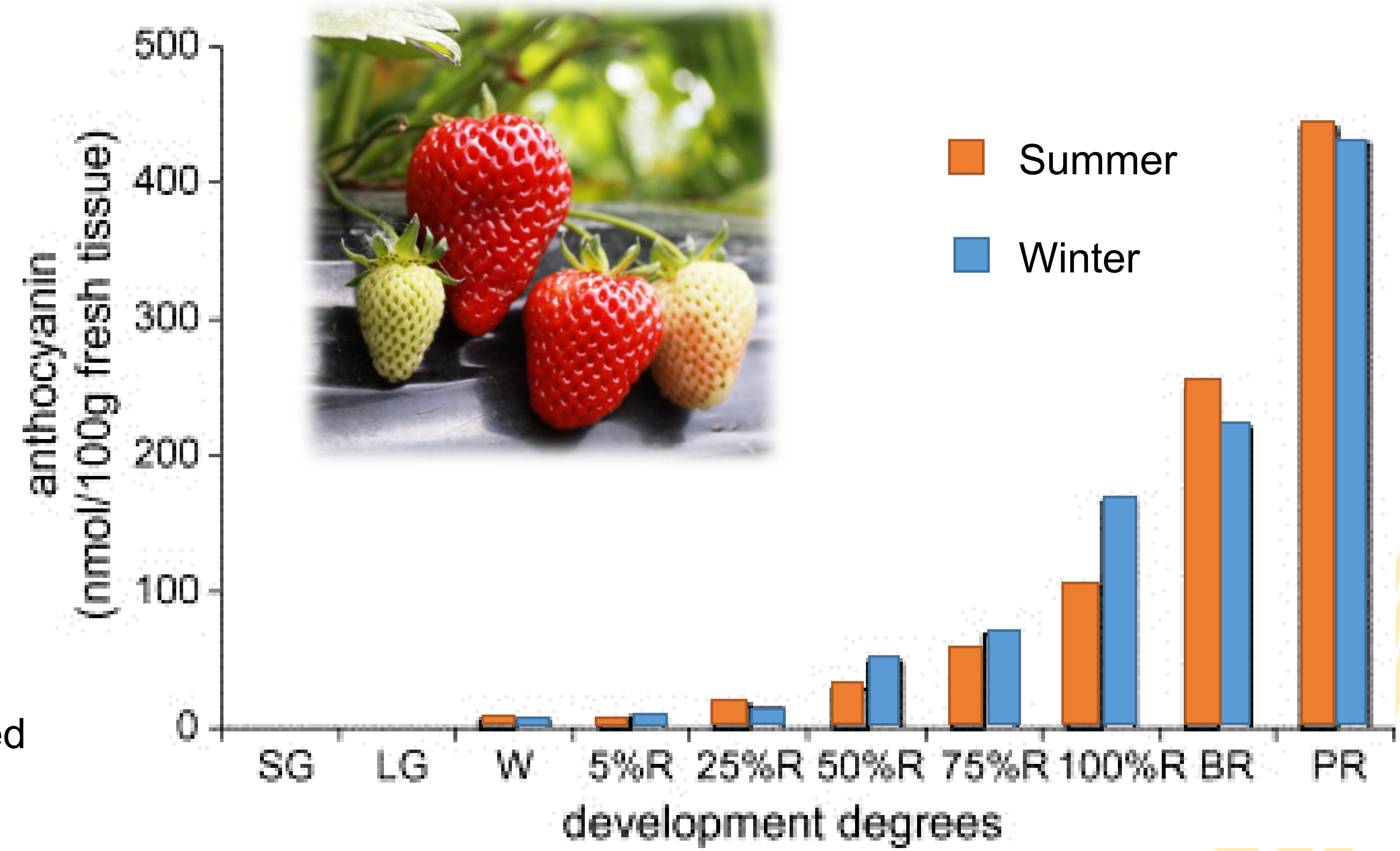
Anthocyanins = red color



SG = small green

LG = large green

W = white

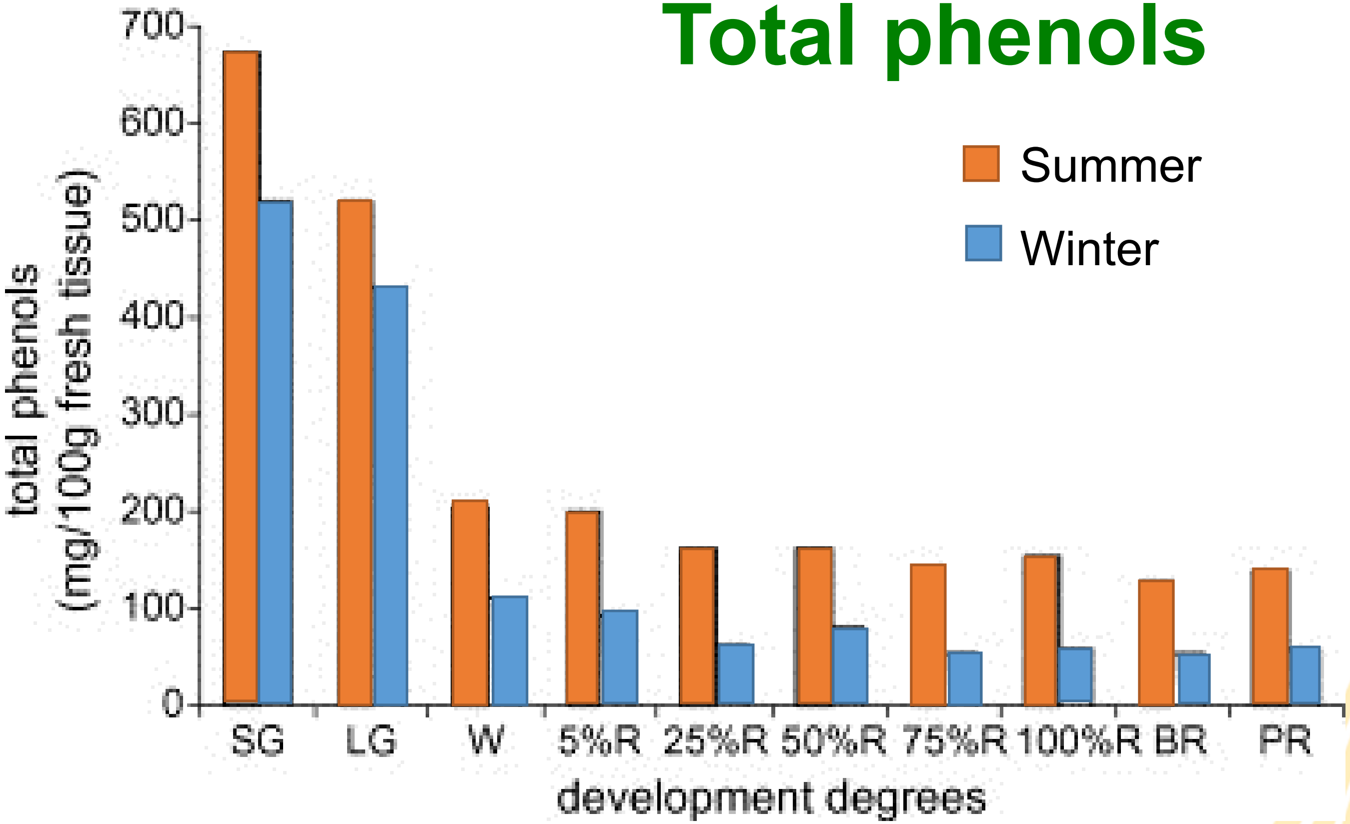
5-100%R = 5-100% red

BR = bright red

PR = purple red

(Ferreyra et al., 2007)

Total phenols



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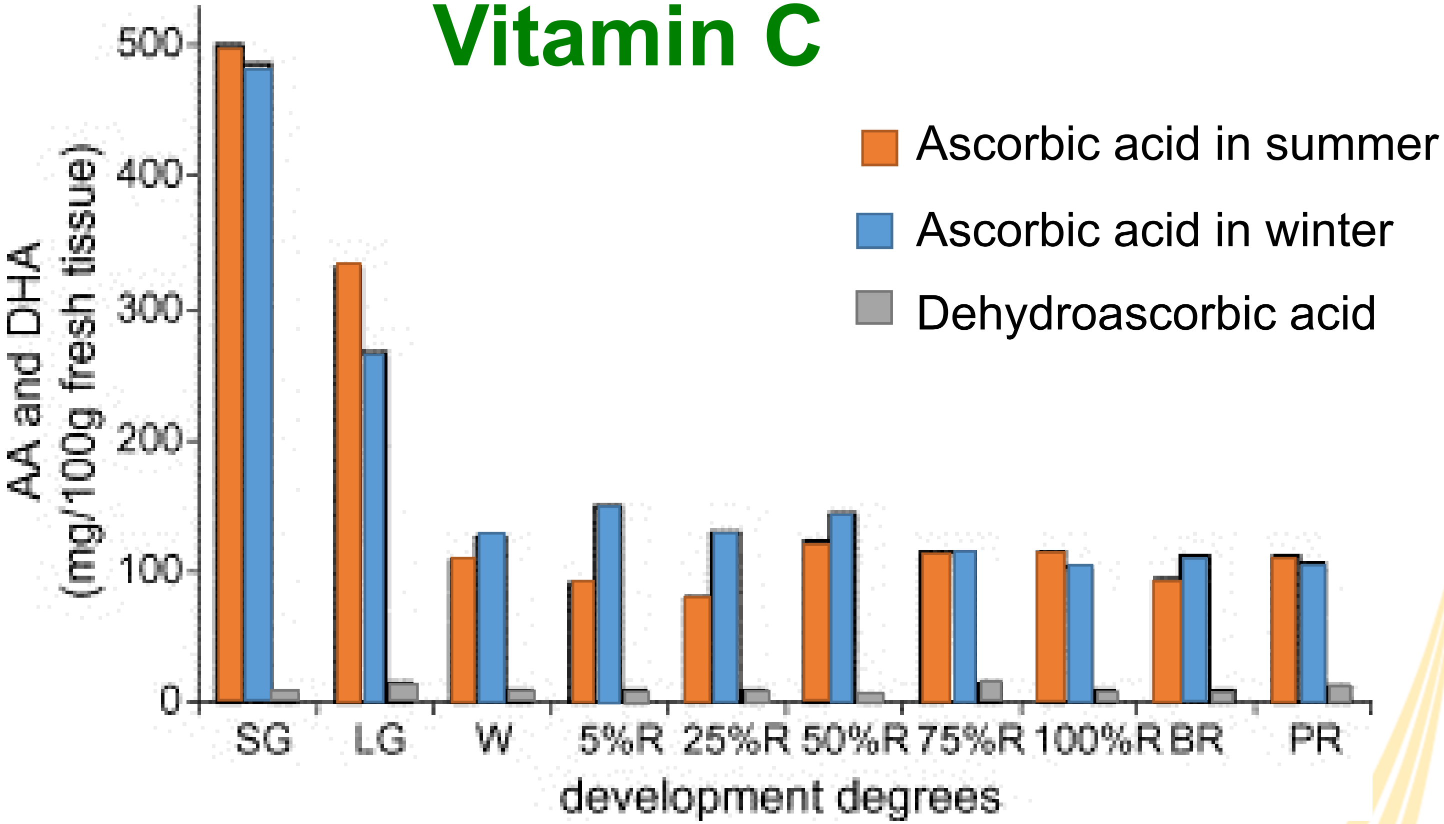
Vitamin C



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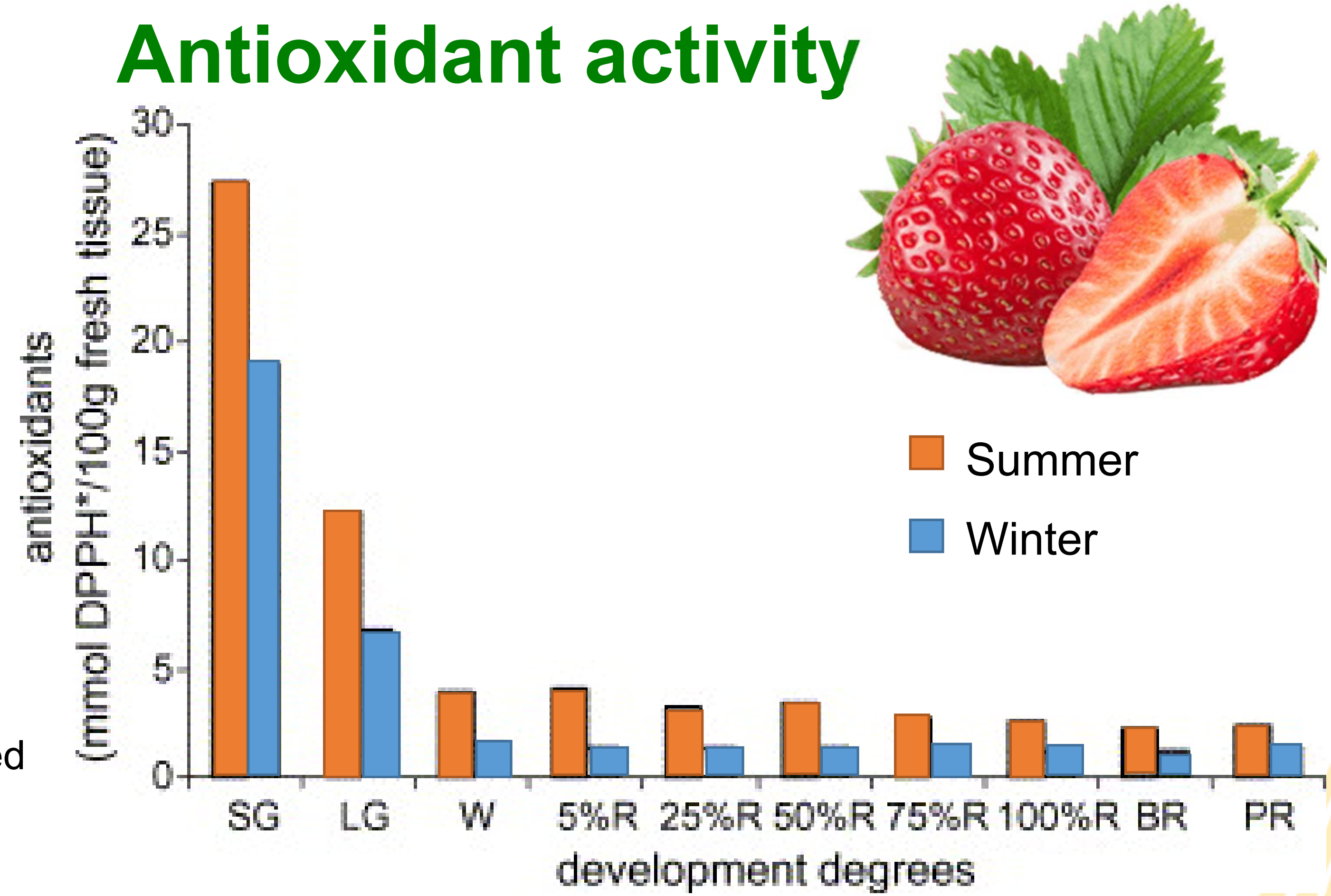
Antioxidant activity



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(Ferreyra et al., 2007)

Maturity affected all bioactive compound contents and antioxidant activity

Season affected only total phenols and antioxidant activity

(Ferreyra et al., 2007)

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Effect of fruit tissue on bioactive components in nectarine

Nectarine

(yellow-flesh and white-flesh)

Peel **Flesh**

(Gil et al., 2002)

Bioactive compounds and antioxidant activities in peel and flesh tissues in white-/yellow-flesh nectarines

White cultivar	Fruit tissue	Total phenolics[1]	Ascorbic acid[1]	β-carotene[2]	β-cryptoxanthin[2]	Antioxidant activity[1]
Arctic Star	peel	875	93	570	Not detected (nd)	393
	flesh	154	42	40	nd	84
Arctic Queen	peel	904	160	170	30	553
	flesh	303	78	100	nd	145
Arctic Snow	peel	929	200	310	50	984
	flesh	454	122	40	nd	402
Fire Pearl	peel	418	134	50	80	230
	flesh	91	69	20	50	46
Brite Pearl	peel	2020	191	280	80	1447
	flesh	901	95	80	nd	837

Yellow cultivar	Fruit tissue	Total phenolics[1]	Ascorbic acid[1]	β-carotene[2]	β-cryptoxanthin[2]	Antioxidant activity[1]
Red Jim	peel	1403	130	1870	240	981
	flesh	415	55	730	140	317
August Red	peel	755	118	2730	270	459
	flesh	287	58	1280	140	159
Spring Bright	peel	829	114	3070	310	471
	flesh	247	35	850	210	126
May Glo	peel	629	119	1920	250	277
	flesh	155	61	580	80	62
September Red	peel	427	78	1990	280	283
	flesh	138	53	1310	150	120

[1] unit in mg/kg, [2] unit in μg/kg

(Gil et al., 2002)

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Different fruit tissue accumulated different amount of bioactive compounds and antioxidant activities.

