

# Nutrients and functional components in fruits and vegetables



Ranjan Sharma



## Definition of plant food sources – fruits and vegetables

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- 'Edible form of plant tissue that includes roots, bulbs, stems, blossoms, leaves, seeds or fruits of certain annual plants, as well as the roots, stems, leaf stalks or leaves of certain perennial non-woody plants'



# Nutrient and functional components

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- Fruits and vegetables are low fat nutrient rich foods
- Considerable interest in fruits and vegetables as sources of functional and nutraceutical ingredients
  - Designer Food- Processed foods that are supplemented with food ingredients naturally rich in disease-preventing substances.
  - Functional Food- any modified food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains.



# Nutrient contents of fruits and vegetables



- High water content
- Very low in energy (kilojoules)
- Low fat, no cholesterol
- Polyphenols, phytochemicals, pigments
- Fibre (soluble & insoluble)
- Good sources of:
  - $\beta$ -carotene
  - Folic acid
  - Non-haem iron
  - Vitamin C (ascorbic acid)



# Composition of selected fruits

	Apricot	Pear	Grape	Tangerine	Mango	Strawberry	Peach
Protein grams	1.41	0.39	0.60	0.60	0.49	0.60	0.71
Fat grams	0.39	0.39	0.39	0.21	0.32	0.39	0.11
Carb grams	11.11	15.10	17.21	11.22	17.00	6.98	11.11
Sodium mg	0.99	0.00	2.01	0.99	2.01	0.99	0.00
Vitamin A IU	2611.99	20.00	100.00	920.00	3894.00	26.98	534.99
Vitamin C mg	10.02	3.99	3.99	30.79	27.69	56.68	6.60
Water %	86.40	83.80	81.30	87.60	81.70	91.60	87.70
Total Fiber gms	2.40	2.40	0.99	2.29	1.80	2.29	2.01
Ash grams	0.81	0.32	0.60	0.39	0.49	0.39	0.49
Calcium mg	14.00	11.01	14.00	14.00	10.02	14.00	5.01
Phosphorus mg	19.01	11.01	10.02	10.02	11.01	19.01	11.99
Potassium mg	296.01	125.01	191.01	157.00	156.01	166.00	197.00

Amounts per 100 g fruit



# Composition of selected vegetables

	Asparagus	Carrots	Peas	Green beans	Spinach
Kcal/svg	22.99	42.97	80.97	31.09	22.00
Fat (g)	0.19	1.03	0.40	0.13	0.33
Cholesterol (mg)	0.00	0.00	0.00	0.00	0.00
Total Carbohydrate (g)	4.48	10.16	14.48	7.09	3.53
Fiber (g)	2.09	2.97	5.10	3.45	2.73
Sodium (mg)	1.94	35.00	4.97	6.00	79.33
Potassium (mg)	272.99	322.97	244.00	209.09	558.00
Protein (g)	2.24	1.03	5.38	1.82	2.87
Vitamin A (IU)	582.99	28129.06	640.00	668.00	6715.33
Vitamin C (mg)	13.13	9.38	40.00	16.36	28.00
Calcium (mg)	21.04	27.03	24.97	37.09	99.33
Iron (mg)	0.87	0.50	1.52	1.04	2.73
Folate (mcg)	128.06	14.06	64.97	36.55	194.67

Amounts per 100 g raw vegetable



# Fat, protein and fibre

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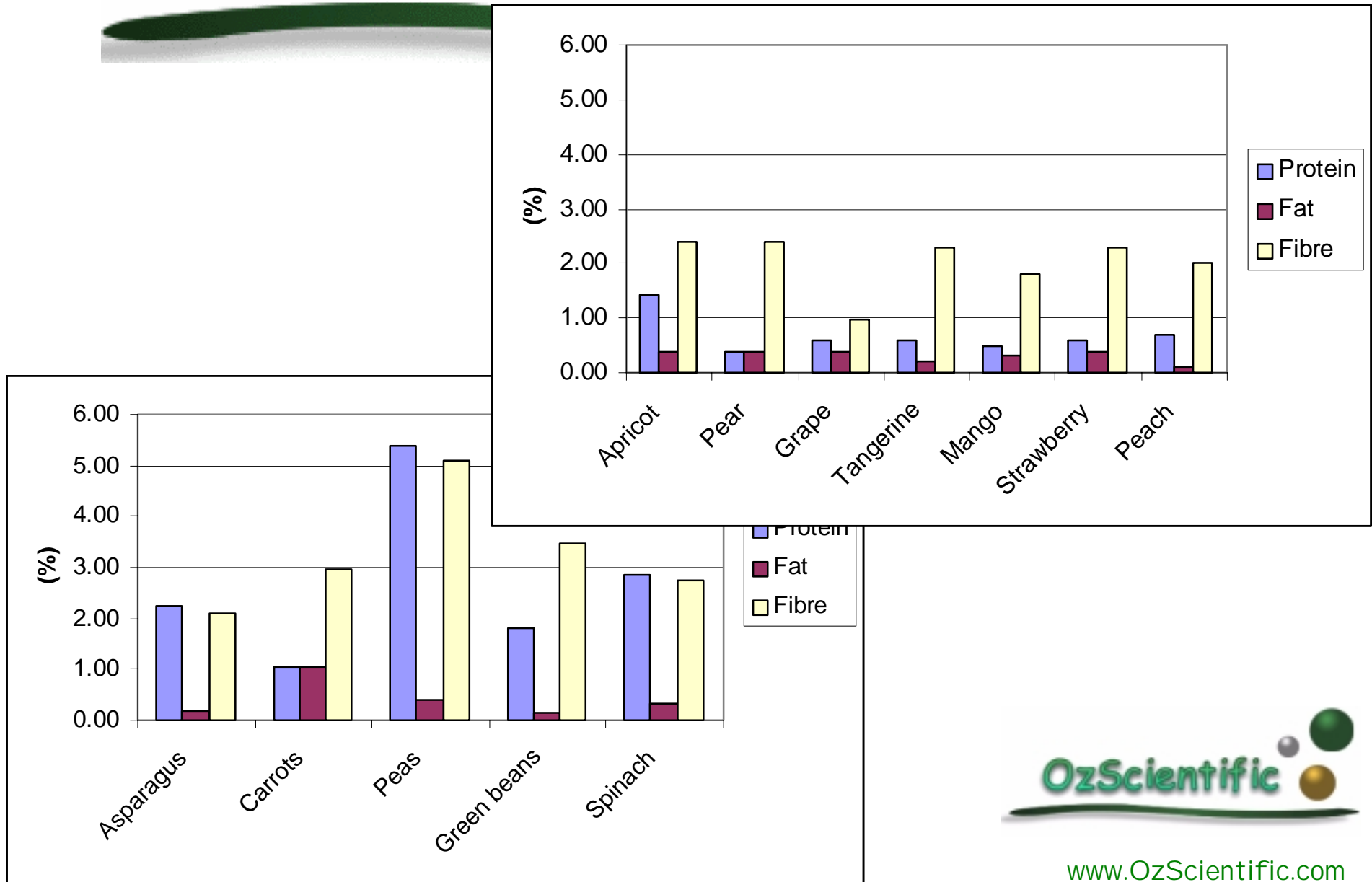
- Fruits and vegetables low in fat (0-<1% fat).
  - High fat intake increases risk of heart disease, cancer and obesity.
  - Indirectly increases risk of diabetes and high blood pressure.
- Most contain low amounts of protein
- Good source of dietary fibre

