NMDM121
MEDICINAL FOOD SCIENCE

Session 8
Introduction to Functional Foods
Nutritional Medicine Department
Session Summary

• Explain what functional foods are and discuss the advantages and disadvantages associated with the consumption of functional foods.

• Define the following terms and identify good dietary sources:
  – Phytochemicals
  – Prebiotics
  – Probiotics
  – Antioxidants

• Discuss the advantages and cautions associated with using therapeutic juices as a source of phytochemicals.
Functional Foods

• In the past 20 years nutrition research has focused on both nutrients and other bioactive compounds and their role in disease prevention and risk reduction. This is in contrast to preceding decades in which deficiency diseases and the nutrients needed to cure these diseases were the central research focus.

• “Prescriptive eating,” which involves food selection based on the knowledge of healthy attributes ascribed to specific constituents within food, is one of the top 10 food trends among consumers.

(Academy of Nutrition and Dietetics, 2013)
Functional Foods

• The term “functional foods” is considered a marketing term by many and there is no consistent definition that is recognized globally by regulatory bodies.
• All food is essentially functional as it provides energy and nutrients needed to sustain life.
• However, there are a number of working definitions used to define functional foods (see next slide).
• “Nutraceuticals” is a term often used interchangeably with the term “functional foods.” However, the two terms are not interchangeable, as the term nutraceutical refers to nearly any bioactive component that delivers a health benefit, commonly in supplement form, and functional foods are only in food form.
## Functional Foods

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Working Definition of Functional Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academy of Nutrition and Dietetics</td>
<td>“Foods defined as whole foods along with fortified, enriched, or enhanced foods that have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels.”</td>
</tr>
<tr>
<td>International Food Information Council</td>
<td>“Foods or dietary components that may provide a health benefit beyond basic nutrition and may play a role in reducing or minimizing the risk of certain diseases and other health conditions.”</td>
</tr>
<tr>
<td>European Commission</td>
<td>“A food that beneficially affects one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either an improved state of health and well-being and/or reduction of risk of disease. It is part of a normal food pattern. It is not a pill, a capsule or any form of dietary supplement.”</td>
</tr>
</tbody>
</table>

(Academy of Dietetics and Nutrition, 2013)
Functional Foods

• Before 1995, the focus of the food industry was mainly on subtracting ingredients considered less healthy from processed foods in an effort to make foods healthier, e.g. low fat, sugar-free, etc.

• Functional foods, in contrast, shift the focus from eliminating less healthy ingredients to adding beneficial ingredients for similar effects.

• Functional food research holds many promises for improving the quality of life for consumers; however, to achieve such outcomes, scientific research must effectively establish the bioavailability and efficacy of these compounds at levels that are physiologically achievable under typical dietary patterns.
Functional Foods

Functional foods can be classified into three general categories:

• Conventional foods containing natural bioactive food compounds – e.g. isoflavones in soy-based foods, naturally occurring antioxidants in fruits and vegetables, probiotics in yoghurt.

• Modified foods containing bioactive food compounds through enrichment or fortification – e.g. omega-3 enriched eggs, sterol-enriched margarine or milk.

• Food ingredients that are synthesised, such as indigestible carbohydrates, which provide prebiotic benefits – e.g. gums produced by bacteria.

(Academy of Dietetics and Nutrition, 2013)
Functional Foods

Discussion/Reflection

• What are the advantages and disadvantages associated with the rise in popularity of functional foods?
Phytochemicals
Phytochemicals: Introduction

- Phytochemicals are biologically active substances found in plants in small amounts.

- Plants produce these chemicals to enable them to grow; to reproduce; to defend themselves against insects, pathogenic microorganisms, other plants and other threats; and to perform many other biological functions.

