Session 16
FAT SOLUBLE VITAMINS
PART 2

Naturopathic Medicine
Department
Activity

• View the following video to revise vitamin A and D from last session and as an introduction to vitamin E and K.

http://www.youtube.com/watch?v=BE4V4vad4Rc
(13 mins)
Topic Summary

• Fat Soluble Vitamins
  • Vitamin K
  • Vitamin E
    • Structure and requirements
    • Functions and metabolism
    • Therapeutic uses
    • RDI
Vitamin K

http://commons.wikimedia.org/wiki/File:Vitamin_K_allgemein.svg
## Vitamin K

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount</th>
<th>Vitamin K (mcg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>½ cup</td>
<td>200</td>
</tr>
<tr>
<td>Spinach, raw</td>
<td>½ cup</td>
<td>106</td>
</tr>
<tr>
<td>Avocado</td>
<td>1 fruit</td>
<td>80.4</td>
</tr>
<tr>
<td>Pistachio nuts</td>
<td>½ cup</td>
<td>42.6</td>
</tr>
<tr>
<td>Soy bean oil</td>
<td>1 tbsp</td>
<td>26.2</td>
</tr>
</tbody>
</table>
Vitamin K

• General term for several related compounds with vitamin K activity.

• There are two principal forms of vitamin K
  • Vitamin K1 (phylloquinone) found in plant foods
  • Vitamin K2 (menaquinone) derived from animal and bacterial sources

• Bacteria in the human colon synthesise menaquinones, which can be absorbed, and partially meet requirements for vitamin K

(Zimmerman, 2001)
Functions

• Carboxylation reactions → binds Ca to molecules
  • Blood coagulation
    ➢ Activates thrombin (enzyme required to convert fibrinogen to fibrin) through carboxylation (adds carboxyl to amino acids).
    ➢ Needs to be reduced (to KH$_2$) by NADPH before being utilised.

• Synthesis of bone and teeth
• Suppresses calcification of soft tissues
Functions

- Vitamin K
- Calcium and thromboplastin (a phospholipid) from blood platelets
- Fibrinogen (a soluble protein)

Several precursors earlier in the series depend on vitamin K

Prothrombin (an inactive protein)

Thrombin (an active enzyme)

Fibrin (a solid clot)
Functions

• Kidney function
  • Involved in production of a protein which may inhibit the formation of kidney stones

• Retinal function
  • Prevents retinal degeneration

• Sulphur and prostaglandin metabolism
  • Supports sulphur metabolism in the brain
  • Inhibits prostaglandin production in bone

(Kohlmeier, 2003)
Factors Increasing Demand

- Liver disease
  - Affects storage and recycling
- Alcohol
  - Limits activation through liver
- Drugs
  - Antibiotics, warfarin
  - Fat malabsorption
- Newborns
  - Issues with synthesis and intake
- Vitamin E supplementation
Deficiency Symptoms

- Excessive bleeding (Heimburger 2006)
- Easy bruising (Cornelissen et al, 1997)
- Hypoprothrombinemia
- Haemorrhage
- Bone weakness

Newborn infants receive a single dose of vitamin K at birth because of a sterile intestinal tract. (Shils et al, 2006)
Toxicity

- Uncommon
- Usually non-toxic
  - Phylloquinone is nontoxic
  - Menadione may cause toxicity
    - Hemolytic anemia
    - Hyperbilirubinemia
    - Kernicterus
- High doses decrease the effectiveness of anticlotting medications.
Therapeutic Uses

• Osteopenia
  • Vitamin K stimulates renal calcium absorption and prevents bone loss, whilst stimulating bone gain (Iwamoto et al, 2003)
  • May not be relevant after hysterectomy (Binkley et al, 2002) unless combined with vitamin D (Kamezawa, 1999)

• Haemorrhage

• Cystic Fibrosis (Wilson 2001)
Vitamin K2 and Bone

Emerging research shows:

- Vitamin K2 deficiency results in decreased levels of active osteocalcin (protein which helps bind calcium to bone matrix), which increases risk for fragile bones (Booth et al. 2004).
- Vitamin K2 combined with calcium and vitamin D can decrease bone turnover (Schurgers et al. 2007).
- A significant study clearly demonstrated that vitamin K2 is essential for maintaining bone strength in postmenopausal women, and also improved bone mineral content (Knapen et al 2007).
Adequate Intake AI

- Men: 70mcg
- Women: 60mcg
- Therapeutic range (adult) 2 to 5mg.
Review Questions

1. List the foods highest in Vitamin K
2. How is Vitamin K synthesised endogenously?
3. What are the main known functions of Vitamin K?
4. Which factors may increase the demand for Vitamin K intake?
5. How might we recognise a Vitamin K deficiency?
Activity

- Patients prescribed ‘warfarin’, a blood thinning medication, are sometimes recommended to avoid green leafy vegetables.
  - Why would this be the case?
  - What potential drawbacks to this suggestion can you envisage given what you have so far learned in this course?

- Discuss your thoughts initially in small groups then with the class group

- Online students should discuss their views within the online discussion forum
Vitamin E - Tocopherol

http://commons.wikimedia.org/wiki/File:VitaminE.png
## Vitamin E - Tocopherol

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount</th>
<th>Vitamin E (mg αTE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheatgerm oil</td>
<td>1 tbsp</td>
<td>26.2</td>
</tr>
<tr>
<td>Wheatgerm cereal</td>
<td>1 cup</td>
<td>19.5</td>
</tr>
<tr>
<td>Sunflower seeds</td>
<td>¼ cup</td>
<td>17.2</td>
</tr>
<tr>
<td>Hazel nuts</td>
<td>½ cup whole</td>
<td>15.4</td>
</tr>
<tr>
<td>Soy beans cooked</td>
<td>1 cup</td>
<td>3.19</td>
</tr>
<tr>
<td>Safflower oil</td>
<td>1 tbsp</td>
<td>4.69</td>
</tr>
<tr>
<td>Avocado</td>
<td>1 fruit</td>
<td>2.69</td>
</tr>
<tr>
<td>Spinach, cooked</td>
<td>1 cup</td>
<td>1.63</td>
</tr>
<tr>
<td>Broccoli</td>
<td>½ cup, chopped</td>
<td>1.25</td>
</tr>
<tr>
<td>Peaches</td>
<td>1 medium</td>
<td>0.69</td>
</tr>
<tr>
<td>Eggs</td>
<td>1 large</td>
<td>0.53</td>
</tr>
</tbody>
</table>
Vitamin E

- Collectively refers to 8 different compounds with similar structures.
- Found in both plant and animal products, particularly vegetable oils, nuts and seeds.
- Easily destroyed during food preparation, processing and storage.
- Aim to preserve - by heating as little as possible and storing in airtight containers.
Vitamin E

• Four different tocopherol compounds, the alpha-tocopherol being most common.
  • Unlike A and D being stored in the liver, E is stored in adipose tissue

• Tocols/Tocopherols
  • Saturated side chains
  • Found in leafy plant foods
  • Low levels in animal fat

• Tocotrienols
  • Unsaturated side chains
  • Found in bran and germ section of cereals
Functions

• Lipid antioxidant
  • Regeneration requires vitamin C, glutathione and NADPH
  • Maintains membrane PUFA integrity

The regeneration of vitamin E  (Taken from Groff & Gropper)

© Endeavour College of Natural Health
endeavour.edu.au
Functions

• Fertility
  • Required for healthy oocyte production and placental function

• Cardiovascular health
  • Prevents smooth muscle cell proliferation
  • Inhibits cell adhesion
  • Inhibits platelet aggregation
  • Vasodilator
Functions

• Cell signaling
  • Smooth muscle contraction
  • Signal transduction cascades
  • Maintain longterm activation