[http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health\\_benefits.ppt](http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health_benefits.ppt)



[www.OzScientific.com](http://www.OzScientific.com)

# Fat, protein and fibre - fruits & vegetables



# Fiber



- Fruits and vegetables high in fiber.
- Dietary fiber has many health benefits.
- Dietary fibers divided into two types:
  - Insoluble fibers
  - Soluble fibers

[http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health\\_benefits.ppt](http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health_benefits.ppt)



# Insoluble Fiber



- Insoluble fibers help with bowel function and colon cancer.
  - Larger, softer stool
  - Eases passage
  - Prevents compaction
  - Stimulates GI tract muscles
  - Decreases transit time

[http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health\\_benefits.ppt](http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health_benefits.ppt)



# Soluble Fiber



- Soluble fibers slow down the rate food leaves the stomach.
  - Slows down rate of glucose absorption.
- Soluble fibers bind
  - Binds bile acids
  - Binds carcinogens

[http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health\\_benefits.ppt](http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health_benefits.ppt)



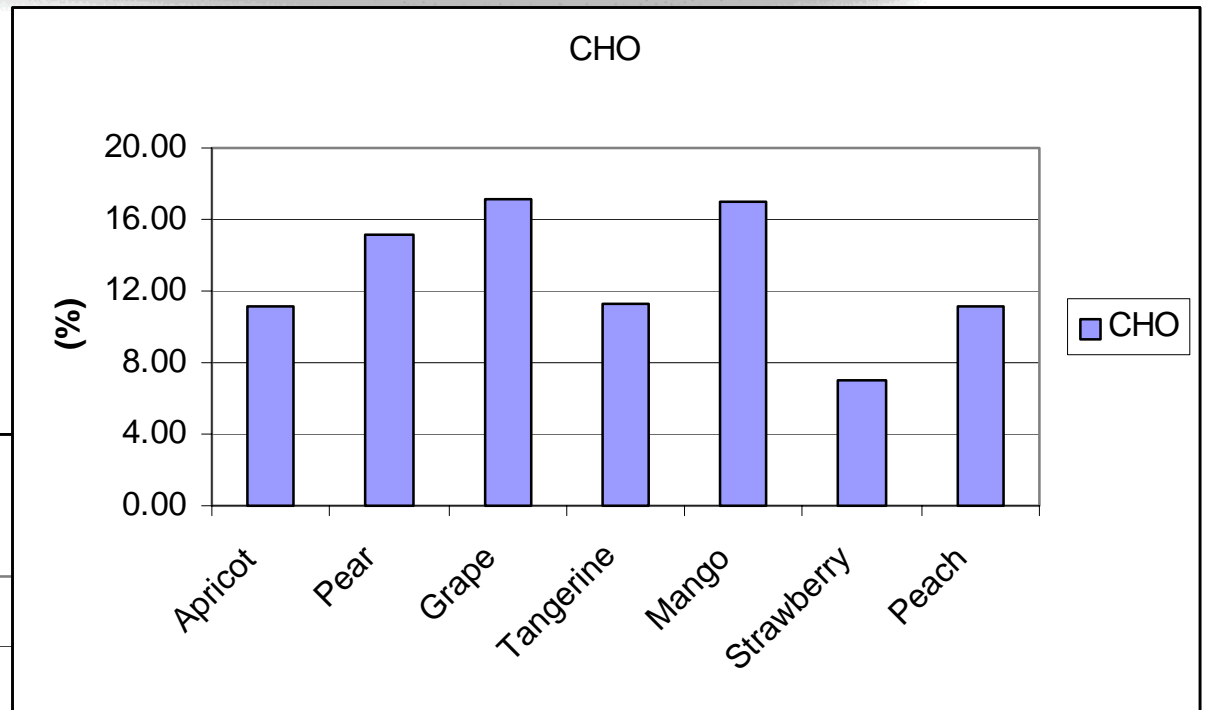
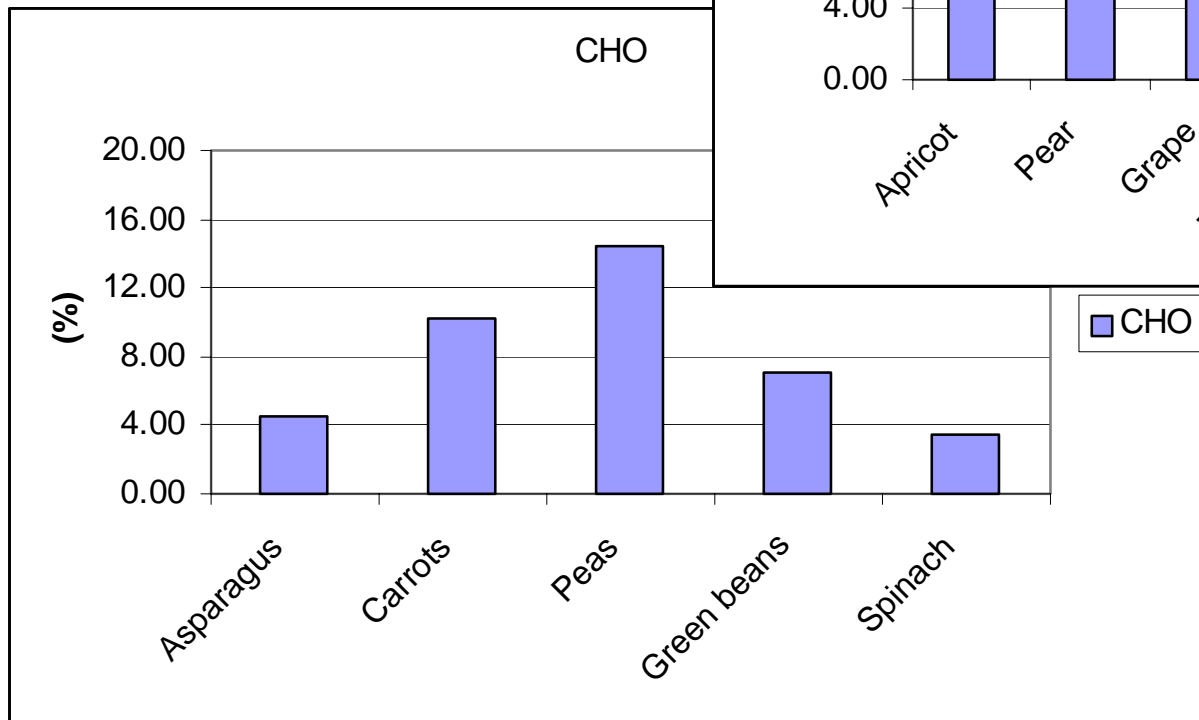
# Dietary Fiber