Bioactive compound contents and antioxidant activities were different depended on cultivar/genotypes.

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Effect of different environments on bioactive components in lettuce

Green house

Open-air grown

(Romani et al., 2002)

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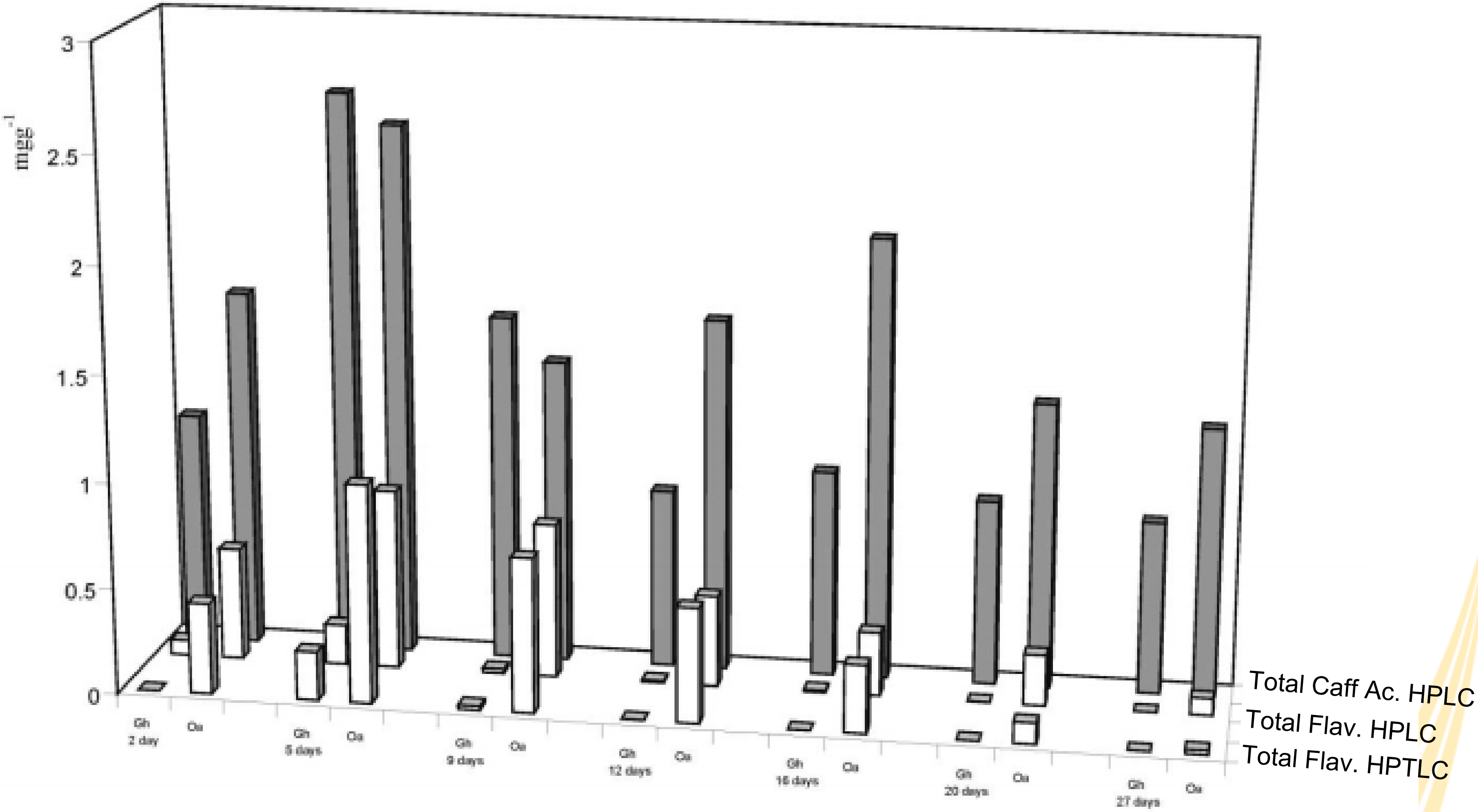

Gh = Green house
Oa = Open air

(Romani et al., 2002)

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Effect of cultivation method (hydroponic VS soil) on carotenoid contents of lettuce

Hydroponic

- Energy: nutrient solution
- Cover with a polyethylene roof

Soil

- Energy: phytosynthesis
- Open-air

(Kimura and Rodriguez-Amaya, 2003)

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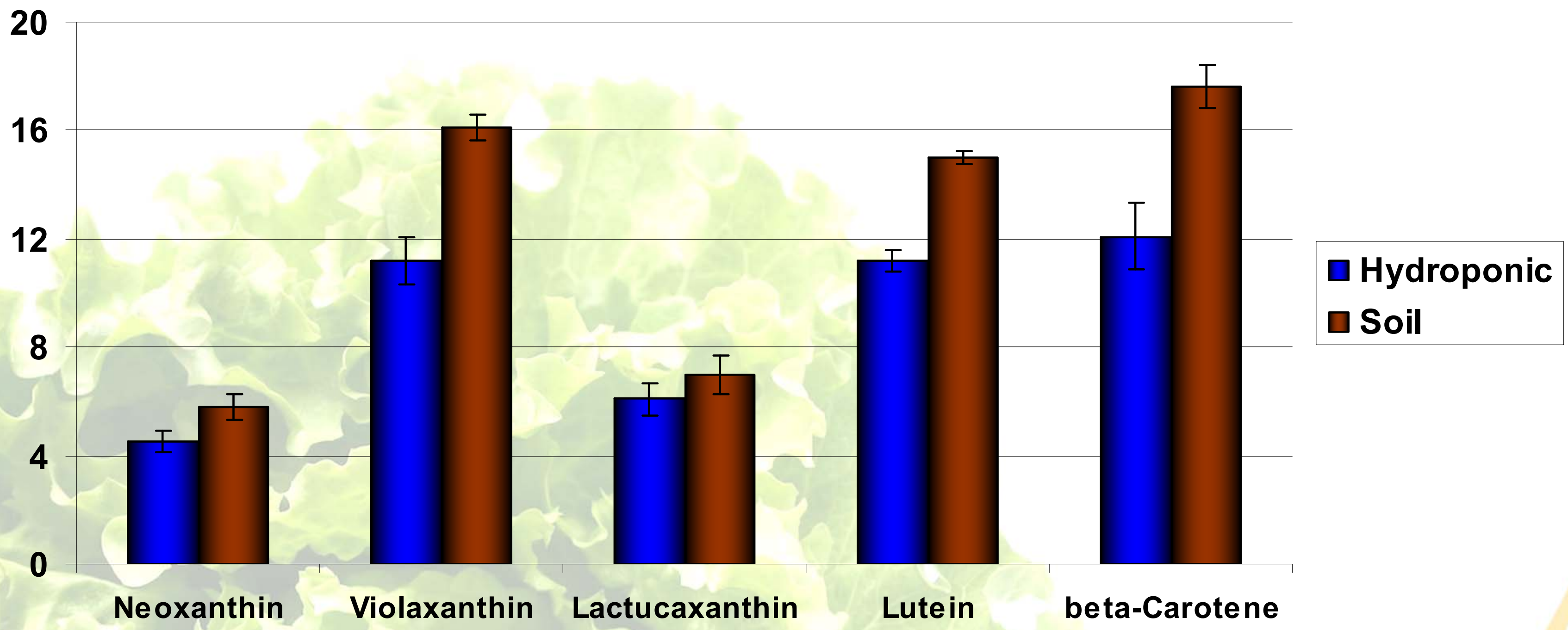
Carotenoid contents in lettuce



Carotenoid content: Soil >> Hydroponic

(Kimura and Rodriguez-Amaya, 2003)

Effect of fertilizer on bioactive components and antioxidant activity in cassava tubers

Empty fruit bunch compost
(N: 1.46%, P: 1.47%, K: 2.58%)

Vegetable waste vermicompost
(N: 2.32%, P: 1.54%, K: 1.06%)

Inorganic fertilizer
(N: 15%, P: 15%, K: 15%)

cassava (*Manihot esculenta* crantz) var. Medan and Pontian

Omar et al., 2012

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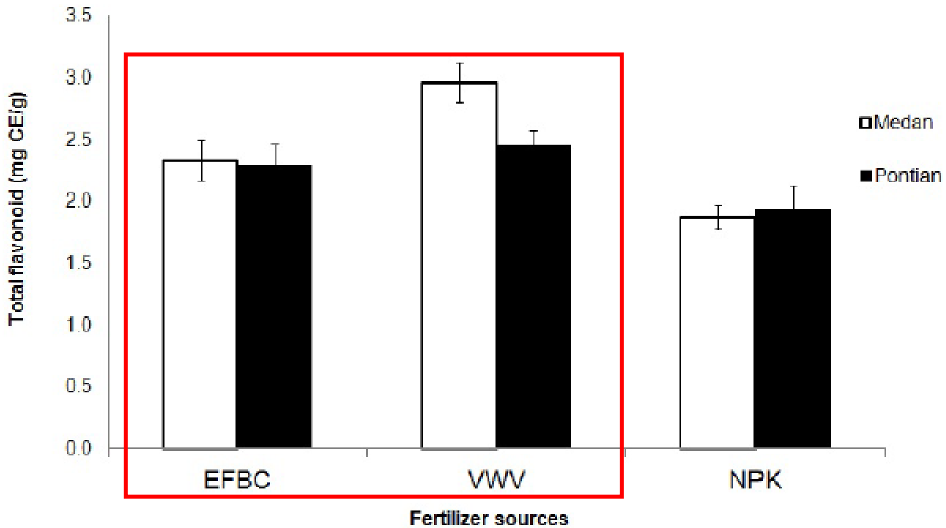
Total flavonoids