- Phytochemicals are not established as nutrients but, nevertheless, seem to contribute significantly to protection against degenerative and age-related diseases.
Phytochemicals: Introduction

- Increasing evidence suggests that increased consumption of plant-based foods plays an important role in reducing the risk of chronic diseases such as cardiovascular disease, cancer, type 2 diabetes, Alzheimer’s disease, cataract and age-related functional decline.
- Plant-based foods contain a range of nutrients as well as a vast array of phytochemicals.
- The health benefits associated with consuming plant-based foods are believed to be due to the synergistic effect between the many nutrients and phytochemicals.
Phytochemicals: Introduction

- There are thousands of individual dietary phytochemicals that have been identified in fruits, vegetables, whole grains, legumes, nuts and seeds so far, but there are also many that have not yet been identified.
- Each phytochemical often has many different biological activities so research in this area is complex.

http://www.med-health.net/images/10415758/image001.jpg
Phytochemicals: Introduction

- The mechanism of absorption of most phytochemicals is thought to involve a carrier, however, the complete absorptive processes have not been elucidated.

- Some phytochemicals that are not absorbed in the small intestine have been shown to undergo microbial degradation by colonic microflora.

- These differences in the metabolism of these thousands of phytochemicals in the body complicate the interpretation of research studies and the ability to make recommendations.

(Gropper, Smith & Groff, 2009)
Phytochemicals: Classification

- Phenolics
- Carotenoids
- Organosulphur compounds
- Phytosterols
- Alkaloids
- Nitrogen-containing compounds
Phytochemicals: Phenolics

- Phenolics (also called polyphenols) are found only in plants and certain fungal species and are not synthesised by animals or humans.
- The number of phenolic compounds identified in plant extracts has already exceeded 8000.
- Total dietary intake of phenolics could be as high as 1 gram/day – much higher than the other categories of phytochemicals.
- Phenolics are further classified into sub-groups as shown on the next slide.
- Flavonoids are the most abundant phenolics in the diet.
Phytochemicals: Phenolics

Phenolics (Polyphenols)

- Phenolic acids
- Flavonoids
- Stilbenes
- Lignans
- Others
Phytochemicals: Phenolics

(Han et al., 2007)
# Phytochemicals: Phenolics

Highest total phenolic content in common fruits and vegetables:

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wild blueberry</td>
<td>Spinach</td>
</tr>
<tr>
<td>Blackberry</td>
<td>Red capsicum</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>Beetroot</td>
</tr>
<tr>
<td>Cranberry</td>
<td>Broccoli</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Brussels sprouts</td>
</tr>
<tr>
<td>Plum</td>
<td>Eggplant</td>
</tr>
<tr>
<td>Raspberry</td>
<td>Asparagus</td>
</tr>
<tr>
<td>Strawberry</td>
<td>Green capsicum</td>
</tr>
<tr>
<td>Red grape</td>
<td>Yellow onion</td>
</tr>
<tr>
<td>Apple</td>
<td>Cauliflower</td>
</tr>
</tbody>
</table>

(Liu, 2013)
Phytochemicals: Phenolics

Phenolic Acids

• Hydroxybenzoic acids – e.g. ellagic acid, gallic acid:
  ➢ Food sources: strawberry, raspberry, grape juice and pomegranate juice.

• Hydroxycinnamic acids – e.g. caffeic acid, chlorogenic acid, ferulic acid:
  ➢ Food sources: apple, blueberry, cranberry, cherry, orange, lemon, grapefruit, spinach, coffee, tea, cider.
  ➢ Caffeic acid and chlorogenic acid have demonstrated antioxidant activity *in-vitro* and they may inhibit the formation of mutagenic and carcinogenic N-nitroso compounds.

(Han et al., 2007)
## Phytochemicals: Phenolics

### Flavonoids

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
<th>Good food sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavonols</td>
<td>Quercetin, kaempferol</td>
<td>Apples, onions</td>
</tr>
<tr>
<td>Flavones</td>
<td>Apigenin, luteolin</td>
<td>Celery, parsley</td>
</tr>
<tr>
<td>Flavanols</td>
<td>Catechin, epicatechin, epigallocatechin, EGCG</td>
<td>Green tea, cocoa, berries, apples and grapes</td>
</tr>
<tr>
<td>Flavanones</td>
<td>Naringenin, hesperetin</td>
<td>Lemons, orange, grapefruit</td>
</tr>
<tr>
<td>Anthocyanidins</td>
<td>Cyanidin, delphinidin, malvidin</td>
<td>Blackberries, blueberries, cherries, strawberries, plums, pomegranate, raspberries, black grapes</td>
</tr>
<tr>
<td>Isoflavonoids</td>
<td>Genistein, daidzein</td>
<td>Soy beans and soy products</td>
</tr>
</tbody>
</table>
Phytochemicals: Phenolics

Stilbenes

• The most well-studied stilbene is resveratrol – found in grapes (skins and seeds), grape juice, red wine and peanuts.