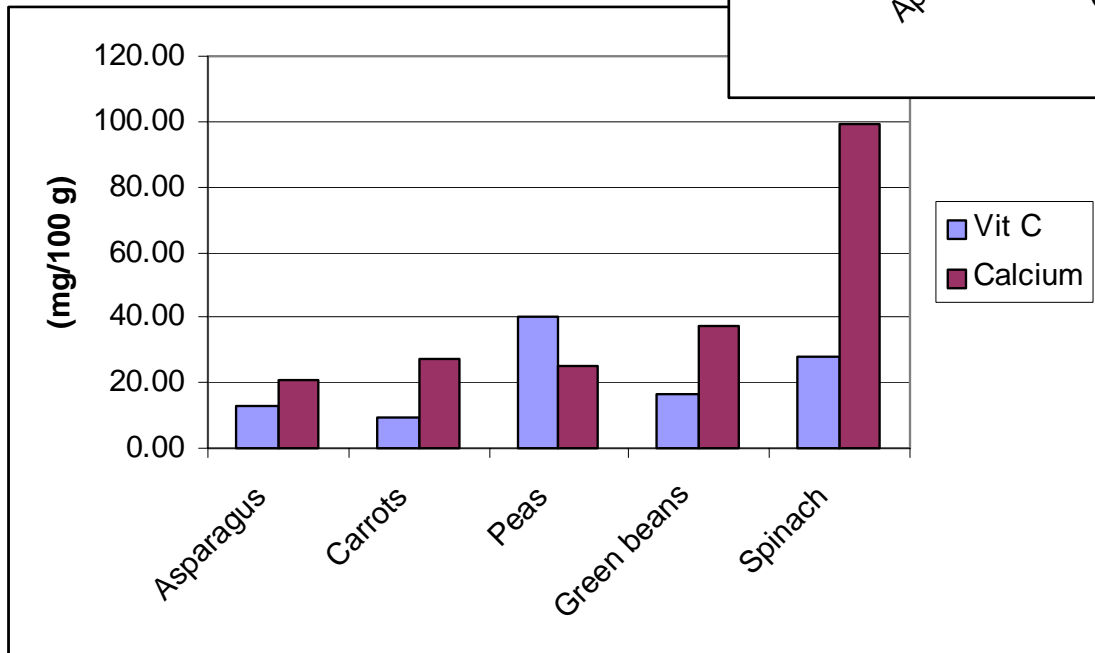
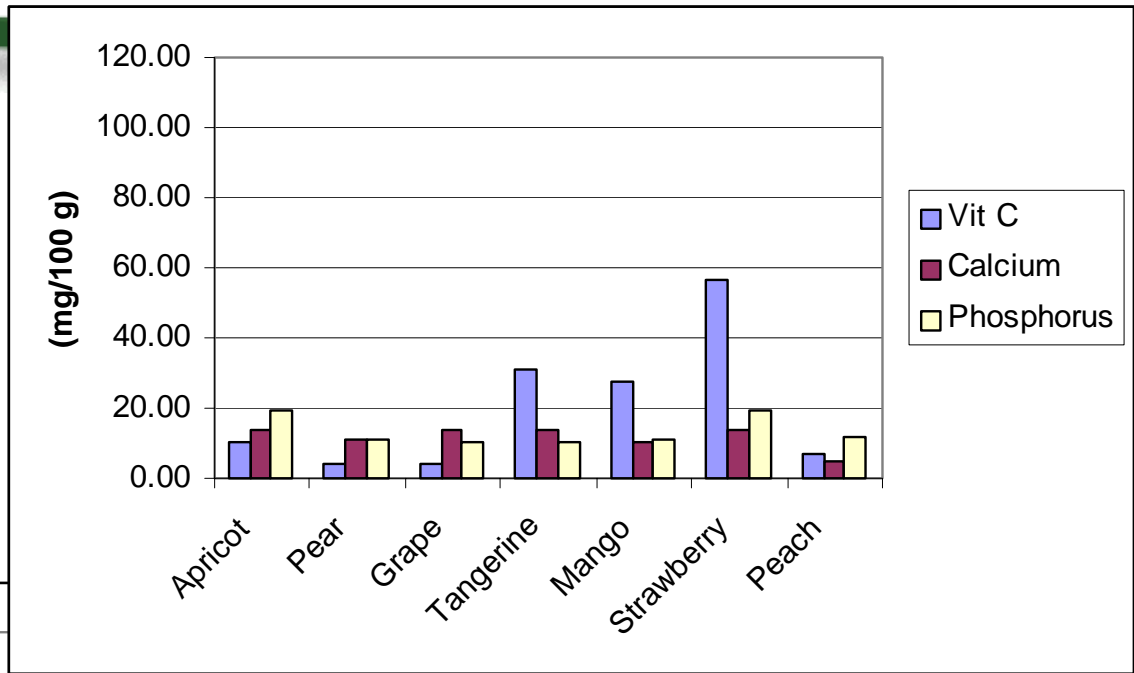
- Typical Western diets are low in fiber
- Recommend fiber intake is 20 to 30 grams of fiber each day, with an upper limit of 35 grams of fiber
- Dietary fiber should come from a variety of foods including whole grains, legumes, fruits, and vegetables