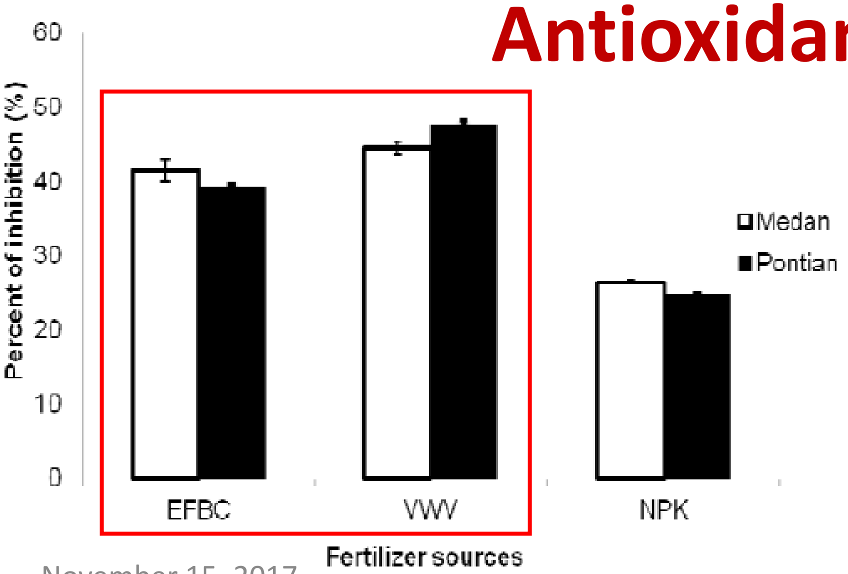
Organic fertilizer

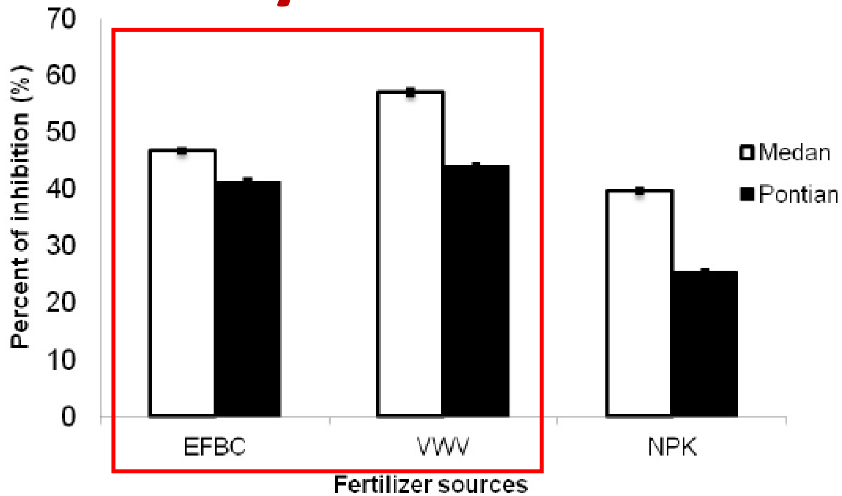
EFBC = Empty fruit bunch compost

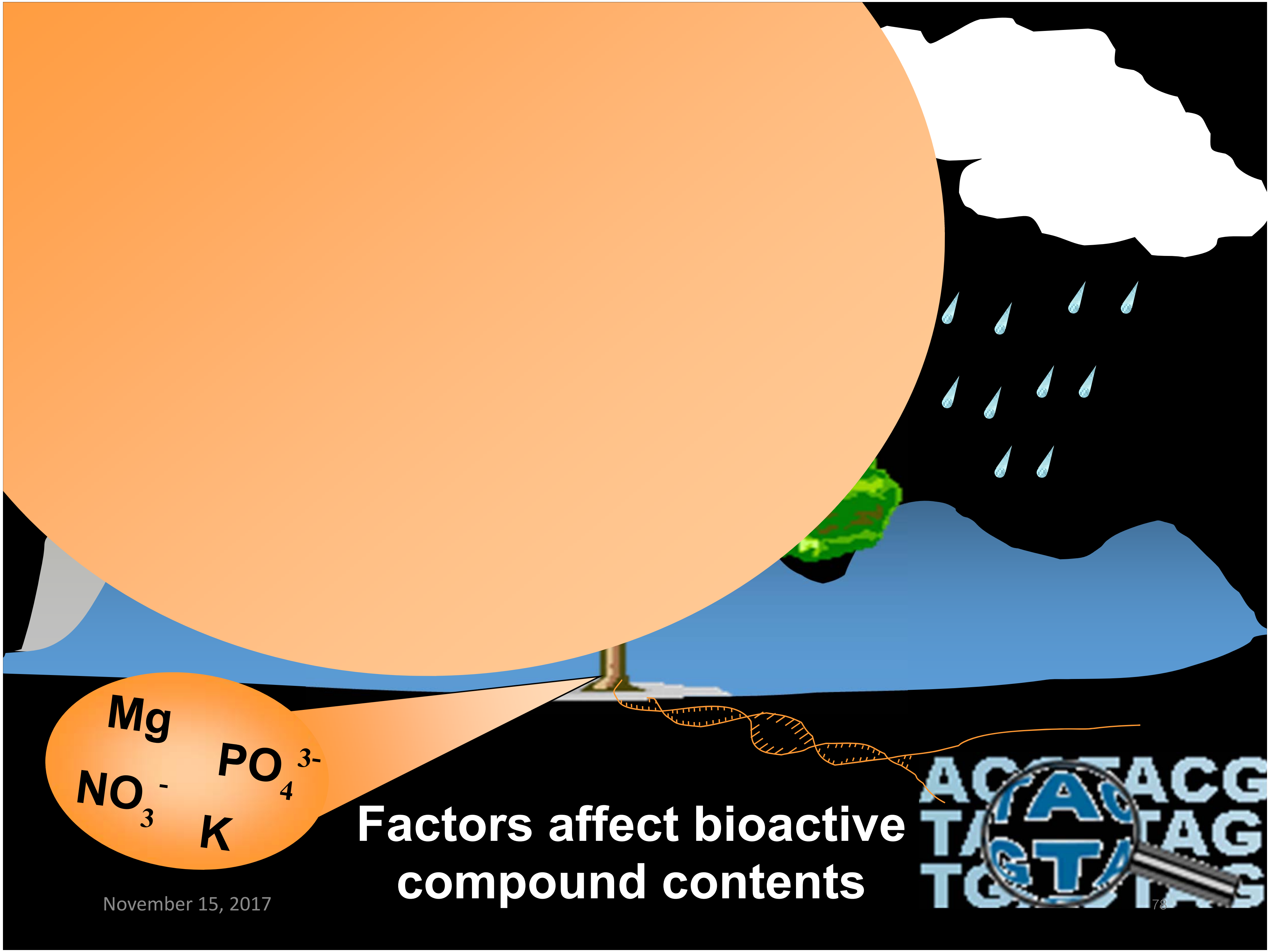
VWV = Vegetable waste vermicompost

NPK = Inorganic fertilizer

Antioxidant activity






Mg
PO_4^{3-}
NO_3^-
K
Factors affect bioactive compound contents
ACGTACG
TAGTAG
TGATAG

มหาวิทยาลัยมหิดล

Effect of postharvest handling on bioactive compounds

Postharvest handling:

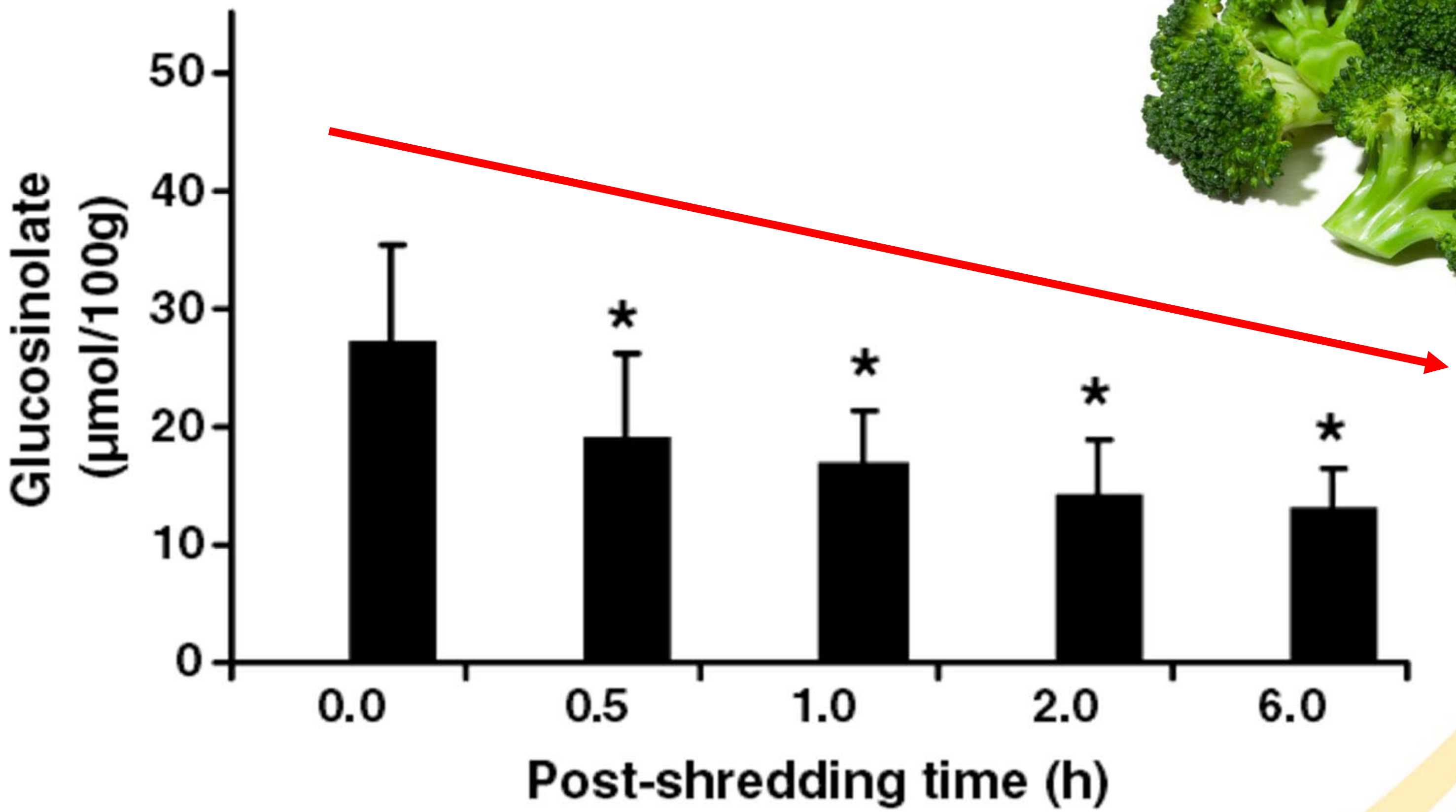
The stage that occurring in the period after harvest

- Cleaning
- Packing
- **Processing**
- **Storage**
- Transportation
- Distribution

Post harvest handling: Processing

- Changes glucosinolate content in broccoli heads by shredding
- Comparisons on bioactive components and antioxidant activity of fresh, freeze-dried and hot-air-dried tomatoes

Changes glucosinolate content in broccoli heads by shredding



Glicoraphanin ●

(Glucosinolate)

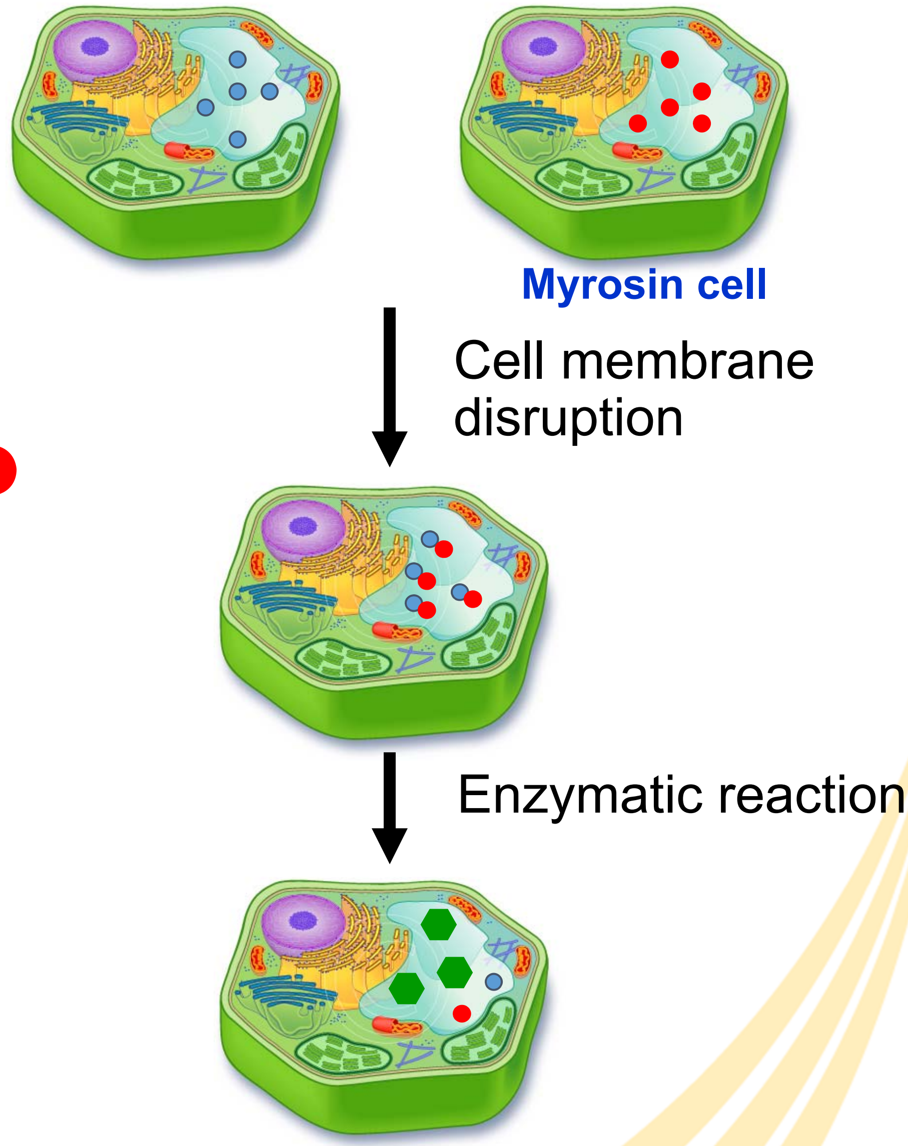
↓

Myrosinase ●

(enzyme)

Sulforaphane ⬢

(Isothiocyanate)



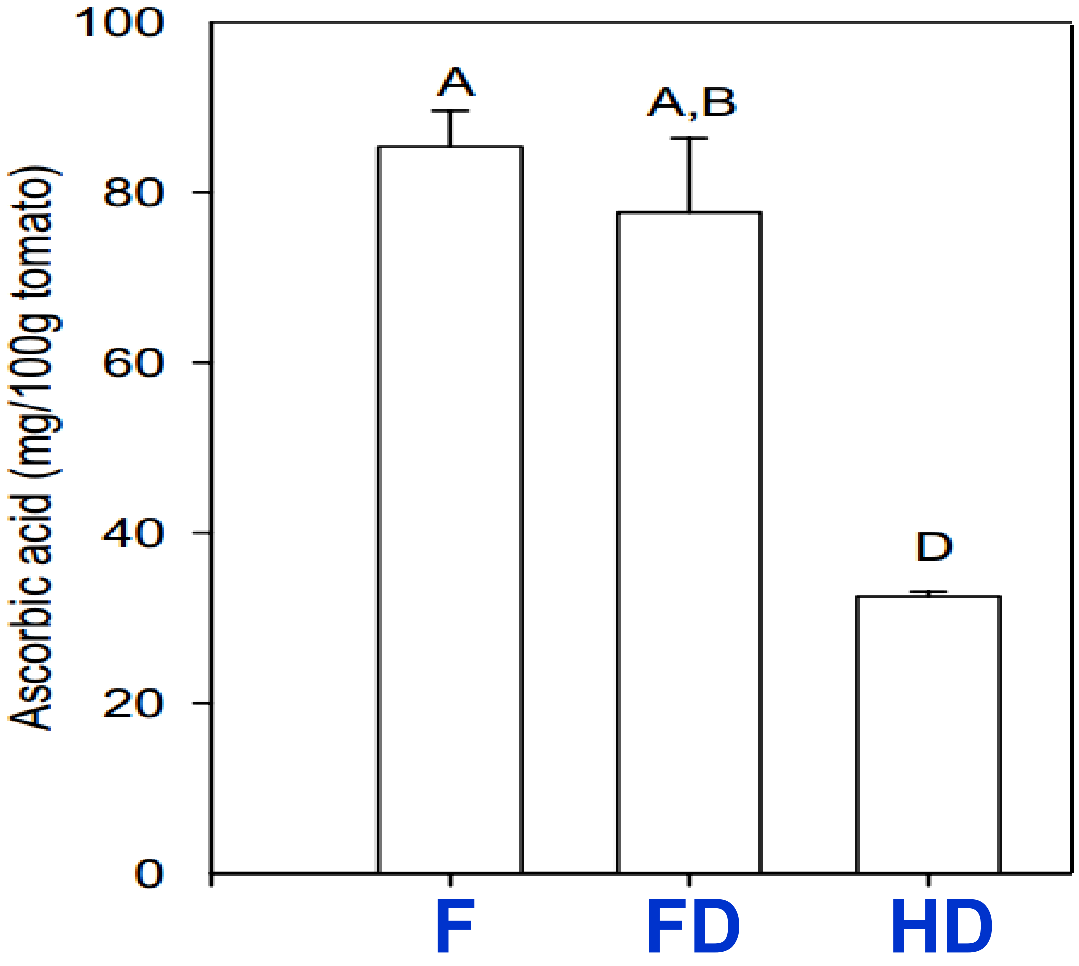
มหาวิทยาลัยมหิดล

Comparisons on bioactive components and antioxidant activity of fresh, freeze-dried and hot-air-dried tomatoes

Fresh **Freeze-dried** **Hot air-oven dried**

(Chang et al., 2006)