• *In-vitro* and animal studies suggest that resveratrol may have the following biological actions:
  - Neuroprotective
  - Anti-atherosclerosis and cardioprotective
  - Protective effect on endothelial cells and blood vessels
  - Anti-inflammatory
  - Antimutagenic and anticarcinogenic
  - Regulate cell cycle progression
  - Effects on signal transduction pathways

(Han et al., 2007)
Phytochemicals: Phenols

Lignans

- Lignans are found in a wide variety of plant foods including seeds (flax, sesame, sunflower, pumpkin), whole grains (rye, oats, barley), fruits (especially berries) and vegetables.
- When plant lignans are ingested they can be metabolised by intestinal bacteria to the mammalian lignans, enterodiol and enterolactone. These can mimic some of the effects of oestrogens.
- It is likely that individual differences in the metabolism of lignans influence the biological activities and health effects of these compounds.

(Higdon, 2007)
Phytochemicals

Lignans: Phytoestrogens

• The term phytoestrogen is generally used to define a class of compounds that is non-steroidal and is either of plant origin or metabolically derived from plant precursors.

• Hundreds of foods have been shown to contain phytoestrogens. The three classes of phytoestrogens are:
  ★ Isoflavones - found in legumes with soybeans and soy products being the major dietary source.
  ★ Lignans – found in high fibre foods such as whole grains with flaxseed and sesame seed being good sources; also found in berries.
  ★ Coumestans – highest amounts found in alfalfa and clover sprouts.

(Bedell et al., 2014)
Phytochemicals

Lignans: Phytoestrogens

• After the consumption of plant isoflavones, lignans and coumestans, enzymatic metabolic conversions occur in the gut, resulting in the formation of heterocyclic phenols.

• These compounds structurally resemble oestrogen and have weak oestrogenic activity. However, they are all selective oestrogen receptor modulators (SERMs) and each has a profile of action of its own.

• SERMs are defined as a group of compounds that behave like oestrogen agonists in certain tissues, and like antagonists in others.

(Bedell et al., 2014)
Phytochemicals

Lignans: Phytoestrogens

• Because phytoestrogens act as SERMs there is interest in their potential role in helping to manage menopausal symptoms and reducing the risk associated with reproductive cancers.

• The research literature can be difficult to evaluate because the clinical outcomes may be related to an individual’s ability to metabolise phytoestrogens effectively.

• Soy isoflavones are discussed further in Session 15: Pulses and grains and lignans are discussed further in Session 20: Nuts, seeds and oils.
Phytochemicals: Carotenoids


Phytochemicals: Carotenoids

- Carotenoids are a class of > 600 naturally occurring pigments synthesised by plants, algae and photosynthetic bacteria.
- They are responsible for the yellow, orange and red colours of many fruits and vegetables such as red capsicums, carrots, apricots and tomatoes.
- Leafy green vegetables can also be a good source of carotenoids but chlorophyll masks their colours.
- Carotenoids play essential functions in photosynthesis and photoprotection in plants. The photoprotection role is due to their ability to quench reactive oxygen species, especially singlet oxygen, which is formed from exposure to light and radiation (Liu, 2013).
Phytochemicals: Carotenoids

• Humans and animals are not able to synthesise carotenoids; however, carotenoids are present in blood and tissues.

• Of the > 600 carotenoids only about 50 are constituents of the human diet, while only ~20 are present in human blood and tissues.

