NMDF121

Session 13
WATER SOLUBLE VITAMINS PART 3

Naturopathic Medicine Department
Topic Summary

- B Vitamins
  - Vitamin B3
  - Vitamin B5
  - Biotin
Activity

- View the following video on B complex vitamins (2 mins)
  
  http://www.youtube.com/watch?v=72Obfr0tT6k
Niacin - Vitamin B₃

Nicotinic Acid

Nicotinamide

http://upload.wikimedia.org/wikipedia/commons/f/f8/Niacin.png
## Vitamin B₃

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount</th>
<th>Niacin (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuna, canned</td>
<td>100g</td>
<td>11.7</td>
</tr>
<tr>
<td>Lamb liver</td>
<td>100g</td>
<td>12.2</td>
</tr>
<tr>
<td>Peanuts, salted</td>
<td>½ cup</td>
<td>8.8</td>
</tr>
<tr>
<td>Chicken, roast</td>
<td>100g</td>
<td>7.9</td>
</tr>
<tr>
<td>Lamb, cooked</td>
<td>100g</td>
<td>6.6</td>
</tr>
<tr>
<td>Wheatgerm</td>
<td>½ cup</td>
<td>3.9</td>
</tr>
<tr>
<td>Kidney beans</td>
<td>1 cup</td>
<td>3.0</td>
</tr>
<tr>
<td>Corn</td>
<td>1 cup</td>
<td>2.6</td>
</tr>
</tbody>
</table>
Vitamin B₃

• Niacin is generic term for nicotinic acid and nicotinamide

• Both forms can be absorbed in the stomach, but are more readily absorbed in the small intestine.
  • In some foods, such as corn, niacin may be tightly bound to small peptides, decreasing bioavailability. (Groff, Smith & Gropper, 2004)

• Although resistant to heat, may be leeched out of food in water
Vitamin B₃

• Synthesised in liver from tryptophan ~3%

• 1mg of niacin is produced from ingestion of 60mg of dietary tryptophan
  • Vitamins B2, B6 and Fe required for conversion of tryptophan → NAD.
  • Deficiency of any of these factors can impair NAD synthesis.
Functions

• NAD and NADP enzyme cofactor (~200 enzymes)
  • ATP production
  • Insulin receptor function
  • Alcohol dehydrogenase
  • Synthesis of fatty acids, cholesterol and steroid hormones
  • Calcium signaling
  • DNA synthesis and repair
Factors Increasing Demand

• Dietary deficiency of niacin or protein
  • Vitamin $B_6$ deficiency impairs conversion from tryptophan
• Inflammatory bowel disease
• Alcohol consumption
• Medications
  • Antituberculosis
  • Sedative/anticonvulsant - Phenobarbitol
• Hartnup syndrome
  • Reduced conversion from tryptophan

(Shils et al, 2006)
Deficiency Symptoms

- **Pellagra**
  - Characterised by the 4 D’s
    - Dermatitis
    - Dementia
    - Diarrhoea
    - Death
Deficiency Symptoms

- Photophobia
- Abdominal pain, diarrhoea; Digestive disturbances, indigestion
- Glossitis; Bright red painful ‘raw beef’ tongue with fissures
- Fatigue and weakness; Depression
- Symmetrical dermatitis on dorsal surface of hands with erythema, slight oedema, pruritus and burning (Ryan 1999)
- Cheilosis/ chelitis (Pencharz 1982)
- Anxiety (Gibson 2005)
Toxicity

• Niacin flush can occur with relatively low doses, as little as 50mg depending upon chemical form and individual factors (MacKay et al 2010).

• Flushing does occur at therapeutic dosages of 1500-2000 per/day used for CVD risk reduction
  • Consuming with meals and aspirin can reduce (Reavley 1998, Papaliodis 2008)

• Liver toxicity reports with use of slow-release unregulated supplements (Guyton 2007)

• Other symptoms:
  • Impaired glucose tolerance
  • Nausea and vomiting (Whitney 2011)
• Therapeutic Range 100-3000mg

RDI

<table>
<thead>
<tr>
<th>Age</th>
<th>EAR (as niacin equivalents)</th>
<th>RDI (as niacin equivalents)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td></td>
</tr>
<tr>
<td>19-30 yr</td>
<td>12 mg/day</td>
<td>16 mg/day</td>
</tr>
<tr>
<td>31-50 yr</td>
<td>12 mg/day</td>
<td>16 mg/day</td>
</tr>
<tr>
<td>51-70 yr</td>
<td>12 mg/day</td>
<td>16 mg/day</td>
</tr>
<tr>
<td>&gt;70 yr</td>
<td>12 mg/day</td>
<td>16 mg/day</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td></td>
</tr>
<tr>
<td>19-30 yr</td>
<td>11 mg/day</td>
<td>14 mg/day</td>
</tr>
<tr>
<td>31-50 yr</td>
<td>11 mg/day</td>
<td>14 mg/day</td>
</tr>
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<td>14 mg/day</td>
</tr>
<tr>
<td>&gt;70 yr</td>
<td>11 mg/day</td>
<td>14 mg/day</td>
</tr>
</tbody>
</table>