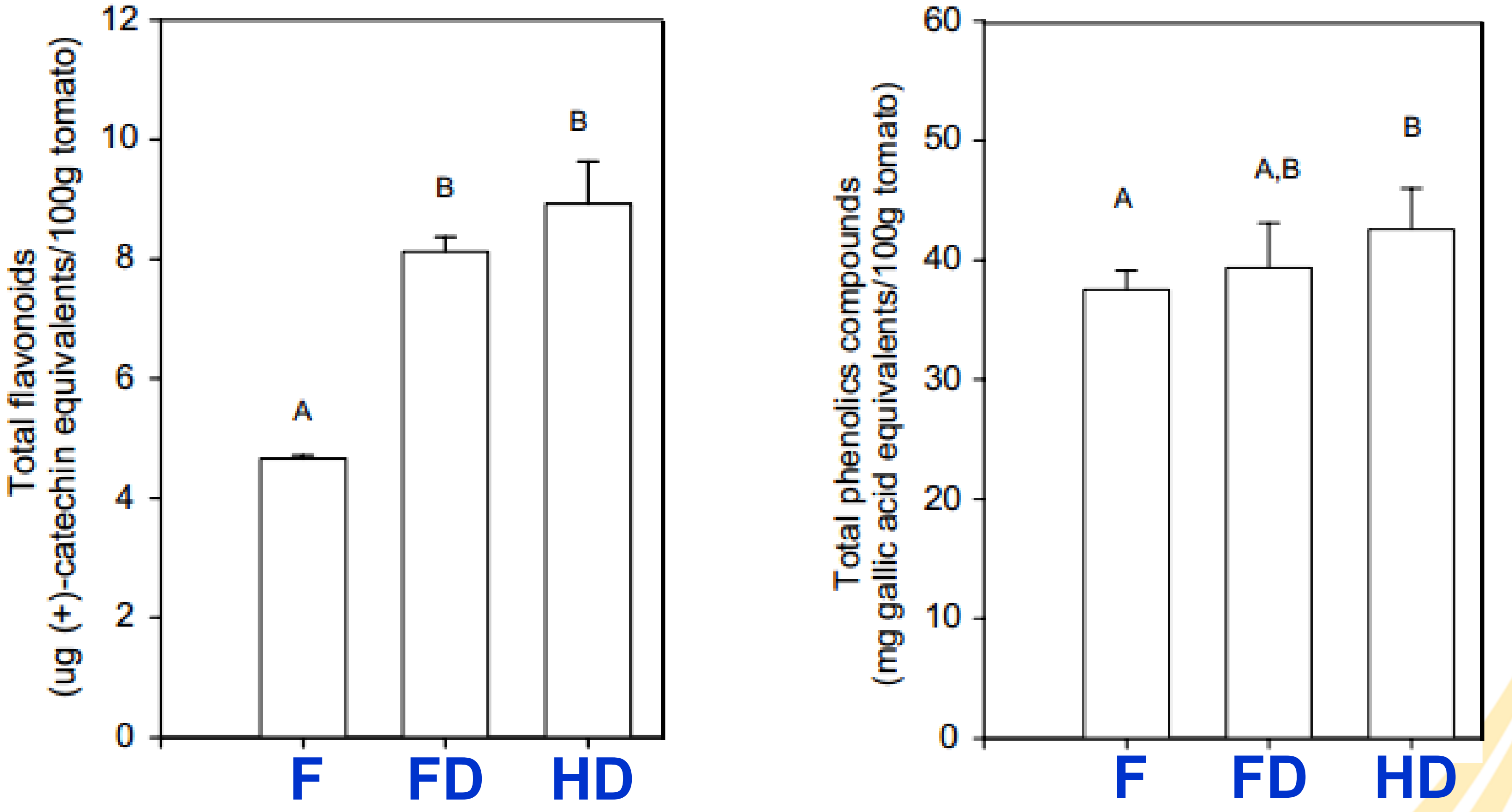
Vitamin C



F = Fresh, FD = Freeze dried, HD = Hot-air-dried

มหาวิทยาลัยมหิดล

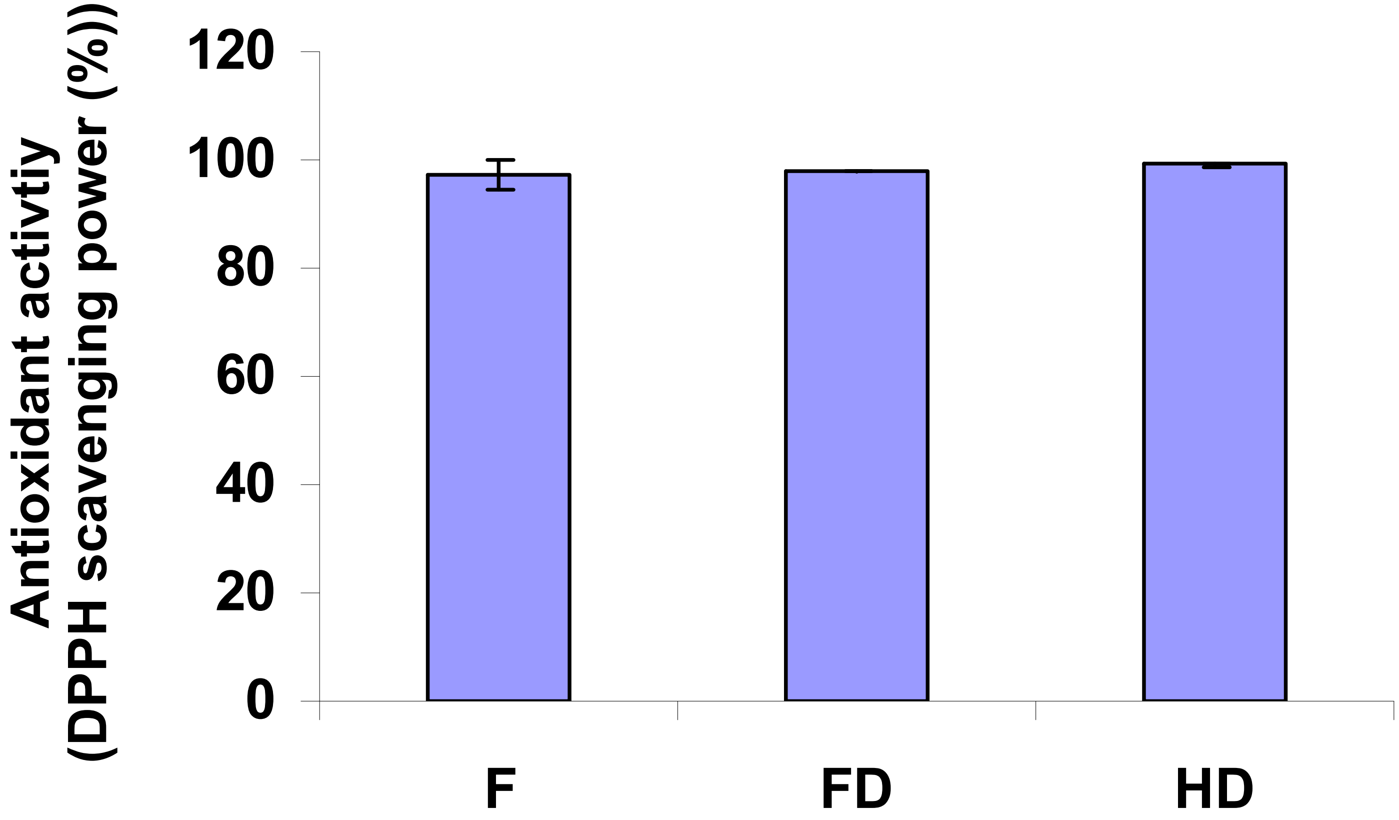
Total flavonoids and total phenolics



F = Fresh, FD = Freeze dried, HD = Hot-air-dried

มหาวิทยาลัยมหิดล

Antioxidant activity



F = Fresh, FD = Freeze dried, HD = Hot-air-dried

มหาวิทยาลัยมหิดล

- Different food processes affect phytochemical contents and antioxidant activity in different ways.
- Drying processes reduced vitamin C, particularly a high temperature process.
- Flavonoids & phenolic acids: high temperature of hot-air-drying process or very low temperature of freeze drying process would deactivate enzyme that is the cause of browning reaction.

Enzymatic browning reaction

is a process of becoming brown.

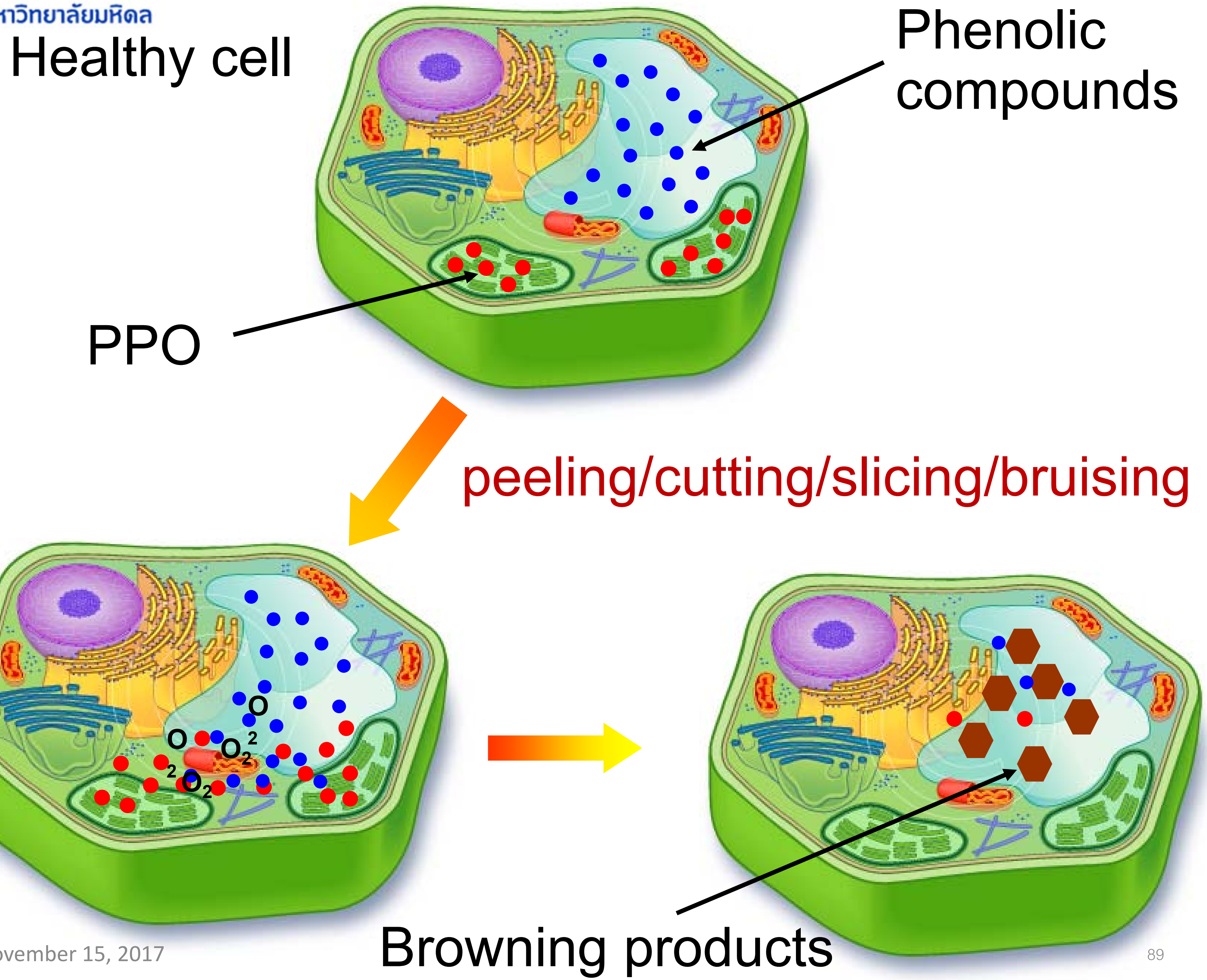
- Desirable: developing flavor in tea
- Undesirable: fresh fruit and vegetables

Enzyme: Polyphenol oxidase (PPO)

Phenolic compounds

Oxygen

Water


Healthy cell
Phenolic compounds
PPO
peeling/cutting/slicing/bruising
Browning products

มหาวิทยาลัยมหิดล

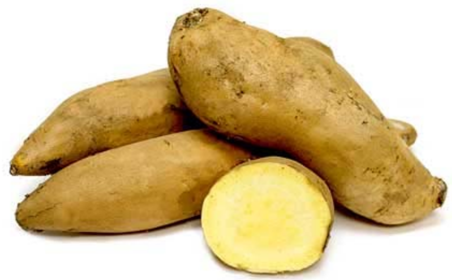
Techniques for preventing enzymatic browning

- Dip in acid solution: lemon juice
- Thermal process: blanching
- Keep in low temperature (reducing rate of reaction)
- Remove oxygen: vacuum pack, flush with nitrogen
- Use chemicals such as sulfites and citrates

Postharvest handling: Storage

- Changes in phenolic acids, carotenoids, total phenolics and antioxidant activities in sweet potato during storage

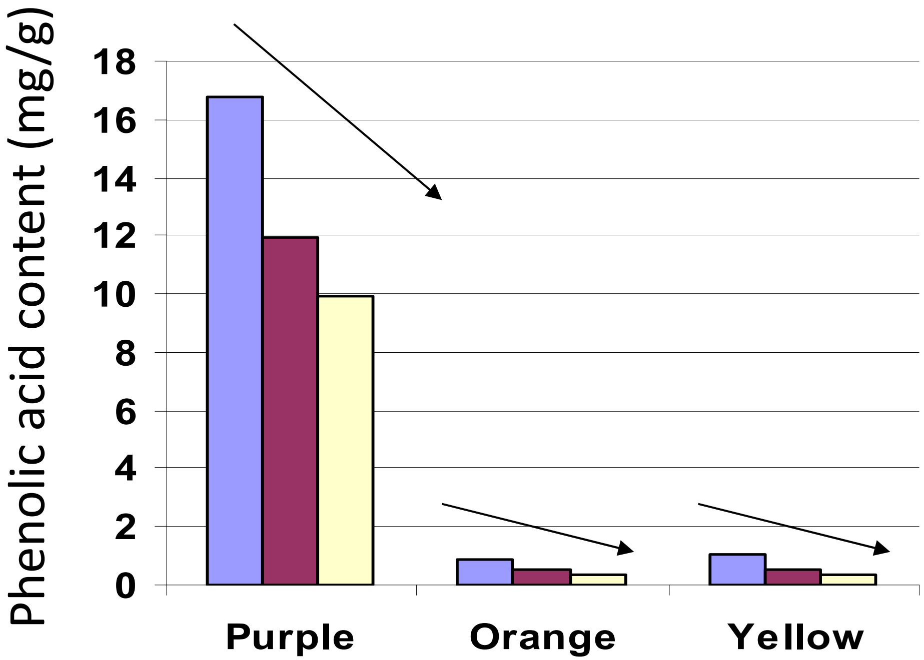
Stored at 15 °C and 80 - 85%RH in the dark for 0, 4, 8 months