• The most important include: β-carotene, α-carotene, lycopene, lutein, zeaxanthin, β-cryptoxanthin, α-cryptoxanthin, γ-carotene, neurosporene, ζ-carotene, phytofluene and phytoene - all present in human plasma.

• Carotenoids, as highly lipophilic molecules, are typically located inside cell membranes.

(Fiedor & Burda, 2014)
Phytochemicals: Carotenoids

Carotenoids

Provitamin A:
- $\alpha$-carotene
- $\beta$-carotene
- $\beta$-cryptoxanthin

Non Provitamin A:
- Lycopene
- Lutein
- Zeaxanthin
Phytochemicals: Carotenoids

- Carotenoids accumulate mostly in the liver and adipose tissue.
- Relatively high amounts have also been reported for the adrenal gland, corpus luteum, testes, skin and retina (macula).
- Concentration in brain stem tissue was below the detection limit.

(Fiedor & Burda, 2014).

www.taste.com.au
Phytochemicals: Carotenoids

• A review of the recent evidence suggests that:
  ➢ Carotenoid intake and status are relatively consistently associated with reduced CVD risk.
  ➢ Increased lycopene intake may reduce prostate cancer progression with a potential role for carotenoids at other cancer sites.
  ➢ Lutein and zeaxanthin have a plausible role in the maintenance of eye health.
  ➢ An association between carotenoid intake and cognitive and physical health seems possible, although research is limited to date.

(Woodside et al., 2014)
Phytochemicals:
Organosulphur Compounds

Organosulphur compounds

Glucosinolates
Present in Brassicaceae vegetables such as broccoli, cabbage, etc.

Allylic Sulphur Compounds
Present in Liliaceae vegetables such as onion, garlic, etc.
Phytochemicals

Organosulphur Compounds

• Glucosinolates in cruciferous vegetables are converted into bioactive indoles and isothiocyanates when plant cells are crushed through chopping or chewing and the enzyme, myrosinase, is released.

• Some of the actions associated with the bioactive sulphur compounds from cruciferous vegetables include:
  – Upregulation of phase II liver detoxification enzymes
  – Anticarcinognenic effects
  – Potential beneficial effects on oestrogen metabolism
Phytochemicals

Organosulphur Compounds

• When raw garlic cloves are crushed, chopped or chewed, an enzyme called alliinase catalyses the conversion of alliin (S-allylcysteine sulfoxide) into allicin.

• Garlic has the following actions (based on *in-vitro* and animal studies):
  – Antimicrobial activity
  – Induces apoptosis in cancer cells
  – Immune modulation
  – Cholesterol-lowering effects
  – Blood pressure-lowering effects
  – Anti-thrombotic

*(Borlinghaus et al., 2014)*
Phytochemicals

Phytosterols

• Phytosterols are plant-derived sterols that are similar in structure to cholesterol.
• There is increasing evidence that reintroducing plant foods that provide phytosterols into the modern diet can improve serum lipid profiles and reduce the risk of CVD.
• The most abundant phytosterols in the diet are sitosterol and campesterol.
• Hunter-gatherer diets were rich in phytosterols – likely providing as much as 1000 mg per day.
• Modern dietary intake has been estimated to vary from 150-450 mg/day.

(Higdon, 2007)
## Phytochemicals

### Phytosterols

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving</th>
<th>Phytosterols (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat germ</td>
<td>½ cup</td>
<td>197</td>
</tr>
<tr>
<td>Canola oil</td>
<td>1 Tbspn</td>
<td>91</td>
</tr>
<tr>
<td>Peanuts</td>
<td>30 g</td>
<td>62</td>
</tr>
<tr>
<td>Almonds</td>
<td>30 g</td>
<td>34</td>
</tr>
<tr>
<td>Brussels sprouts</td>
<td>½ cup</td>
<td>34</td>
</tr>
<tr>
<td>Rye bread</td>
<td>2 slices</td>
<td>33</td>
</tr>
<tr>
<td>Olive oil</td>
<td>1 Tbspn</td>
<td>22</td>
</tr>
</tbody>
</table>