NHMRC, 2009
Therapeutic Uses

• CVD
  - Reverse thickening of lining of carotid artery, increase HDL, reduce triglycerides, improve endothelial function and decrease vascular inflammation (Thoenes, 2007)

• Gastric acid secretion
  - Promotes histamine release (Prouskey and Kerwin, 2002)

• Post-ischemic injury
  - Reduces size of infarction and improves recovery (Hoane et al, 2003)

• Peripheral vascular disease
  - Lowers fibrinogen levels (Phillip et al, 1998)

• Skin cancer
  - Prevents photoimmunosuppression (Gensler et al, 1999)
Review Questions

1. List the foods highest in niacin
2. What are the main functions of niacin?
3. Which factors may increase the demand for niacin intake?
4. How might we recognise a niacin deficiency?
5. From which substance can niacin be synthesised endogenously?
6. How has B3 been utilised therapeutically in the research?
Pantothenic Acid - Vitamin B$_5$

http://commons.wikimedia.org/wiki/File:Pantothenic_acid_structure.svg
## Vitamin B₅ – Pantothenic Acid

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount</th>
<th>Pantothenic Acid (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef liver, cooked</td>
<td>85g</td>
<td>5.03</td>
</tr>
<tr>
<td>Avocado</td>
<td>1 avocado</td>
<td>1.95</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>1 cup</td>
<td>1.46</td>
</tr>
<tr>
<td>Trout, cooked</td>
<td>1 fillet</td>
<td>1.39</td>
</tr>
<tr>
<td>Wheatgerm</td>
<td>½ cup</td>
<td>1.24</td>
</tr>
<tr>
<td>Peanuts</td>
<td>½ cup</td>
<td>1.23</td>
</tr>
<tr>
<td>Lentils, cooked</td>
<td>1 cup</td>
<td>1.20</td>
</tr>
<tr>
<td>Whole milk</td>
<td>1 cup</td>
<td>0.73</td>
</tr>
<tr>
<td>Eggs, hard boiled</td>
<td>1 large</td>
<td>0.70</td>
</tr>
<tr>
<td>Cottage cheese</td>
<td>1 cup</td>
<td>0.47</td>
</tr>
<tr>
<td>Almonds</td>
<td>½ cup</td>
<td>0.33</td>
</tr>
</tbody>
</table>
Vitamin $B_5$ – Pantothenic Acid

- Distributed widely in nature, therefore because it is present in virtually all plants and animal foods, a deficiency is quite unlikely.
  - Easily damaged with freezing and canning
  - Processing and refining grains decreases by 75%
Functions

• Coenzyme A production
  • CoA forms acetyl-CoA, an intermediate in the citric acid cycle that produces energy in cells from fats, proteins and carbohydrates.

  o Acetyl CoA production
    • Starts citric acid cycle
    • First step in fatty acid synthesis

• Detoxification
  • In phase 2 of liver detoxification, acetyl-CoA is used to conjugate toxic substances for excretion.
Functions

• Production of:
  • Acetylcholine
  • Antibodies
  • Cholesterol
  • Bile salts
  • Haeme in haemoglobin
  • Steroid hormones
  • Ketones
  • Cell membranes

(McGuire, 2011)
Deficiency

• Deficiency is rare, and there is no specific deficiency syndrome, however symptoms include:
  • Burning feet syndrome –
    – Tingling in feet and legs with fatigue, weakness and nausea (McGuire, 2011)
  • Vomiting, nausea, and stomach cramps
  • Insomnia and fatigue
  • Irritability, restlessness, and apathy
  • Numbness, tingling
  • Muscle cramps, staggering gait
  • Hypoglycemia (Insel, 2011)
Toxicity

• No reported toxicities
  • >10g may cause diarrhoea and increase in histamine
  • doses up to 10g have been taken for several months without toxicity
  • 100mg may cause increased niacin excretion

(Zimmerman, 2001)
RDI

- Therapeutic range is 20-200 mg

<table>
<thead>
<tr>
<th>Age</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
</tr>
<tr>
<td>19-30 yr</td>
<td>6 mg/day</td>
</tr>
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</tr>
<tr>
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<td>6 mg/day</td>
</tr>
<tr>
<td>&gt;70 yr</td>
<td>6 mg/day</td>
</tr>
<tr>
<td>Women</td>
<td></td>
</tr>
<tr>
<td>19-30 yr</td>
<td>4 mg/day</td>
</tr>
<tr>
<td>31-50 yr</td>
<td>4 mg/day</td>
</tr>
<tr>
<td>51-70 yr</td>
<td>4 mg/day</td>
</tr>
<tr>
<td>&gt;70 yr</td>
<td>4 mg/day</td>
</tr>
</tbody>
</table>