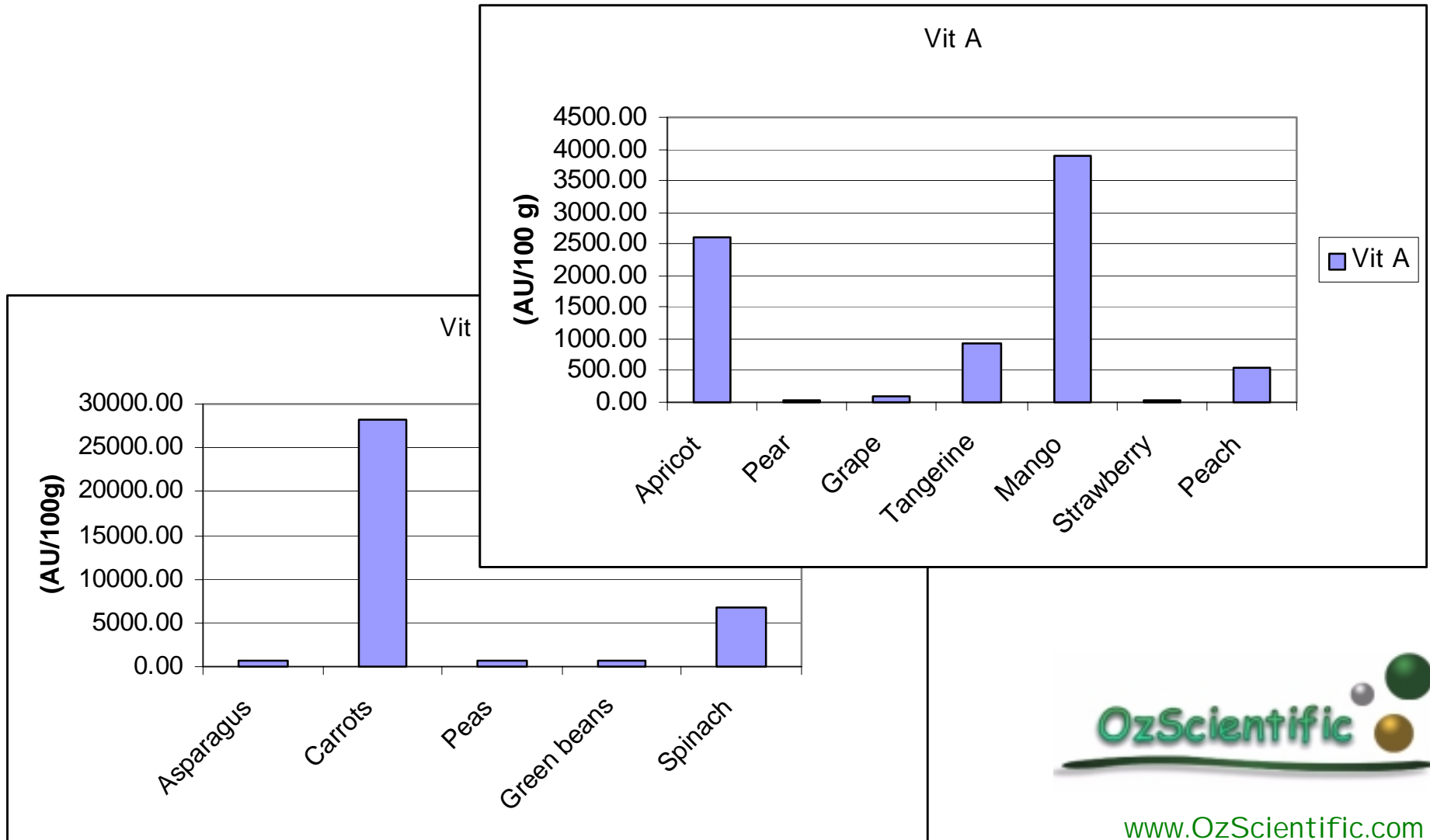
# Carbohydrate - fruits and vegetables



# Vit C, Ca & P - fruits and vegetables



# Vitamin A - fruits and vegetables



# Vitamins



- Fruits and vegetables are high in:
  - Vitamin C
  - Beta-carotene (precursor to vitamin A)
- These function as antioxidants to protect against free radical damage.
- Diets rich in beta-carotene associated with lower risk of certain types of cancer.