(Higdon, 2007)
Phytochemicals

Alkaloids and Others

- **Alkaloids**
  - Often bitter-tasting
  - Many alkaloids can be toxic
  - Example, caffeine

- **Nitrogen-containing compounds**
  - Examples include betalains, melatonin
Phytochemicals
Chlorophyll

- Chlorophyll is the pigment that gives plants and algae their green colour.
- Plants use chlorophyll to trap light needed for photosynthesis.
- The basic structure of chlorophyll is a porphyrin ring similar to that of heme in haemoglobin, although the central atom on chlorophyll is magnesium instead of iron.
- Little is currently known about the bioavailability and metabolism of chlorophyll.
- May have a cancer protective effect by forming tight molecular complexes with carcinogenic compounds such as polyaromatic hydrocarbons, heterocyclic amines and aflatoxins, interfering with their absorption.

(Higdon, 2007)
## Phytochemicals: Examples

<table>
<thead>
<tr>
<th>Phytochemical Class</th>
<th>Phytochemicals</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenolic Acids</td>
<td>Hydroxycinnamic acids: caffeic, ferulic, chlorogenic, neochlorogenic</td>
<td>Blueberry, cherry, pear, apple, orange, grapefruit, white potato, coffee bean, raspberry, strawberry, grape juice</td>
</tr>
<tr>
<td>Anthocyanins</td>
<td>Cyanidin, delphinidin, malvidin</td>
<td>Berries, cherries, red and purple grapes, red cabbage, red onion</td>
</tr>
<tr>
<td>Carotenoids</td>
<td>B-carotene, a-carotene, lutein, lycopene</td>
<td>Tomato, pumpkin, squash, carrot, watermelon, papaya, guava</td>
</tr>
<tr>
<td>Glucosinolates</td>
<td>Glucobrassicin, gluconapin, sinigrin, glucobrassicin</td>
<td>Cruciferous vegetables: Broccoli, cabbage, Brussels sprouts, mustard, watercress</td>
</tr>
<tr>
<td>Organosulphides</td>
<td>Diallyl sulphide, allyl methyl sulphide, S-alllylcysteine</td>
<td>Garlic, onions, leeks</td>
</tr>
<tr>
<td>Lignans</td>
<td>Secoisolariciresinol, mataresinol</td>
<td>Berres, flaxseed/oils, nuts, rye bran</td>
</tr>
<tr>
<td>Isoflavonoids</td>
<td>Genistein, daidzein</td>
<td>Soy beans and soy bean products</td>
</tr>
<tr>
<td>Phytosterols</td>
<td>B-sitosterol, campesterol, stigmasterol</td>
<td>Vegetable oil (soy, rapeseed, corn, sunflower)</td>
</tr>
<tr>
<td>Chlorophyll</td>
<td>Chlorophyll a and chlorophyll b</td>
<td>Spinach, parsley, green beans, kale, chlorella</td>
</tr>
</tbody>
</table>

(Adapted from Gropper, Smith & Groff, 2009; Higdon, 2007)
Prebiotics
Prebiotics

• Prebiotics were first defined as: “nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, thus improving host health.”

• This definition was later refined to include other areas that may benefit from selective targeting of particular microorganisms: “a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora, that confer benefits.”

(Slavin, 2013)
Prebiotics

Classification of a food ingredient as a prebiotic requires scientific demonstration that the ingredient:

- Resists gastric acidity, hydrolysis by mammalian enzymes, and absorption in the upper gastrointestinal tract;
- Is fermented by the intestinal microflora;
- Selectively stimulates the growth and/or activity of intestinal bacteria potentially associated with health and well-being.

(Slavin, 2013)
Prebiotics

• Prebiotics occur naturally in a wide range of plant foods or they are also available as supplements.

• Fructooligosaccharides (FOS) have been shown in human trials to have prebiotic effects.

• Foods that are good sources of FOS include: asparagus, onion, leek, garlic, artichoke, Jerusalem artichokes and chicory root.