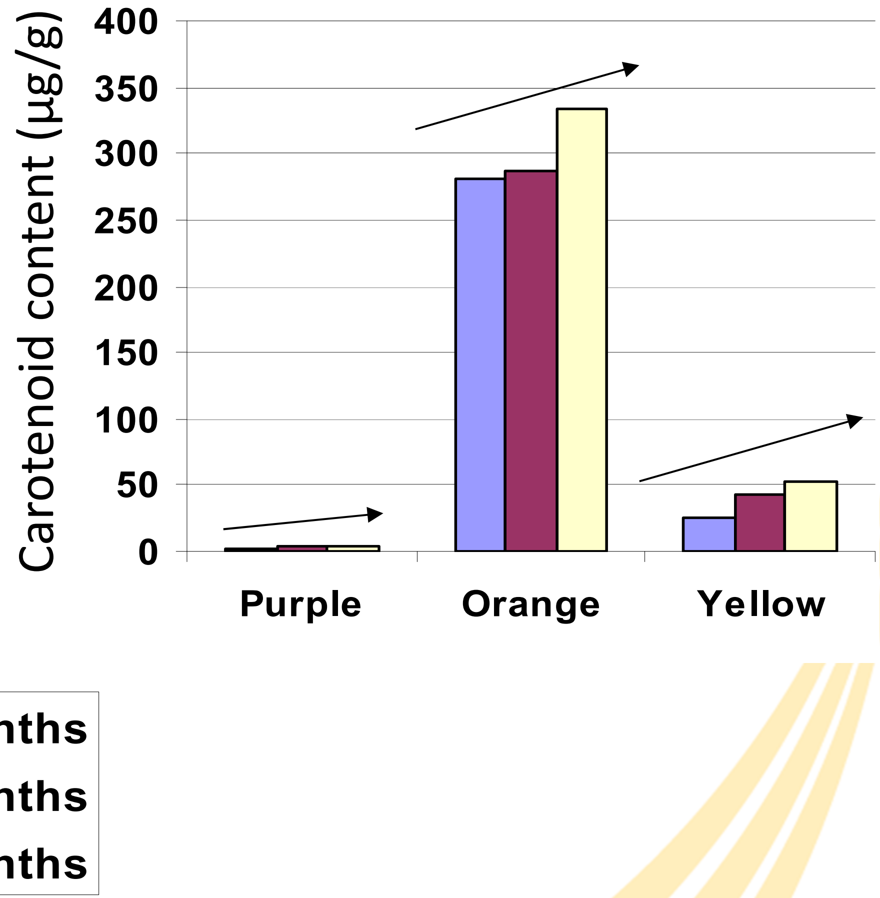


มหาวิทยาลัยมหิดล

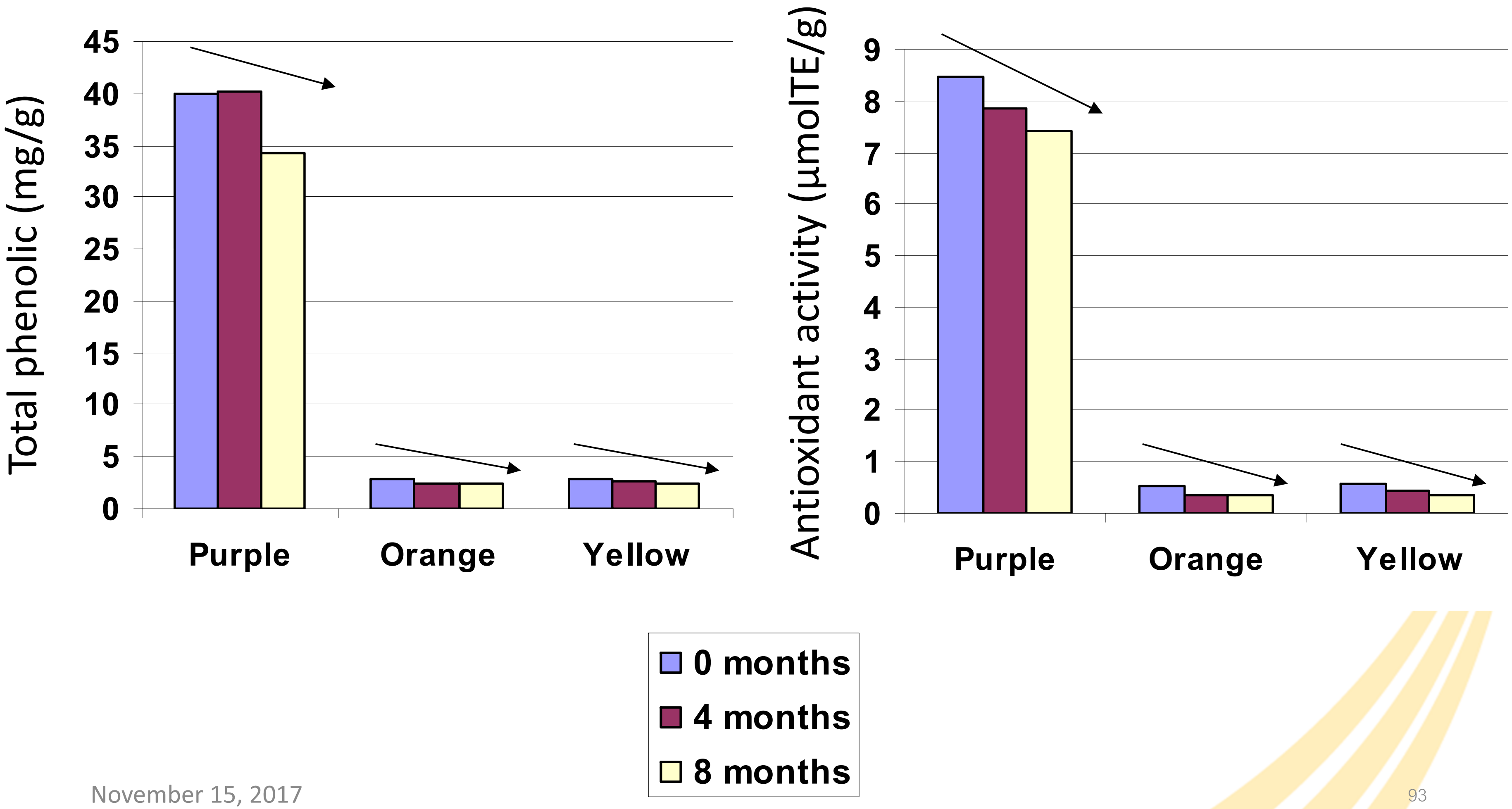
Phenolic acids

Carotenoids





Total phenolics Antioxidant activity



มหาวิทยาลัยมหิดล

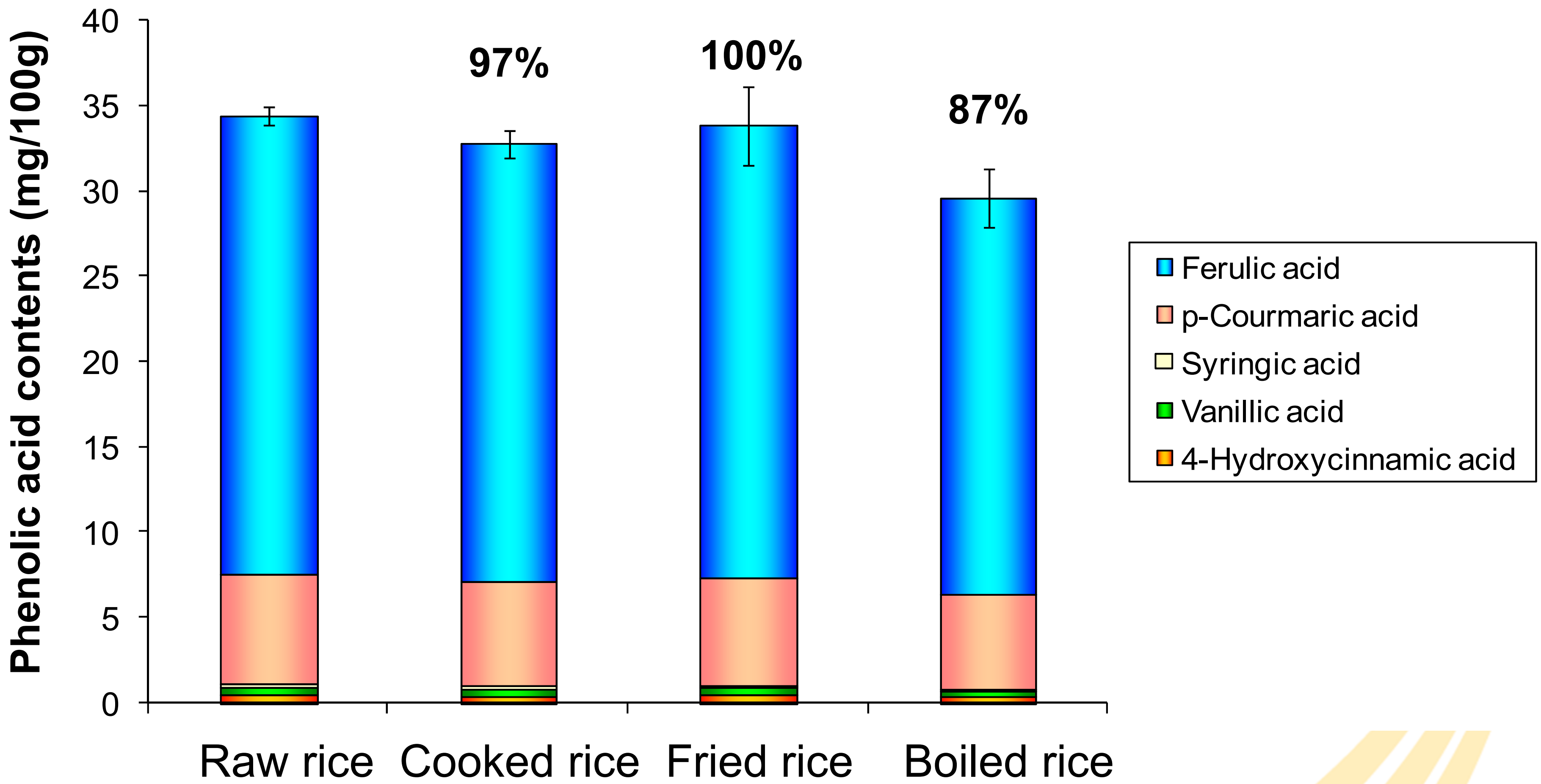
Effect of cooking on bioactive compounds

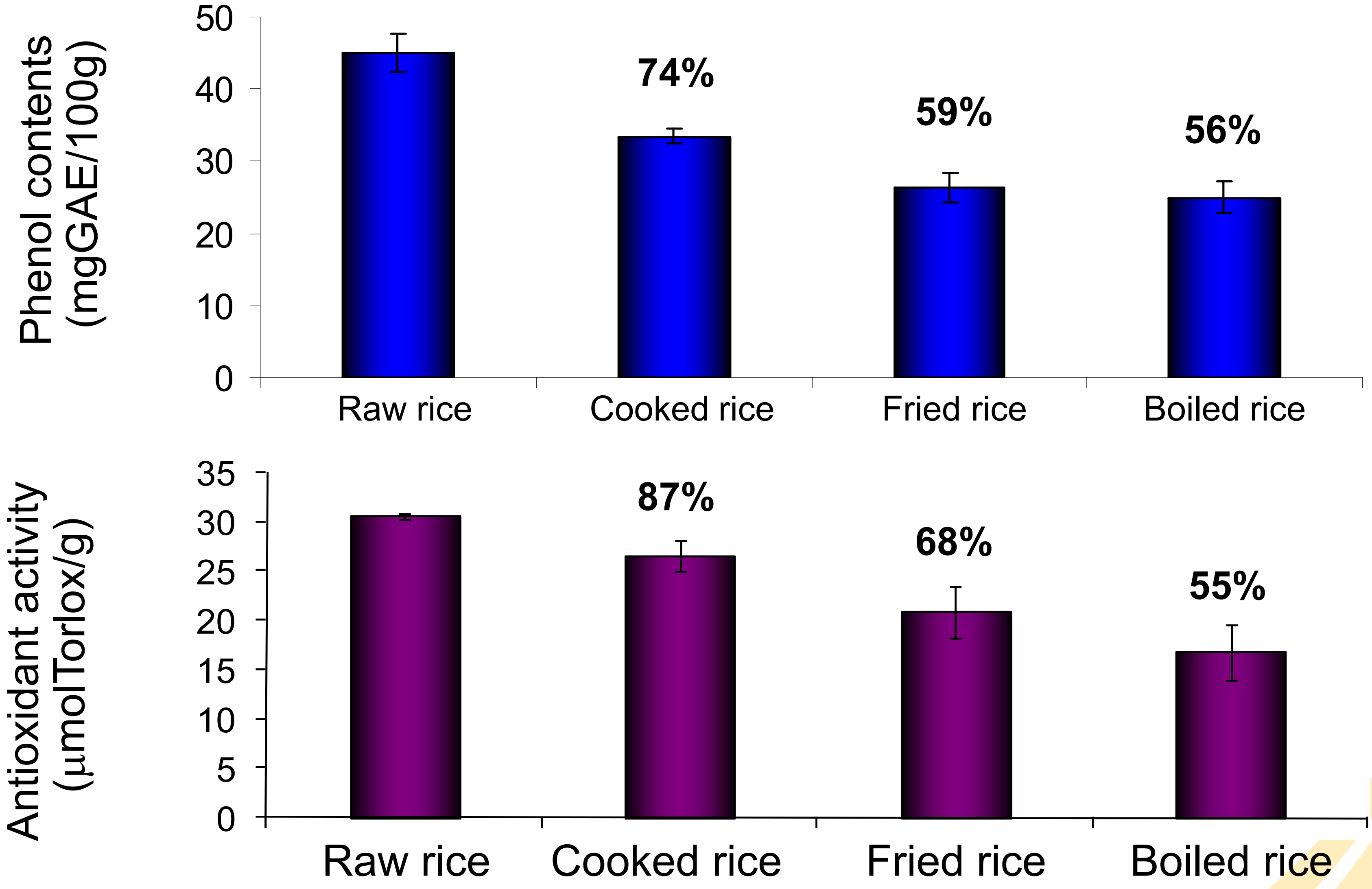
มหาวิทยาลัยมหิดล

Effect of cooking, frying and boiling on bioactive compounds and antioxidant activities in rice

มหาวิทยาลัยมหิดล

Phenolic acids in rice with different cooking methods





Phenol contents (mgGAE/100g)
50
40
30
20
10
0
74%
59%
56%
Raw rice
Cooked rice
Fried rice
Boiled rice
Antioxidant activity (µmolTorlox/g)
35
30
25
20
15
10
5
0
87%
68%
55%
Raw rice
Cooked rice
Fried rice
Boiled rice

Effect of different cooking methods on carotenoids, phenols and antioxidant activities in colored peppers

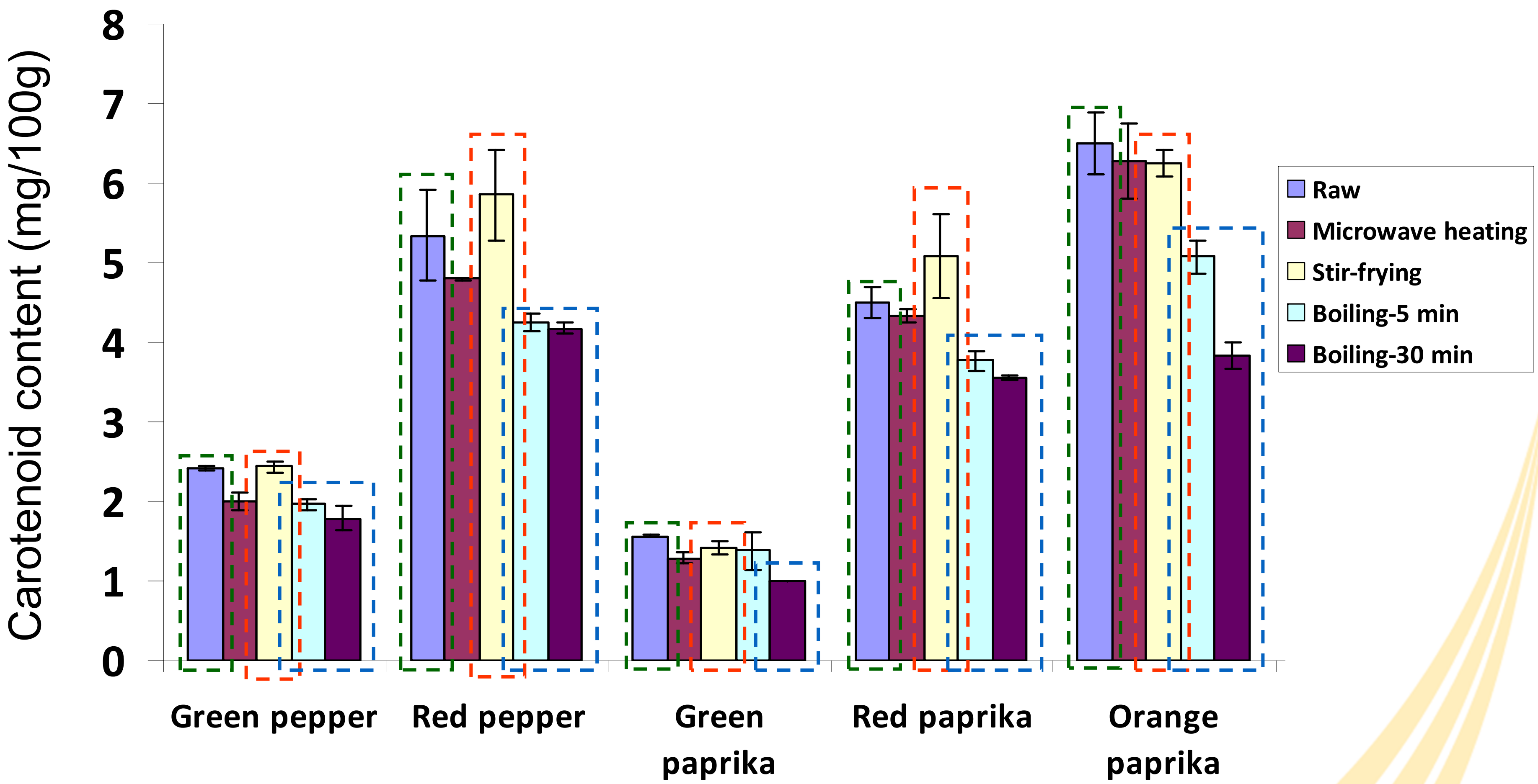
5 varieties of color peppers

- **Raw**
- **Microwave Heating 5 min**
- **Boiling**
  - **5 min**
  - **30 min**
- **Stir-frying 5 min**