• Immune modulator
  • T Helper synthesis

• Inflammation
  • Inhibits 5-lipoxygenase

(Kohlmeier, 2003)
Factors Increasing Demand

- Refined foods
- Consumption of polyunsaturated fatty acids
- Oxidative stress
- Vitamin C or Se deficiencies
- Fat malabsorption
- Newborns
Deficiency Symptoms

• Pathogen mutations from benign virus (Kohlmeier, 2003)
• Erythrocyte haemolysis, haemolytic anaemia (Johnson 1974)
• Peripheral neuropathy (Gibson 2005)
• Oedema (Shenkin 2006)
• Balance disturbances (Kalra 1998)
• Dryness and depigmentation in premature infants (Ryan 1996)
AI

- No RDI, only AI
- AI Males = 10mg/day
- AI Females = 7mg/day
- Infant = 4-5mg/day
- Children 1-3 years = 5mg/day
- UL 300mg/day
Toxicity

- Rare and the least toxic of the fat-soluble vitamins.
- May augment the effects of anti-clotting medication.
- Prolonged high doses (>400IU/day) may increase risk of all-cause mortality (Miller 2005)
- >3000mg/day
  - Hematologic disease
  - Gastrointestinal distress
  - Muscle weakness, fatigue
  - Double vision
Therapeutic Uses

• CVD
  • protects lipid peroxidation (Yang et al, 2004)
  • Anti-inflammatory (Rolfes 2012)
• Anti-coagulant (Booth et al, 2004)
• Hepatitis C
  • Improves PUFA levels in blood (Ota et al, 2004)
  • Important adjuvant use with interferon (Murakami et al, 2006)
• Insulin resistance
  • Associated with lipid peroxidation in cell membranes (Tsujinaka et al, 2005)
Therapeutic Uses

• Skin
  • May protect against UVB exposure induced wrinkles, with vitamin C and EPO (Cho 2007)
  • Correlation between severity of acne vulgaris and levels of vitamin E and zinc (Ozuguz 2013)
  • Protective against UV induced acute and chronic sun damage as indicated by less inflammation and pigmentation in mouse model (Burke 2000)
Review Questions

1. List the foods highest in Vitamin E
2. What are the 2 major classes of vitamin E?
3. What are the main known functions of Vitamin E?
4. How might we recognise a Vitamin E deficiency?
5. What has been vitamin E been utilised for therapeutically in the research?
6. What is the documented caution surrounding the use of supplemental vitamin E?
Activity

• Consider your vitamin E intake from the previous 2 diet diaries you have entered into your diet analysis programme and answer the following questions –

1. Are there any notable differences between the 24 hour and 3 day average intake?
2. Would you recommend increased intakes from the RDI?
3. If so what is your rationale behind this? Think specific and patient related and also from a more general context
4. Is there any specific dietary recommendations you would make to optimise your intake? Include specific food choices and quantities to reach your target.
References

- Burke et al. 2000. Effects of topical and oral vitamin E on pigmentation and skin cancer induced by ultraviolet irradiation in Skh:2 hairless mice. *Nutr Cancer* 38:1; 87-97
References


• Drinka, P.J., (2006) The Importance of Parathyroid Hormone and Vitamin D Status in the Treatment of Osteoporosis and Renal Insufficiency. *Journal of the American Medical Directors Association*, 7(Supplement 1), S5-S9


References


References


References

References

COMMONWEALTH OF AUSTRALIA
Copyright Regulations 1969

WARNING

This material has been reproduced and communicated to you by or on behalf of the Australian College of Natural Medicine Pty Ltd (ACNM) trading as Endeavour College of Natural Health, FIAFitnation, College of Natural Beauty, Wellnation - Pursuant Part VB of the Copyright Act 1968 (the Act).

The material in this communication may be subject to copyright under the Act. Any further reproduction or communication of this material by you may be the subject of copyright protection under the Act.

Do not remove this notice.