(NHMRC, 2009)
Activity

- Conduct a brief literature search in relation to the therapeutic use of pantothenic acid in the treatment of health conditions?
  - Discuss your findings and where you searched, initially in small groups then share these with the class group.
  - Online students should discuss their findings in the relevant discussion forum.
Review Questions

1. List the foods highest in pantothenic acid

2. What are the substrates produced from pantothenate used in energy production?

3. B5 also acts as a cofactor in the production of many substances throughout the body. List some of these.

4. How might we recognise a B5 deficiency?
Biotin

http://commons.wikimedia.org/wiki/File:Biotin.png
# Biotin

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount</th>
<th>Biotin (mcg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakers yeast</td>
<td>7g</td>
<td>14</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>1 oz</td>
<td>14</td>
</tr>
<tr>
<td>Wholemeal bread</td>
<td>1 slice</td>
<td>6</td>
</tr>
<tr>
<td>Cheese, camembert</td>
<td>1 oz</td>
<td>6</td>
</tr>
<tr>
<td>Liver</td>
<td>3 oz</td>
<td>27</td>
</tr>
<tr>
<td>Chicken</td>
<td>3 oz</td>
<td>3</td>
</tr>
<tr>
<td>Avocado</td>
<td>100g</td>
<td>10</td>
</tr>
<tr>
<td>Salmon</td>
<td>3 oz</td>
<td>4</td>
</tr>
<tr>
<td>Raspberries</td>
<td>1 cup</td>
<td>2</td>
</tr>
<tr>
<td>Soybeans</td>
<td>100g</td>
<td>60</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>100g</td>
<td>16</td>
</tr>
<tr>
<td>Egg</td>
<td>1, average size</td>
<td>12</td>
</tr>
<tr>
<td>Milk</td>
<td>1 large glass</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Adapted from Zimmerman, 2001
Biotin

- Body stores of biotin are small, thus diets lacking in biotin will produce signs of deficiency within 3-4 weeks.

- Sources of biotin not only include those through dietary foods, it also includes biotin manufactured by intestinal bacteria within the large intestine.

- Within many foods biotin is found either bound to protein or as biocytin.

(Zimmerman, 2001; Groff, Smith & Gropper, 2004)
Biotin

• The glycoprotein avidin, has been found to bind biotin and prevent its absorption and utilisation by the body.
  • Avidin is heat labile (unstable to heat) thus ingestion of cooked egg whites does not compromise biotin absorption
Functions

• Carboxylation reactions
  • Transfer CO2 groups between molecules in the metabolism of carbohydrates, lipids and amino acids.
  • Assists in glycogen and fat synthesis and amino acid metabolism

• DNA and gene expression
  • Required for transcription of some genes
Factors Increasing Demand

- Drugs
  - Anticonvulsants, antibiotics, alcohol

- Pregnancy and lactation

- Achlorhydria

- Hypocaloric dieting for weight loss can produce biotin deficiency.

- Excess raw egg white consumption
Deficiency Symptoms

• Deficiency symptoms include:
  • Nausea, vomiting
  • Weight loss, anorexia
  • Smooth shiny tongue
    (Carlson, 1995)
  •Premature hair graying
  • Pallor
    (Rushton, 2002)
  • Hair thinning with loss of colour
  • Grayish mucous membranes
    (Ryan, 1996)
Toxicity & RDI

- No reported toxicities
- Therapeutic Range
  500 - 5000mcg

<table>
<thead>
<tr>
<th>Age</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-30 yr</td>
<td>30 µg/day</td>
<td>25 µg/day</td>
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<td>30 µg/day</td>
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</tr>
<tr>
<td>51-70 yr</td>
<td>30 µg/day</td>
<td>25 µg/day</td>
</tr>
<tr>
<td>&gt;70 yr</td>
<td>30 µg/day</td>
<td>25 µg/day</td>
</tr>
</tbody>
</table>
Therapeutic Uses

- Impaired biotin metabolism
- Anticonvulsant therapy (Mock 1997)
- Diabetes (Hemmati 2013)
- Nail disorders (Scheinfeld 2007)
- Uncombable hair syndrome (Boccaletti 2007)
Review Questions

1. List the foods highest in biotin
2. How is biotin manufactured endogenously?
3. Which factors might increase demand for biotin?
4. How might we recognise a biotin deficiency?
References


Guyton et al. (2007). Safety considerations with niacin therapy. *Am J Cardiol.* 99; 6A; 22C-31C


References


McGuire et al. (2011). *Nutritional Sciences from fundamentals to food*. Cengage Learning USA


References


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