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# Vitamin C

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- Functions as an antioxidant
- Helps fight off infections
- Diets rich in vitamin C associated with lower risk of certain types of cancer (including stomach and esophagus cancer), heart disease, and some eye diseases.
- Vitamin C restores oxidized vitamin E to its active state
- Recommended amount is 60 mg/day, but the optimal amount to fight disease may be as high as 200 mg.
- Vitamin C is found in many fruits and some vegetables, such as citrus fruits, peaches, berries, strawberries, melons, broccoli, cauliflower, peppers & greens



## Beta-Carotene & Vitamin A

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- Beta-carotene appears to lower cancer risk, especially lung cancer. The body can convert beta-carotene to vitamin A
- Vitamin A itself appears to lower risk of most cancers. However, unlike beta-carotene, vitamin A is toxic if taken in excessive amounts
- Fruits and vegetables that are rich in beta-carotene are deep yellow-orange in color such as carrots, sweet potatoes, squash, cantaloupe, and tomatoes, and those that are very dark green such as spinach, greens, broccoli and brussel sprouts



# Vitamin E

- Vitamin E may lower risk of stomach and esophageal cancers
- Leads in the battle against heart disease by preventing LDL or "bad" cholesterol from clogging your arteries.
- Also helps boost the immune system.
- Whole grain breads and cereals, wheat germ, broccoli, leafy greens, spinach, fats and oils are rich in vitamin E



# Sodium



- Fruits and vegetables low in sodium (Fruits: <3 mg/100 g; vegetable 1-80 mg/100 g).
- High sodium intake increases risk of
  - high blood pressure for some
  - calcium and bone loss

[http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health\\_benefits.ppt](http://www.fcs.okstate.edu/food/nutrition/basics/pyramid/health_benefits.ppt)



# Potassium

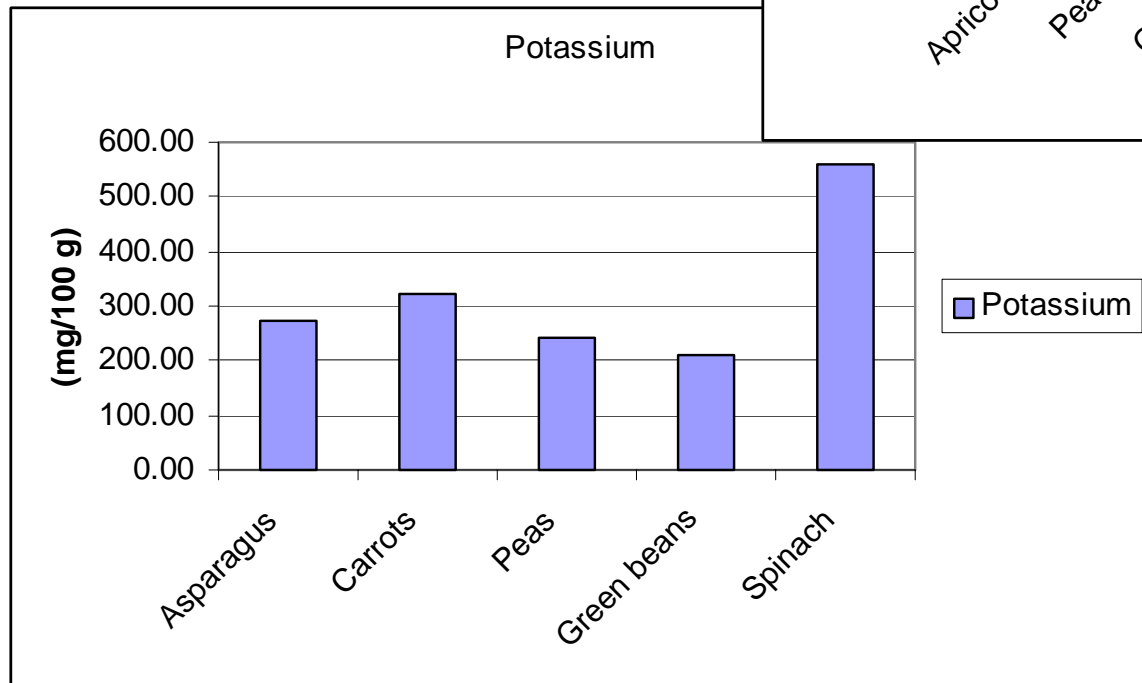
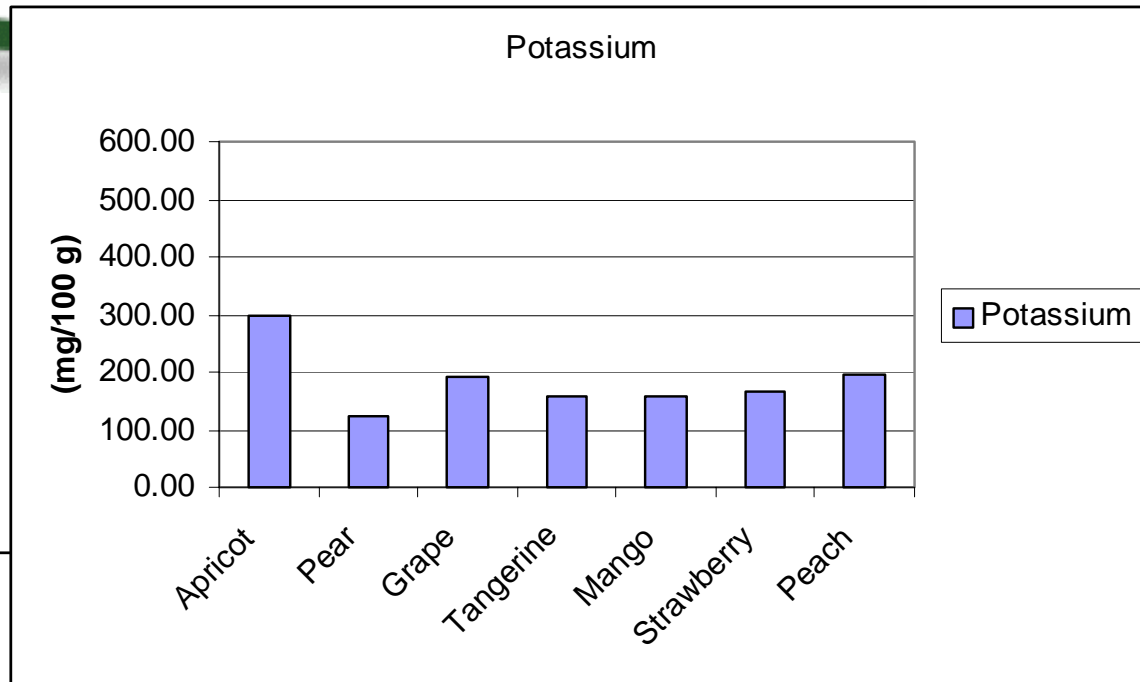