  (Hawrelak, 2002)
Prebiotics

Summary of the main physiological and patho-physiological targets for prebiotic effects, i.e. effects associated with a selective stimulation of growth and/or activity(ies) of one or a limited number of gut microorganisms:

- Improvement and/or stabilisation of gut microbiota composition.
- Improvement of intestinal functions (stool bulking, stool regularity, stool consistency).
- Increase in mineral absorption and improvement of bone health (bone Ca content, bone mineral density).
- Modulation of gastrointestinal peptides production, energy metabolism and satiety.

Continued on next slide

(Roberfroid et al., 2010)
Prebiotics

Continued from previous slide

• Initiation (after birth) and regulation/modulation of immune functions.
• Improvement of intestinal barrier functions, reduction of metabolic endotoxemia.
• Reduction of risk of intestinal infections.

And tentatively:

• Reduction of risk of obesity, type 2 diabetes, metabolic syndrome, etc.
• Reduction of risk and/or improvement in the management of intestinal inflammation.
• Reduction of risk of colon cancer.

(Roberfroid et al., 2010)
Prebiotics

- Analysis of well-preserved coprolites suggest that dietary intake of inulin was about 135 g/day for the typical adult male hunter-forager.
- Consumption in typical US and European diets has been estimated to be several grams per day.
- Inulin, oligofructose, and FOS have been extensively studied as prebiotics, and have been shown to significantly increase faecal *bifidobacteria* at fairly low levels of consumption (5–8 g per day).

(Slavin, 2013)
Probiotics
Probiotics

- Probiotics are defined by FAO/WHO as “living microorganisms, which, upon ingestion in certain numbers, exert health benefits beyond inherent basic nutrition.”
- Some fermented foods fit the definition of a probiotic, however, not all fermented foods meet the definition.
- Probiotics also come in the form of supplements such as powders, capsules or liquids.
- The idea that bacteria might be beneficial to human health was suggested by Elie Metchnikoff at the beginning of the 20th century. He hypothesised that the health and longevity of Bulgarian peasants might be related to their consumption of fermented milk products.
Probiotics

• The term ‘probiotic’ should only be used for foods or products that deliver live microorganisms with a suitable viable count of well-defined strains with a reasonable expectation of delivering benefits for the wellbeing of the host (Hill et al., 2014).

• Microorganisms are named according to genus, species and strain, for example:
  – *Lactobacillus acidophilus* LA5 where *Lactobacillus* is the genus, *acidophilus* is the species and LA5 is the strain.
  – *Lactobacillus rhamnosus* GG where *Lactobacillus* is the genus, *rhamnosus* is the species and GG is the strain.
Probiotics

• The effects of probiotics may be due to various mechanisms of action, including suppressing growth of pathogenic bacteria, blocking epithelial attachment by pathogens, enhancing mucosal function, and modulating host immune response.

• Probiotics are now widely marketed in the form of capsules, powder and functional foods such as fermented milks and yoghurts.

(Pham, Lemberg & Day, 2008)
Probiotics

There is a vast amount of literature on probiotics. Some of the conditions which have evidence to support beneficial effects from specific strains of microorganisms include:

• Diarrhoea – infectious childhood, antibiotic associated.
• IBD – pouchitis, ulcerative colitis
• IBS
• Allergy prevention

(Floch, 2014)
Antioxidants
Antioxidants

- The body’s natural defence and repair systems try to control the destruction caused by free radicals; however, they can become less effective with age or chronic disease resulting in oxidative stress which can further contribute to an array of health problems.

- Antioxidants neutralise free radicals by donating one of their own electrons.

- Researchers have identified oxidative stress as a causative factor, and antioxidants as a protective factor, in the development of an array of chronic conditions.