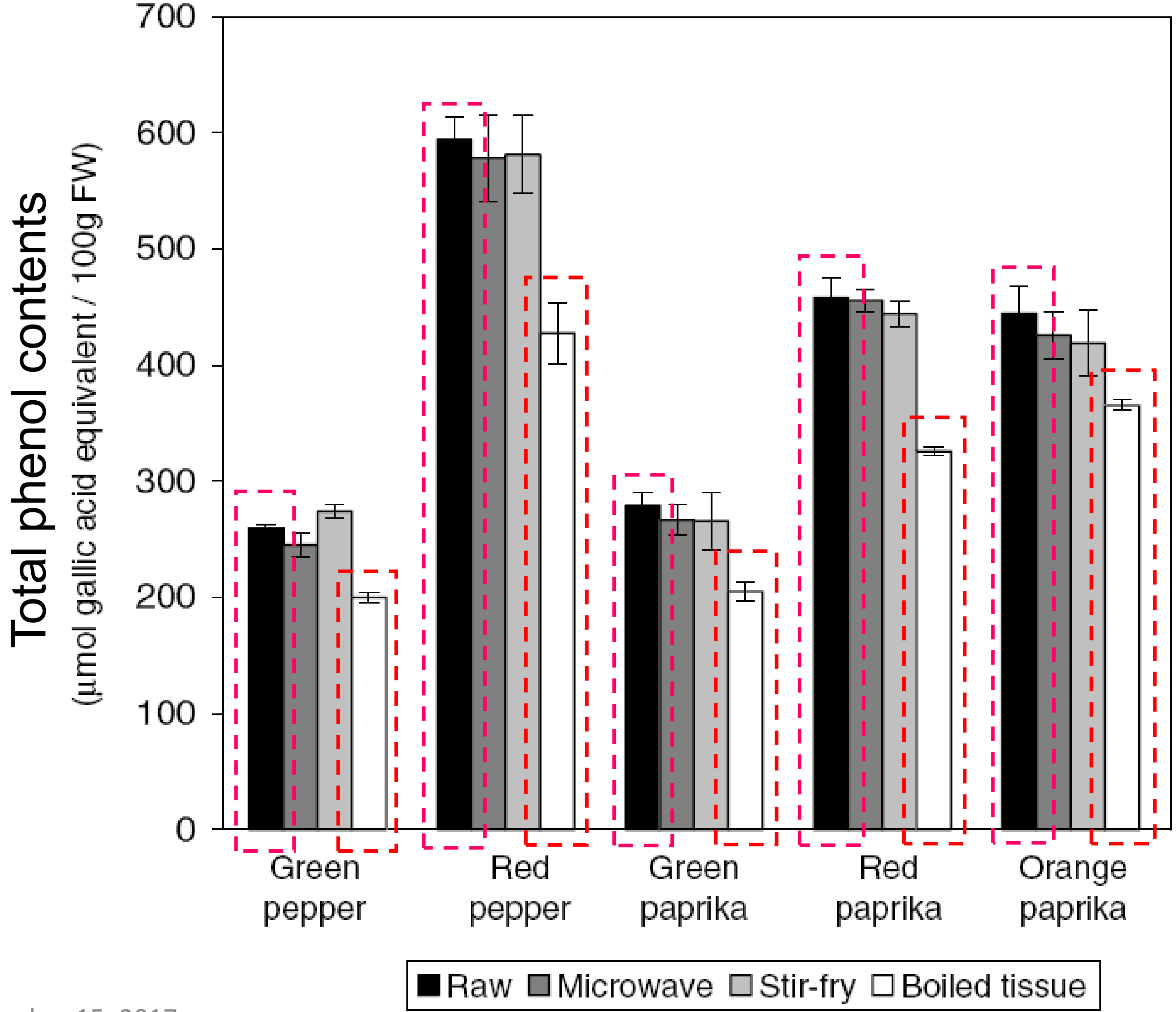
(Chuah et al., 2008)

มหาวิทยาลัยมหิดล

Carotenoid contents in colored peppers with different cooking methods

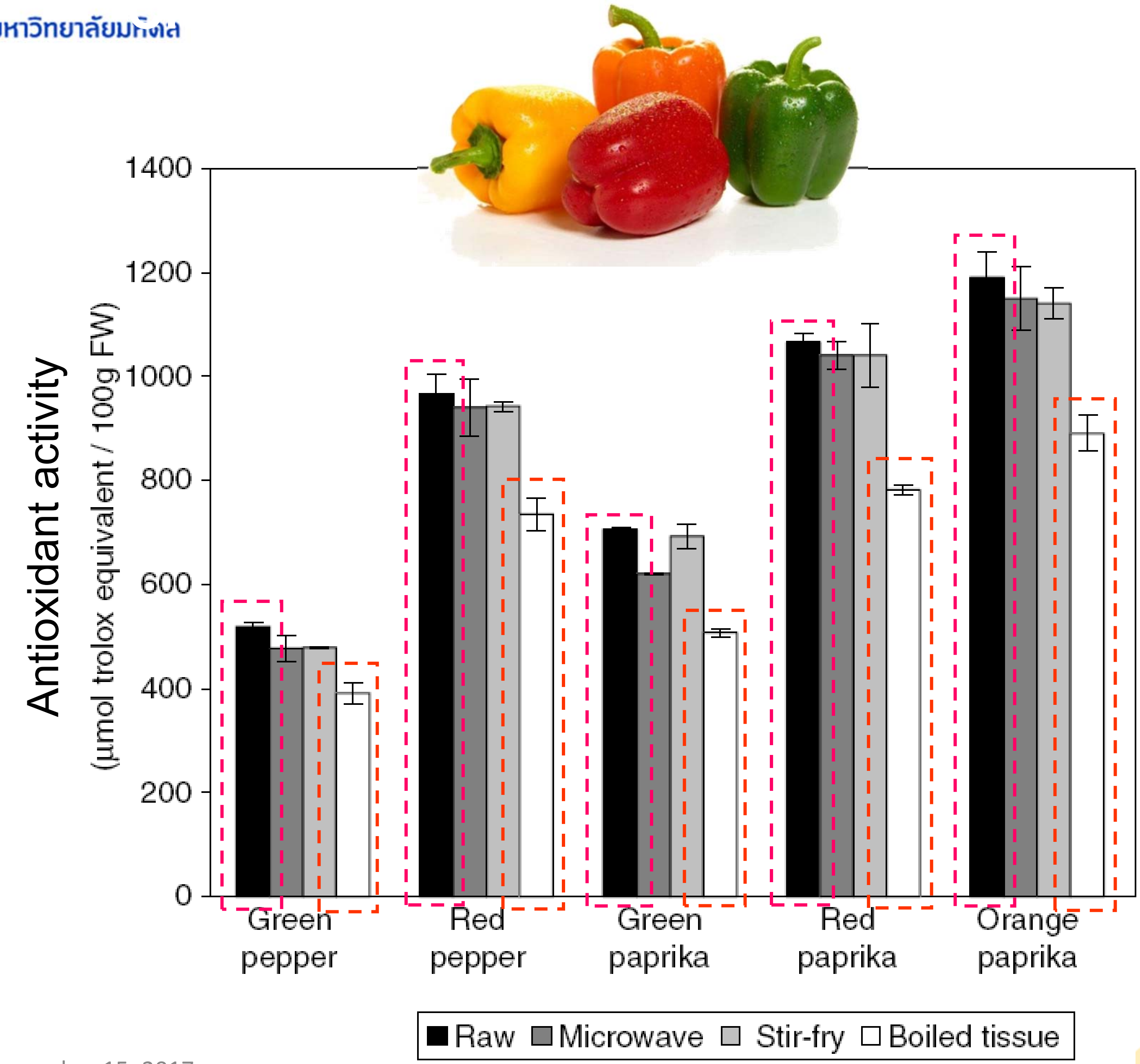


มหาวิทยาลัยมหิดล

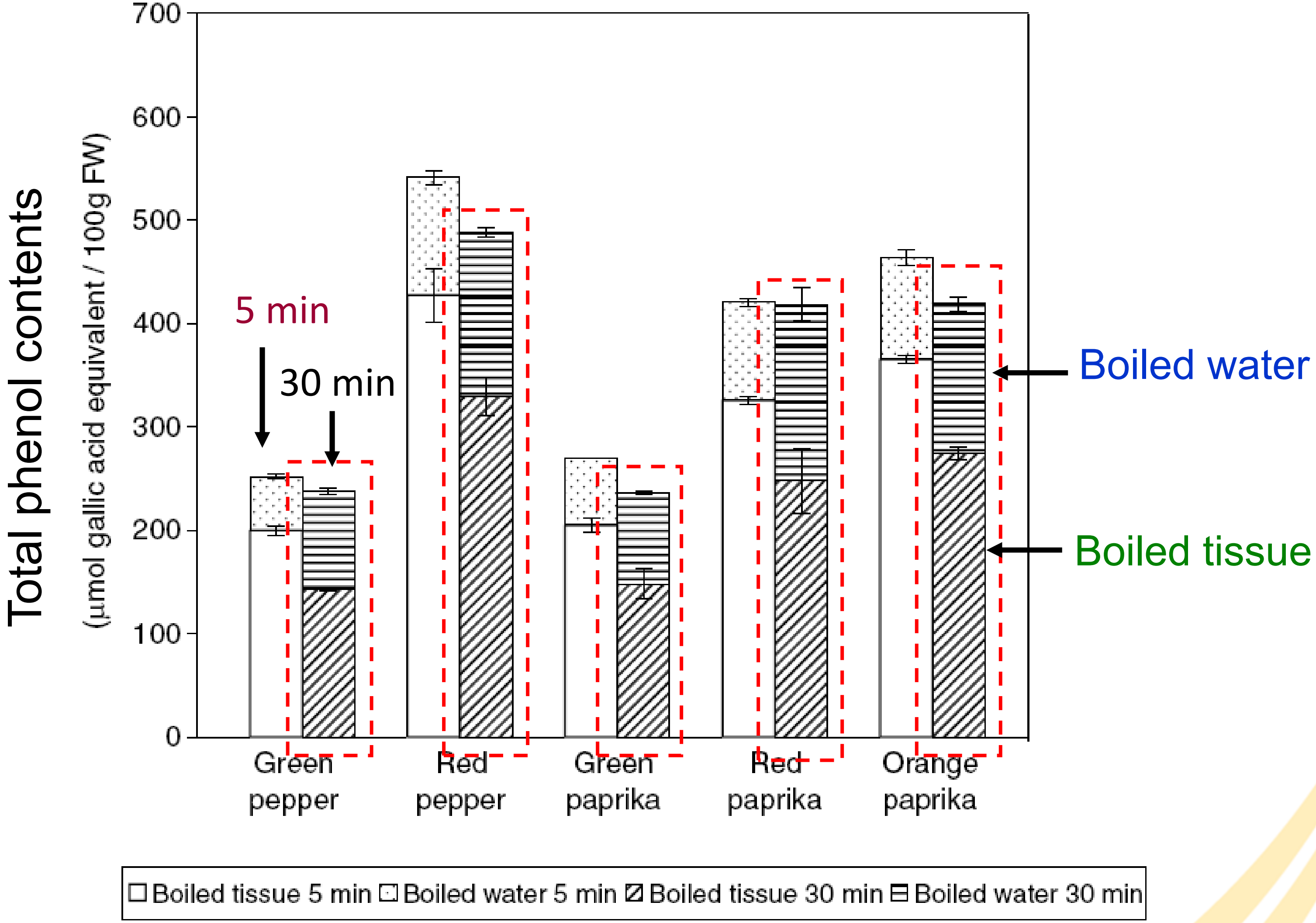


(Chuah et al., 2008)

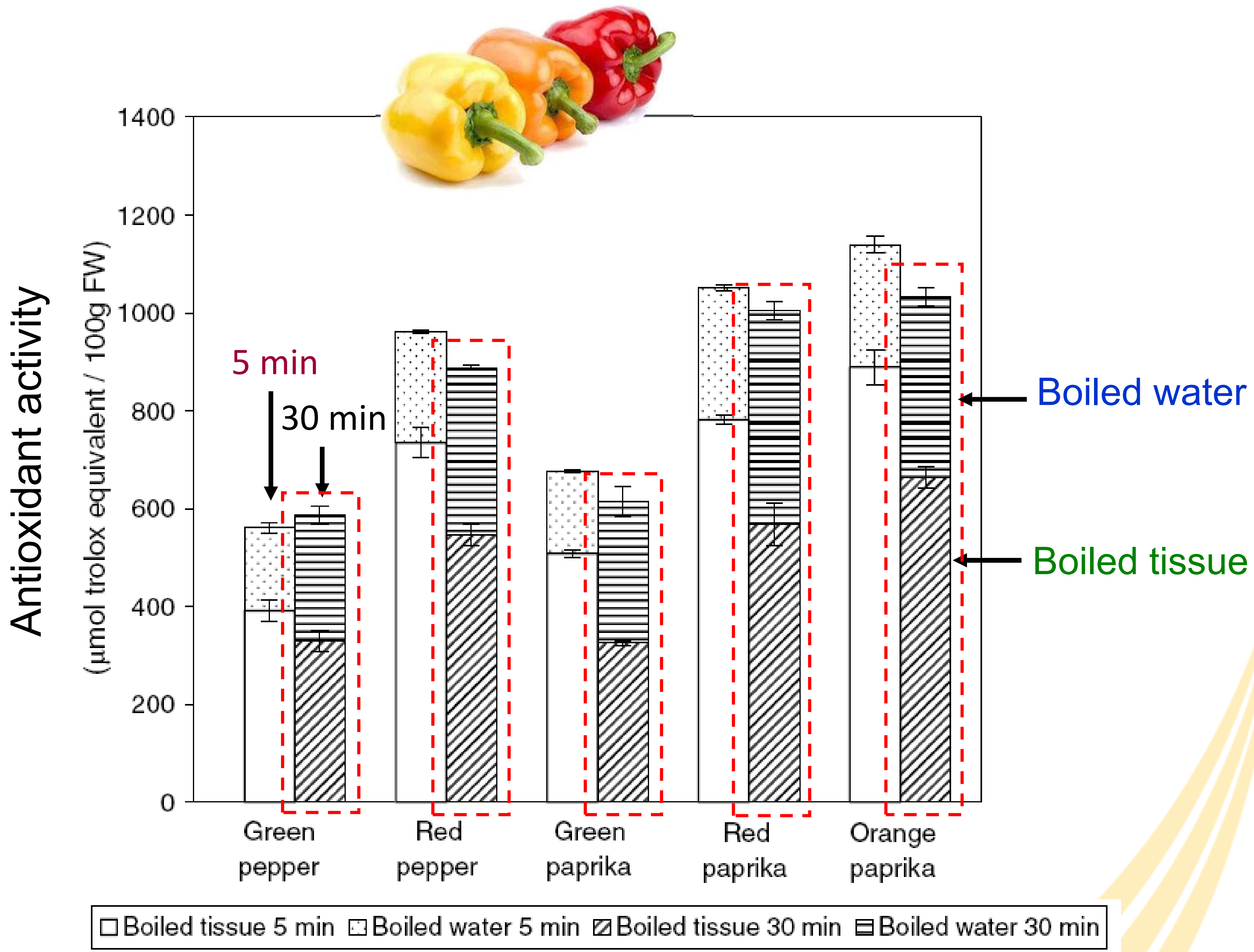
มหาวิทยาลัยมหิดล



(Chuah et al., 2008)