- Fruits and vegetables good source of potassium
  - Low potassium intake increases risk of high blood pressure
  - High potassium intake lowers risk of high blood pressure

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# Potassium levels of fruits and vegetables



# Folate



- Many vegetables and some fruits good source of folate.
- High folate intake lowers risk of neural tube defects.
- High folate intake lowers risk of heart disease.

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# Selenium



- Selenium is a mineral which may lower risk of colon, breast and other cancers
- Foods rich in selenium include wheat germ, bran, tuna fish, onions, tomatoes, and broccoli, depending on soil grown
- Selenium is stored and toxicity can occur with large supplement doses



# Fruit and vegetables as functional foods



- Fruits and vegetables as sources of
  - Phytochemicals
  - Phenolic compounds (or polyphenols)
  - Antioxidants



# Phytochemicals

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- Phytochemicals are natural plant compounds that provide health benefits including decreasing risk of certain types of cancer and heart disease
- Many phytochemicals function as antioxidants (ex: lutein and lycopene).
- Many other ways phytochemicals function to provide health benefits.
- So far, scientists know of 3,000 different phytochemicals with possible health benefits
- Research is just beginning



# Phytochemicals



- Lycopene, found in tomatoes, watermelon and pink grapefruit, which may aid in reduction of prostate cancer and heart disease.
- Anthocyanin, found in blueberries, blackberries, cherries, kiwi, plums and eggplant, which may help reduce the risk of cancer and may prevent urinary tract infections.
- Resveratrol, found in red grapes, wine and peanuts. Resveratrol may help reduce the risk of heart disease and cancer.



# F&V – evidence for health benefits

CONDITION	STRENGTH OF EVIDENCE	ASSESSMENT OF EVIDENCE
Cancer	Substantial for some sites	Convincing for many cancers
Cardiovascular Disease	Growing use of biomarkers	Convincing
Hypertension	Few diverse trials	Convincing as adjunct
Stroke	Growing	Promising
COPD and Lung Function	Growing	Highly suggestive
Diabetes	Limited	Potential, plausible mechanisms
Obesity	Sparse direct data	Convincing as adjunct
Longevity	Limited	Plausible
Bone Health	Few human studies	Plausible
Aging and Cognition	Few human studies	Plausible
Neurodegenerative Disease	Limited human data	Plausible
Skin Health and Wrinkling	Sparse	Watching
Diverticulosis	Strong	Convincing
Arthritis	Sparse	Watching
Birth Defects	Substantial, proven	Most convincing
Cataracts	Needs clinical trial	Suggestive

# Phenolics or polyphenols

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- The term phenolic or polyphenol is chemically defined as a substance that possesses an aromatic ring, bearing one or more hydroxy substituents, including its functional derivatives (esters, methyl esters, glycosides, etc.).
- The three groups of phenolic compounds which commonly occur in food materials are
  - Simple phenols and phenolic acids,
  - Hydroxycinnamic acid derivatives, and
  - Flavonoids