(Whitney & Rolfes, 2008)
Free Radical Damage

PUFA → Lipid Radicals

DNA & RNA → Altered DNA & RNA

Altered DNA & RNA → Absence of specific proteins, Excess specific proteins

Absence of specific proteins, Excess specific proteins → Altered proteins

Altered proteins → Impaired cell function, Inflammatory response

Impaired cell function, Inflammatory response → Cell damage, Diseases, Ageing

Adapted from Whitney & Rolfes, 2008
Antioxidants

Source: http://www.healthfruit.com/m/science/antioxidants
Oxidative Stress

(Saldanha et al., 2013)
Antioxidants

- Vitamin C
- Vitamin E and mixed tocopherols
- Beta-carotene and other carotenoids
- Vitamin A (animal food)
- Selenium
- Zinc
- Manganese

- Glutathione (triple amino acid- glutamic acid, glycine, cysteine)
- Lipoic acid
- Methionine, cysteine (sulphur amino acids)
- Glutamine
- Many phytochemicals – e.g. anthocyanins, quercetin, chlorogenic acid, resveratrol, etc.
Antioxidants

Reactive oxygen species (ROS) are necessary for a number of protective reactions. ROS are essential mediators of:

- Antimicrobial phagocytosis.
- Detoxification reactions carried out by the cytochrome P-450 complex.
- Apoptosis which eliminates cancerous and other damaged cells.
Therapeutic Juices

Therapeutic Juices

• Fresh juices are used by holistic nutritionists as a way to deliver a complex array of nutrients and phytochemicals in a concentrated form.
• Even though fibre is beneficial for health, bioavailability of some constituents can be enhanced when fibre is removed as it is by juice extractors.
• Juices should be consumed fresh – as soon as possible after juicing. If juice can’t be consumed immediately then store in the fridge and add an antioxidant such as vitamin C, lemon juice or turmeric.
• Use fresh, organically grown produce for fresh juices.
Therapeutic Juices

Juice Extractors

- It is best to use a non-centrifugal juicer (masticating style or cold-pressed style) as these types of juicers:
  - Extract higher levels of nutrients and phytochemicals from fruits and vegetables.
  - Produce juice that oxidises more slowly.
Therapeutic Juices: Examples

<table>
<thead>
<tr>
<th>Fruit/Vegetable</th>
<th>Traditional therapeutic use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucumbers with skin</td>
<td>Hair, nails and skin</td>
</tr>
<tr>
<td>Beetroot</td>
<td>Hepatoprotective, haematopoiesis</td>
</tr>
<tr>
<td>Cherry</td>
<td>Gout</td>
</tr>
<tr>
<td>Radish</td>
<td>Biliary disease</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Gastric ulcers</td>
</tr>
<tr>
<td>Watercress</td>
<td>Diluted with water – intestinal cleanser and toxin neutraliser</td>
</tr>
</tbody>
</table>

These are just a few examples of traditional uses of juices. Juices are usually formulated from a combination of ingredients. Now that research into phytochemicals has expanded juice combinations can be developed by drawing on the latest research as well as traditional knowledge.
Therapeutic Juices: Cautions

- Fruit and sweet vegetable (such as carrot and beetroot) juices can be high in kilojoules and high in naturally occurring sugars.
- Some fruits and vegetables contain organic acids which may erode tooth enamel (consider using a straw).
- Excessive quantities of potentially toxic compounds could be consumed:
  - e.g. goitrogenic compounds from cruciferous vegetables or oxalates from spinach and silverbeet.
Therapeutic Juices: Cautions

• There has been a case report of a man with chronic kidney disease stage 3 consuming high oxalate juices for 6 weeks as well as taking additional vitamin C, 2 grams daily combined with a low calcium intake.

• He had acute renal failure with a high serum oxalate level and required temporary hemodialysis. Fortunately, he recovered his kidney function partially, but had a loss of glomerular filtration rate by 14 mL/min due to the juicing program.

• For over 6 weeks, he had taken a daily average of 1260 mg oxalate from beets, collard greens, kiwi, parsley, spinach, and soy products.

(Lien, 2013)
Session Summary

• Explain what functional foods are and discuss the advantages and disadvantages associated with the consumption of functional foods.
• Define the following terms and identify good dietary sources:
  – Phytochemicals
  – Prebiotics
  – Probiotics
  – Antioxidants
• Discuss the advantages and cautions associated with using therapeutic juices as a source of phytochemicals.
References


References


References


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