(Chuah et al., 2008)



(Chuah et al., 2008)

Effect of boiling and steaming on phenols and antioxidant activities in red cabbages

Red cabbages: koda and kissendrup

Boiling
- sample:water 1:2
  - 20 min
- sample:water 1:1
  - 20 min
  - 10 min

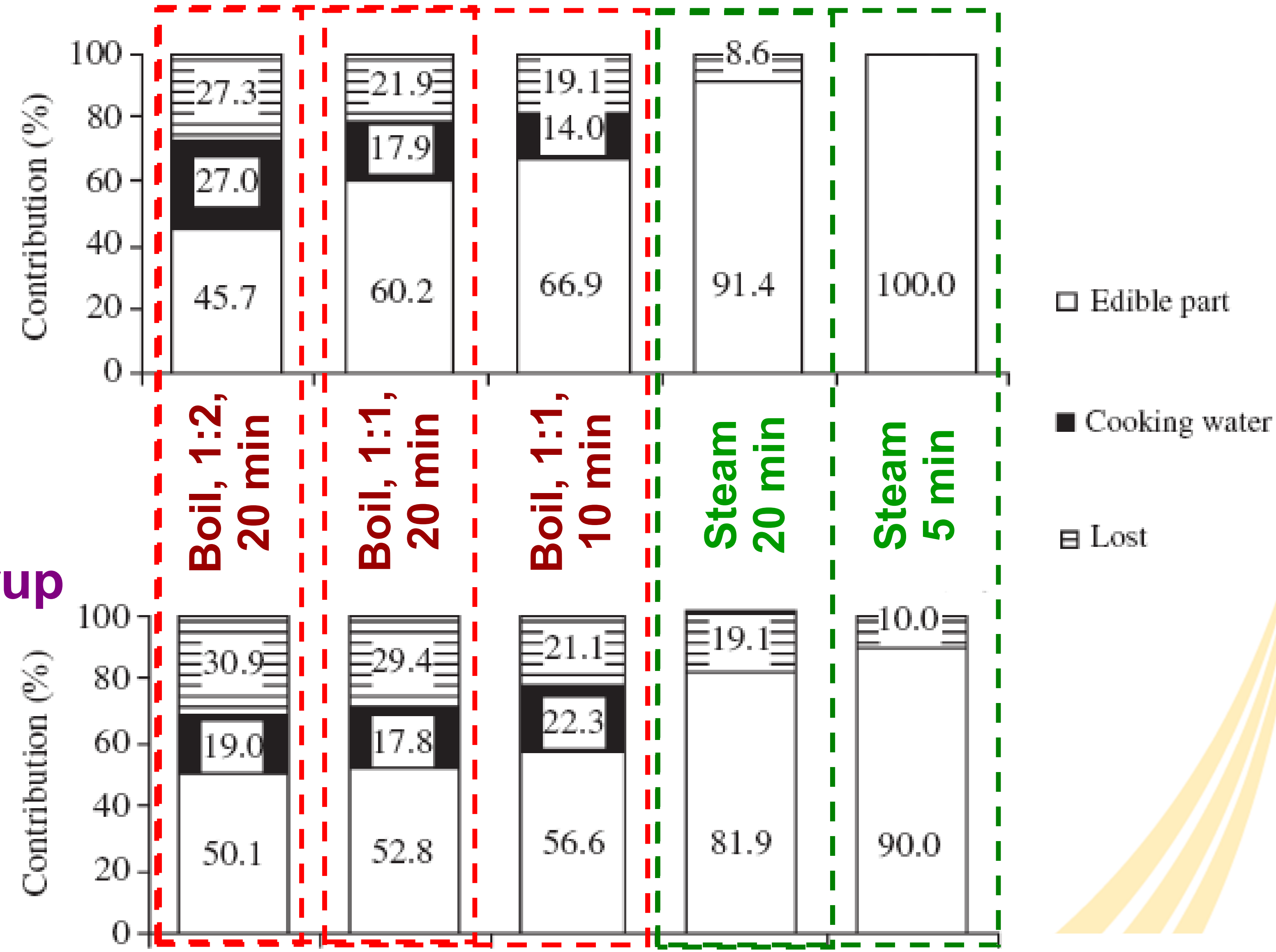
Steaming
- 20 min
- 5 min

(Podsędek et al., 2010)

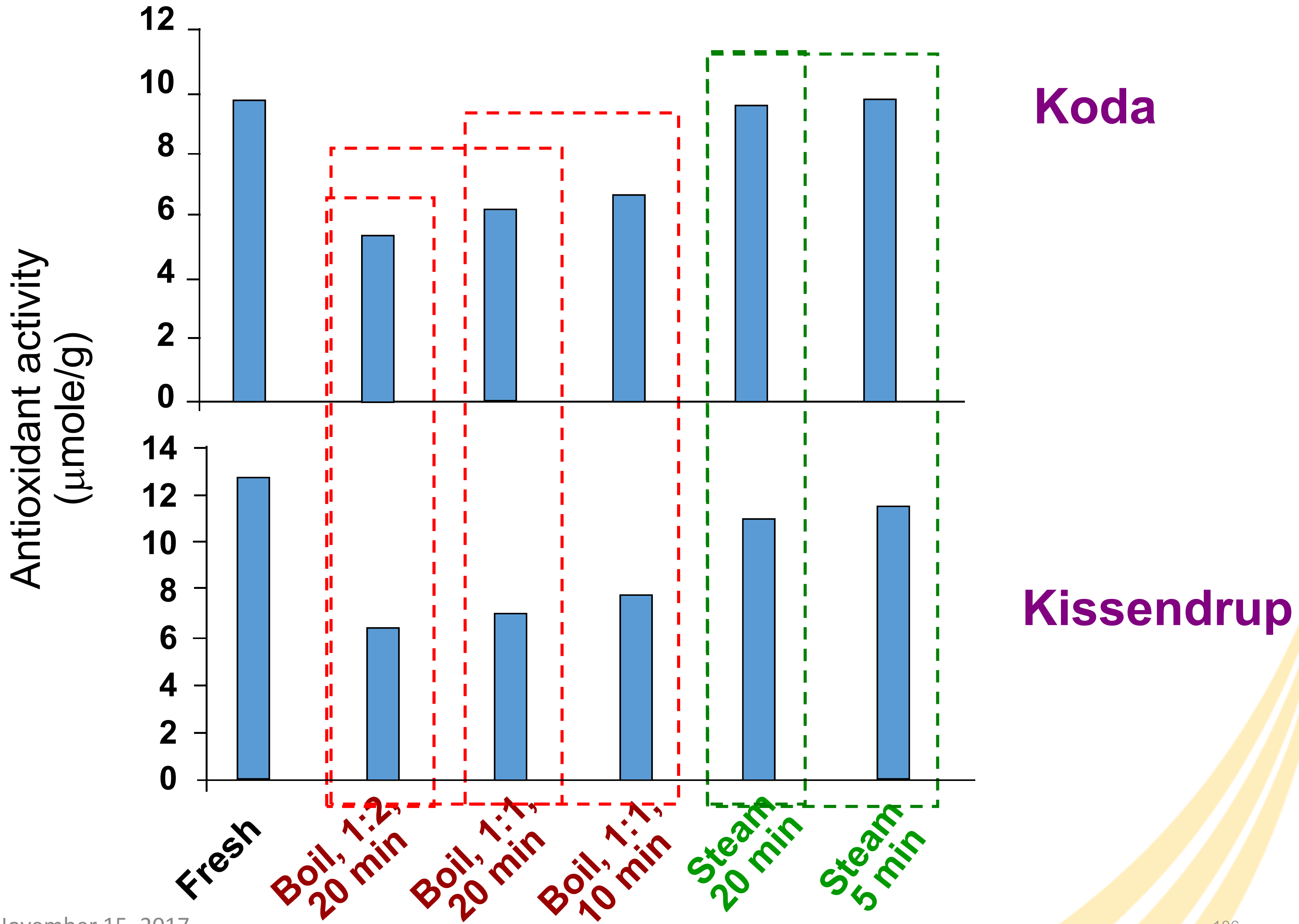
มหาวิทยาลัยมหิดล

Koda

Kissendrup



(Podsędek et al., 2010)



(Podsędek et al., 2010)

มหาวิทยาลัยมหิดล

Effect of cooking time on carotenoids, phenols and antioxidant activities in broccoli

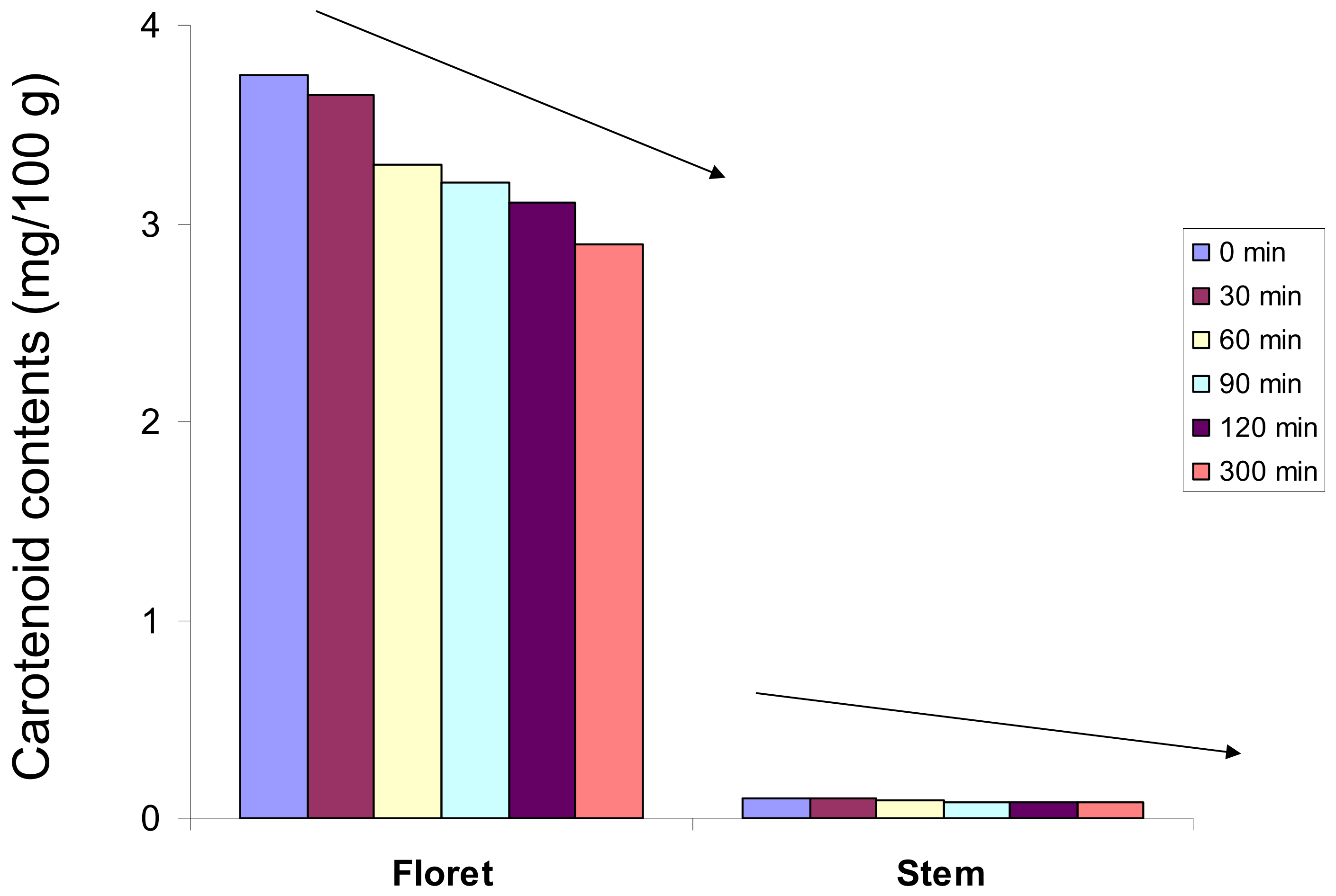
Floret → **Conventional cooking (boiling)** ← **Stem**

↓

0, 30, 60, 90, 120, 300 seconds

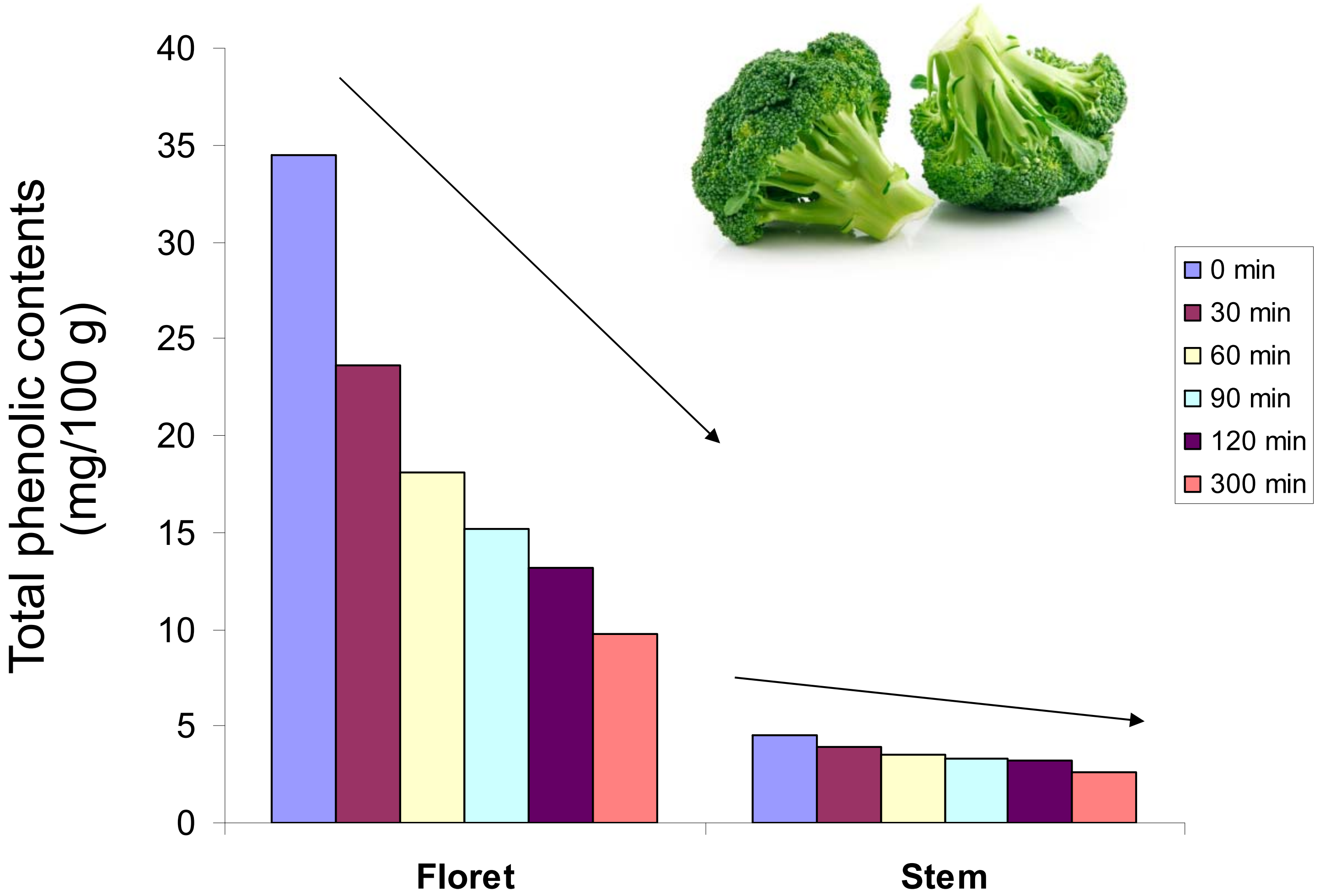
(Zhang and Hamauzu, 2004)