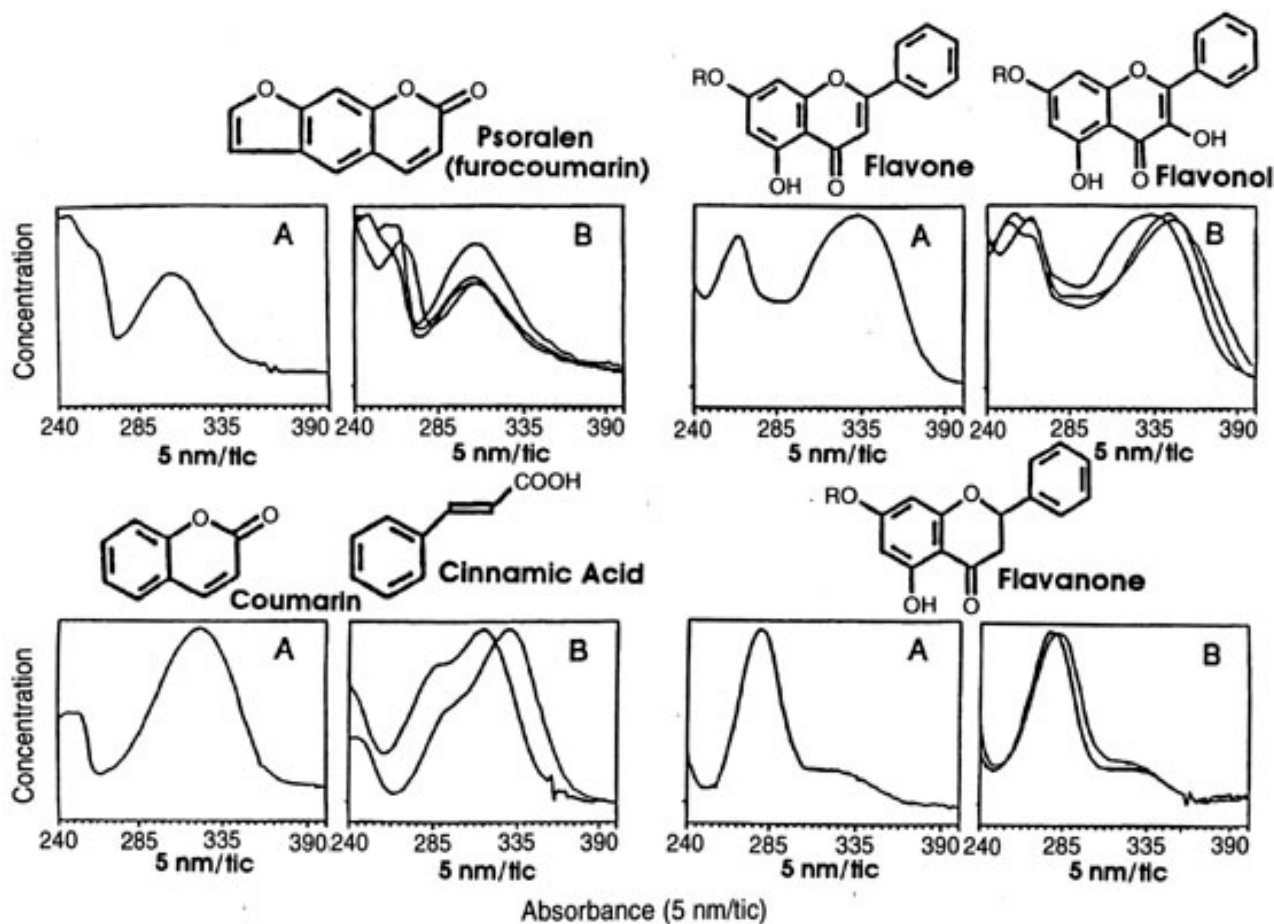
# Flavonoids



- Flavonoids are diphenylpropanes that commonly occur in plants (fruits, vegetables, nuts, seeds, stems, flowers) as well as tea and wine. The flavonoids include
  - Flavones,
  - Flavonols,
  - Isoflavones,
  - Catechins,
  - Flavonones, and
  - Chalcones.



# Structure of phenolic compounds



# Flavonoids



- The biological effects related to their antioxidant properties includes:
  - anti-lipoperoxidant,
  - anti-tumoral,
  - anti-platelet,
  - anti-ischemic,
  - anti-allergic,
  - anti-inflammatory



# Antioxidants



- Antioxidants refer to any substance that delays or inhibits oxidative damage to a target molecule. Lipids, proteins, nucleic acids, and carbohydrates are potential targets of oxidative damage. Antioxidants act and protect the target sample by:
  - Scavenging oxygen-derived species
  - Minimizing the formation of oxygen-derived species
  - Binding metal ions
  - Replacing damage to the target, and
  - Destroying badly damaged target molecules and replacing them with new ones



# Antioxidants



- Antioxidants are powerful free radical scavengers. Free radicals are highly reactive chemical substances that travel around in the body and cause damage to your cells.
- Antioxidants help to reduce the risk of cancer, heart attack and stroke
- Antioxidants are vitamins, minerals and other compounds that can help slow down or prevent damage to your body's cells.
- Antioxidants increase immune function and may decrease risk of infection and cancer.



# Antioxidants



- Natural antioxidants in foods can be found in various sources such as,
  - Endogenous compound in one or more components of the food;
  - Substances formed from reactions during processing; and
  - Food additives isolated from natural sources
- Selenium, vitamins A, C, E, and beta-Carotene all function as antioxidants



# Antioxidants - two broad classes



- Preventive
  - Preventive antioxidants intercept oxidizing species before damage can be done.
- Chain-Breaking
  - Chain breaking antioxidants slow or stop oxidative processes after they begin, by intercepting the chain-carrying radicals.



# Free radicals

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- Are byproducts of metabolism. They are capable of causing cells to lose their structure, function and eventually destroying them.
- Connected with the development of 50 diseases including heart disease and cancer.



# Free Radical Damage

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- Free radical damage can lead to disease.
  - Cell proteins altering functions
  - DNA creating mutations
  - Polyunsaturated fats in cell membranes
  - Polyunsaturated fats in lipoproteins
  - Signal activities within cells

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# Antioxidants in fruits and berries

Antioxidant (mg/kg)	Apple	Blueberry	Blackcurrant	Cranberry	Strawberry
Anthocyanins	4-5	3970-4850	130-8100	460-1720	202-790
Flavanols & proanthocyanidins	0-15	63-70	205-375	285	9-184
Flavonols	17-70	63-70	205-370	139-334	7-174
Hydroxycinnamates	263-308	226-315	104-167	191	14-69
Carotenoids (b-carotene)	0.4		1	0.2	0.1
Vitamin C (Ascorbic acid)	40		1200	120	420-600
Vitamin E (tocopherol)	2		23	10	6

Jongen, 2002, Fruit & Vegetable Processing, CRC Press



# Antioxidants in fruits and berries

Antioxidant (mg/kg)	Grapes, red	Grapes, white	Orange	Peach	Plum
Anthocyanins	72.5-765	0		0-17.8	19-76
Flavanols & proanthocyanidins	1-160	0		24.7-700	140-600
Flavonols	13-25	10-13.5	0-5	0-11.9	5.7-27
Hydroxycinnamates	5-19	5.5	136-163	54-148	500-900
Carotenoids (b-carotene)	0.3	0.3	0-5	0.9	1
Vitamin C (Ascorbic acid)	50	50	510	80	54
Vitamin E (tocopherol)	7	7	0	10	8.6

# Nutrient losses



- Nutrients are lost during cooking due to:
- Soluble nutrients dissolve in the cooking/soaking water *e.g.* sugars, water-soluble vitamins and minerals
- Heat and cooking medium pH changes affects certain nutrients
- Oxidation of vitamins
- Loss of various solids from the food



# Cooking water losses



- Some water soluble nutrients are: sugar, starch, B vitamins, ascorbic acid, minerals
- High solute concentrations
- Prolonged heating
- pH changes
- Oxidation of some vitamins



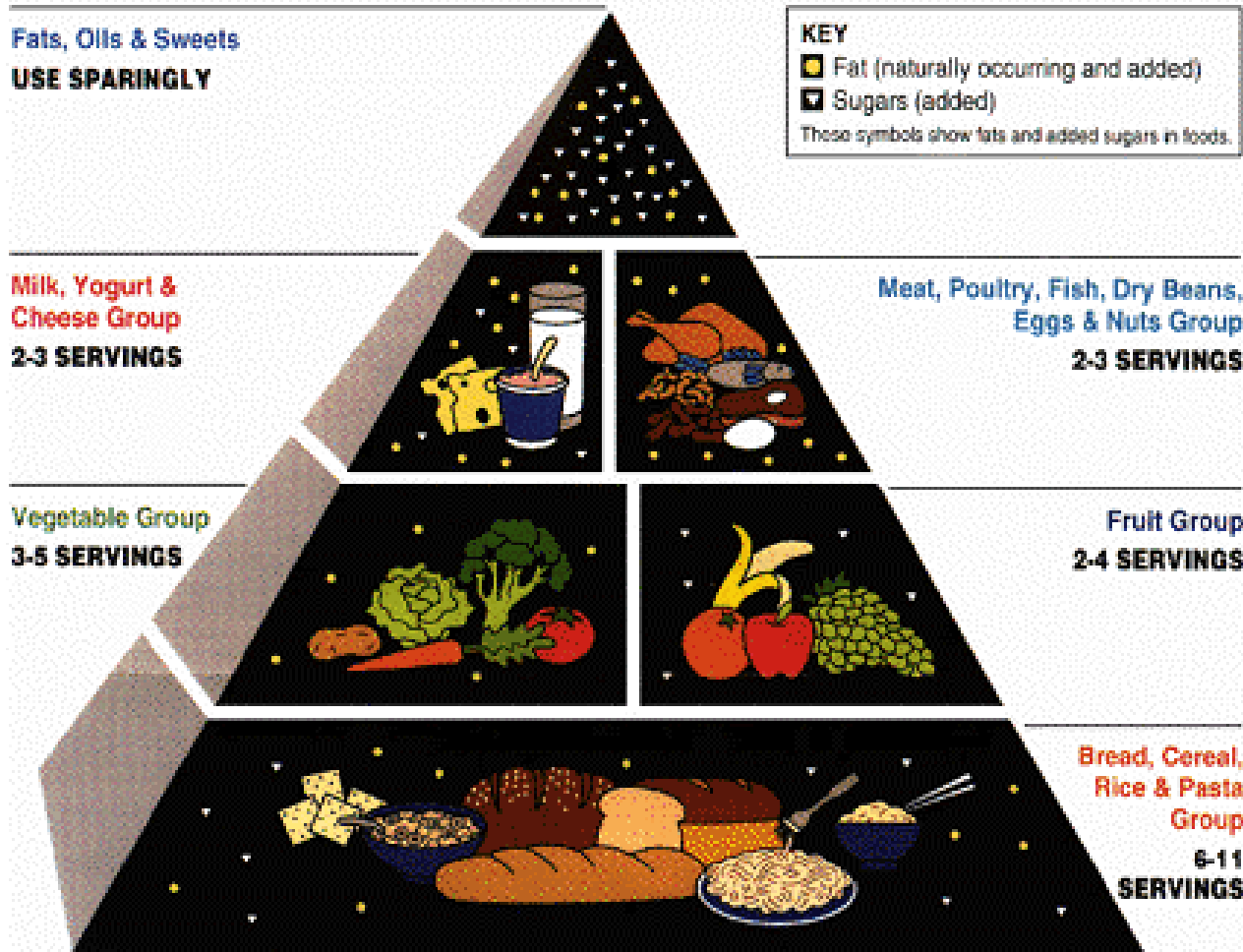
# 'Toxic' substances



- Oxalic acid in spinach
  - Could contribute to kidney stones, gout
- Goitrogens
  - In cabbage family, contribute to goitre
  - Not a problem in Australia as not enough eaten
  - Destroyed by cooking.



# Food Pyramid



USDA and the US Department of Health and Human Services

# How Many Fruits and Vegetables

- The Dietary Guidelines and the Food Guide Pyramid recommended 2 or more fruit servings, 3 or more vegetable servings, and 6 or more bread, cereal, rice, pasta or legume servings daily
- 5 a day campaign in the US





- Lecturer contact:

Ranjan.Sharma@OzScientific.com