Carotenoid contents in broccoli floret and stem

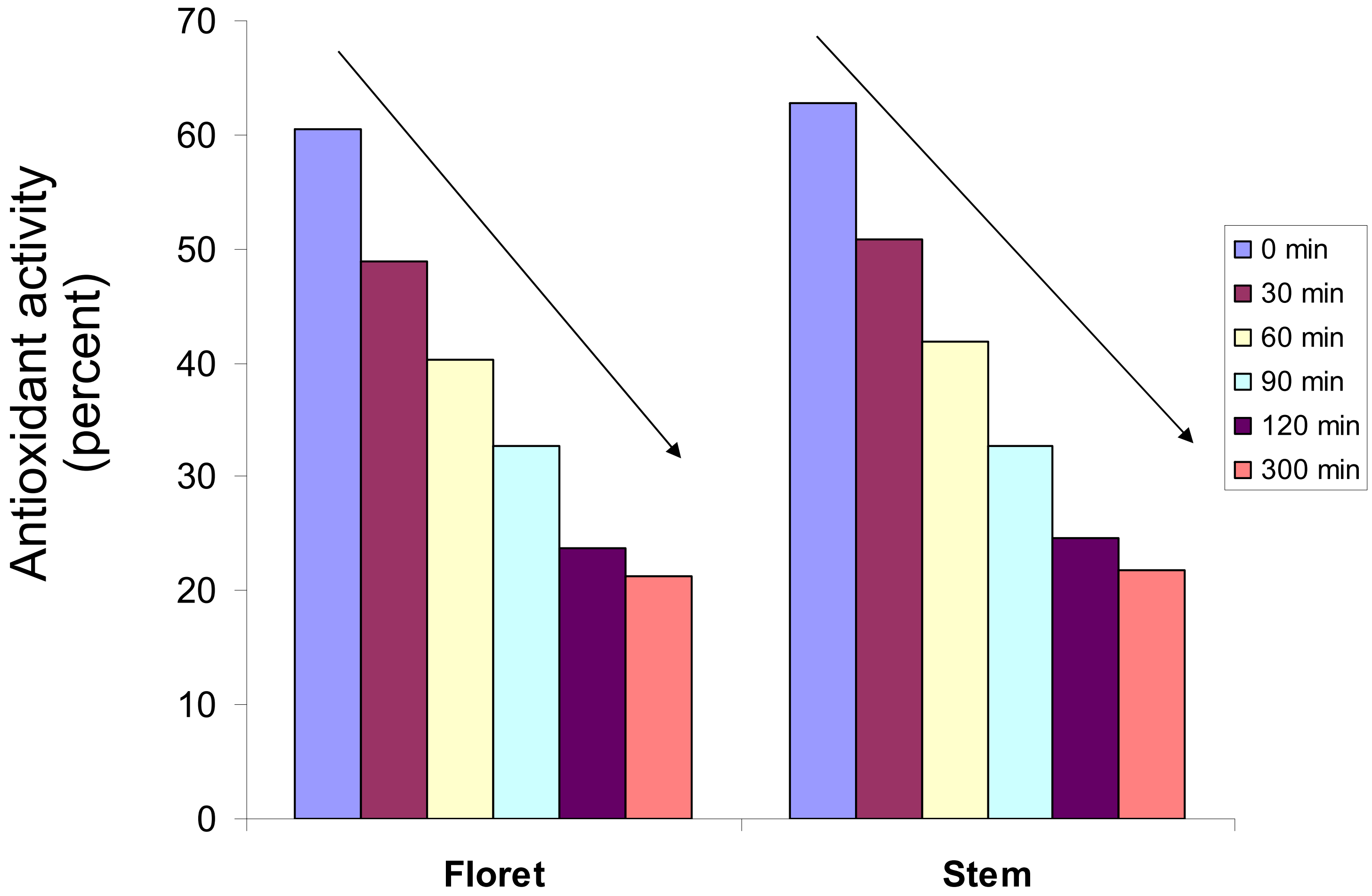


มหาวิทยาลัยมหิดล

Total phenolic contents in broccoli floret and stem



Antioxidant activities in broccoli floret and stem



มหาวิทยาลัยมหิดล

Effect of size of white tumeric on total phenols and antioxidant activities during blanching

White tumeric

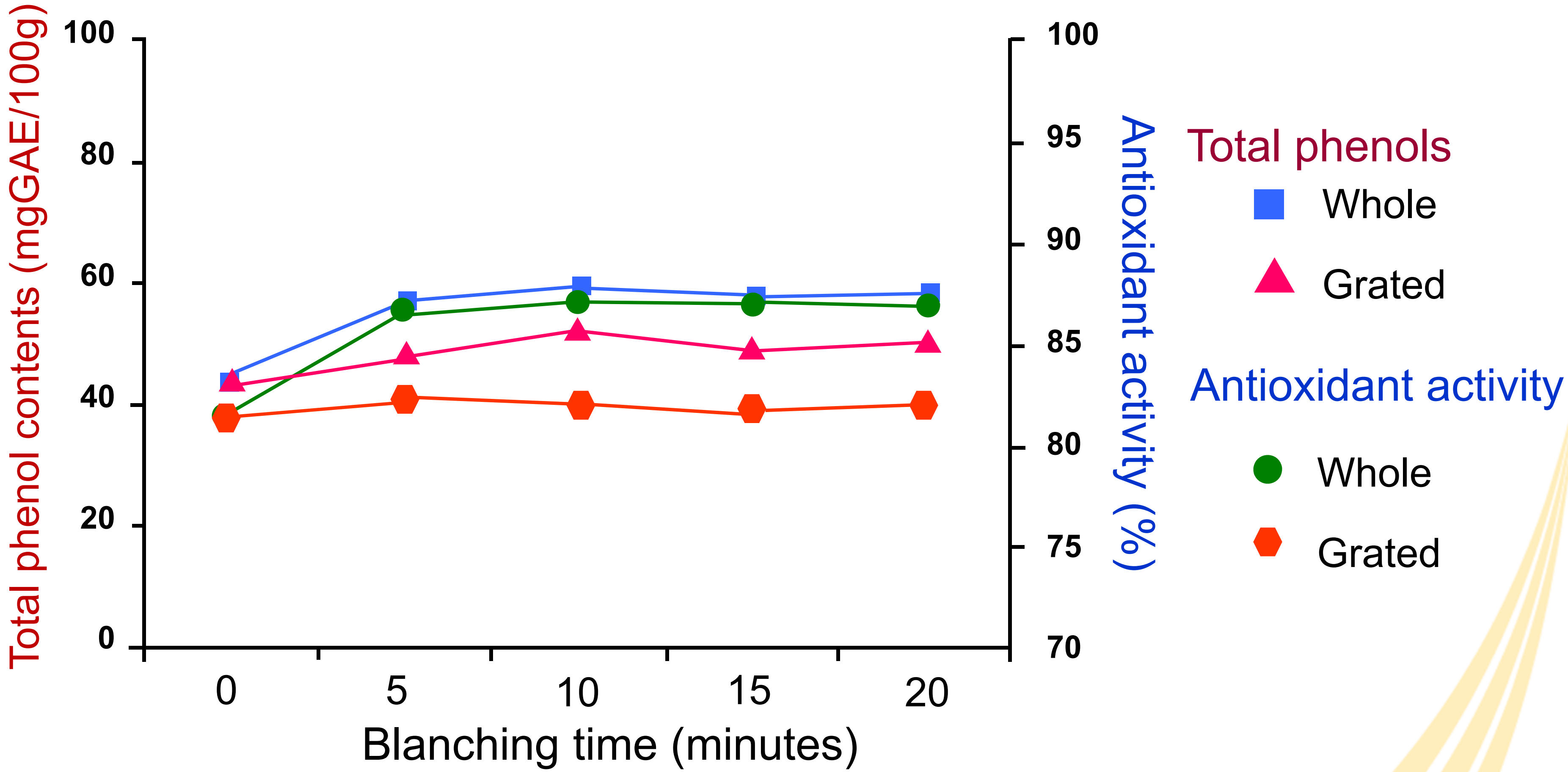
↓

Whole VS Grated

↓

Blanching

(Pujimulyani et al., 2004)



(Pujimulyani et al., 2004)

มหาวิทยาลัยมหิดล

Factors affect bioactive components and antioxidant activities during cooking

- Plant material (genotype, part of plant material)
- Types of bioactive components ▶
- Method/condition of cooking
  - Temperature
  - Time
  - Size ▶
  - Ratio of sample to water ▶
    (blanching or boiling)

มหาวิทยาลัยมหิดล

Types of bioactive components

Water soluble compounds

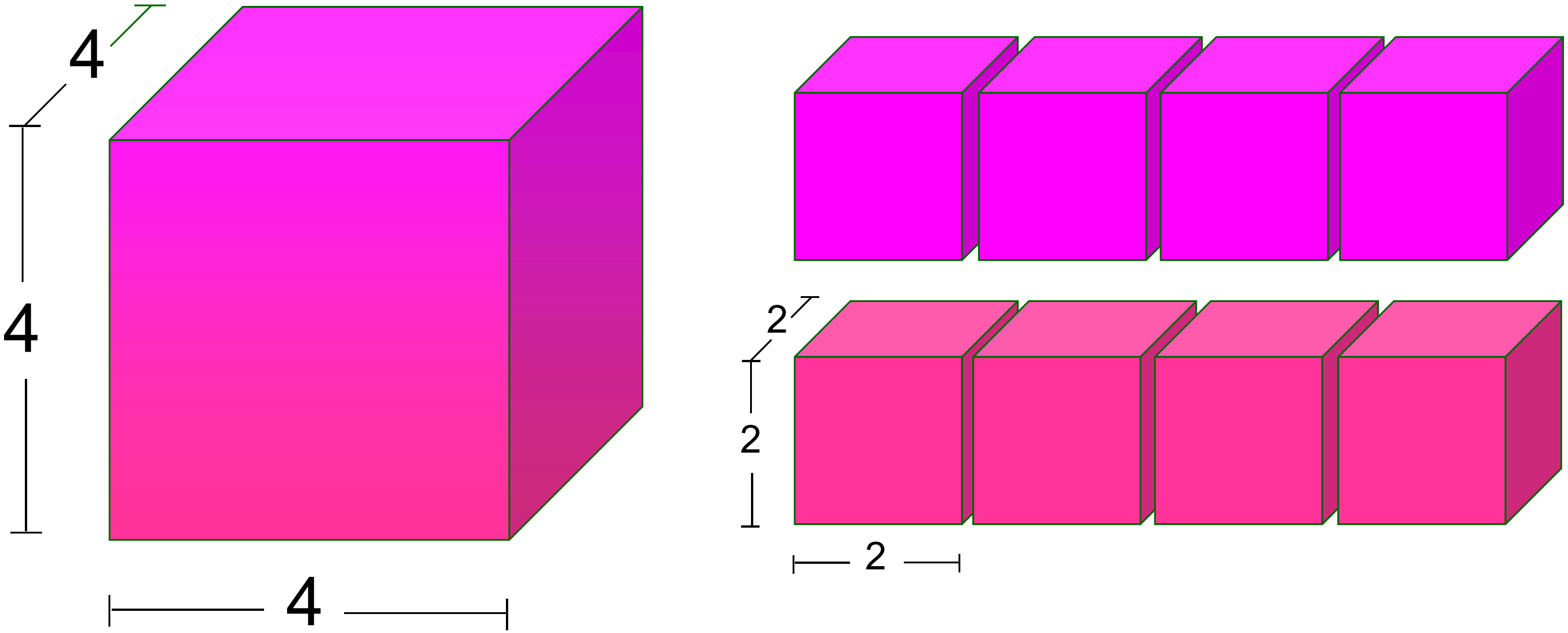
- Phenolic compounds
- Betanins

Fat soluble compounds

- Carotenoids
- Phytosterols

Water soluble compounds are easily to loss by cooking methods that use water as media compared to fat soluble compounds.

Size



Surface area:

16x6 = 96 cm^2

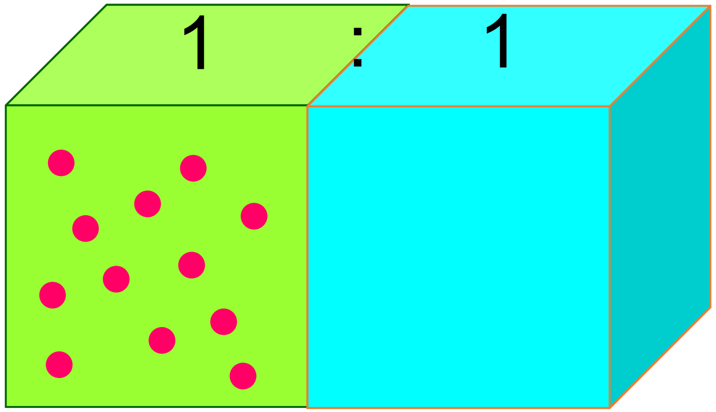
4x6 = 24 cm^2 per cube

24x8 = 192 cm^2

Ratio of sample to water: Diffusion

Concentration | **Concentration**

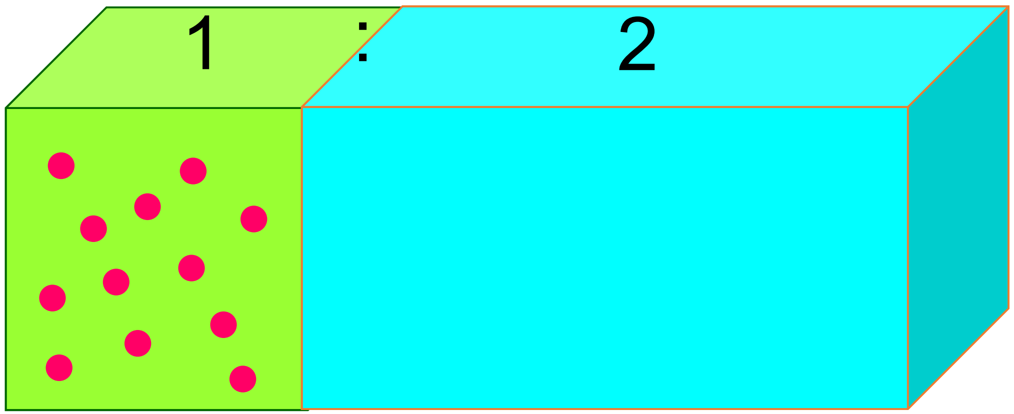
6/1 = 6



6/1 = 6

Concentration = $\frac{\text{Amount}}{\text{Volume}}$

4/1 = 4



8/2 = 4

Eat various foods and do not always eat the same dishes repeatedly




Obtain various nutrients and bioactive components




Also decrease accumulation of toxic substances from foods in our body

มหาวิทยาลัยมหิดล

The 36th International Vegetable Training Course

From Seed to Table and Beyond

"Module 2: Vegetables: From Harvest to Table"

Bioactive Compounds in Vegetables and Fruits