Nutritional Benefits of Animal Products

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Outline

- Lipids
  - Conjugated linoleic acid
- Protein
  - Relationship to bone metabolism
- Minerals
  - Zinc and Iron
- Vitamins
  - B_{12}
Lipids
Lipid Chemistry

- Composed of a string of carbon molecules with an acid group attached
- Saturated or unsaturated
- Function
  - Membrane component
  - Thermal insulation and mechanical protection
  - Hormones
  - Energy storage
Lipid Chemistry
(Saturated fatty acid)

C18:0 or Stearic acid

[Chemical structure of C18:0 or Stearic acid]

[Link to chemlabs.uoregon.edu website for more information]

chemlabs.uoregon.edu/.../stearic_acid.html
Saturated

Unsaturated

Palmitic acid

Linoleic acid
What is CLA?
What are CLA’s?
CLA

- Class of lipids
- Discovered in grilled ground beef (1987)
- Anticarcinogenic activity
- Antiatherogenic activity
- Enhance the immune system
- Enhance growth
- Reduce body fat
## Conjugated dienoic isomers of linoleic acid in uncooked meats

<table>
<thead>
<tr>
<th>Foodstuff(^a)</th>
<th>Total CLA (mg/g fat)(^b)</th>
<th>c-9,t11 (%)(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round beef (n=4)</td>
<td>2.9 ± 0.09</td>
<td>79</td>
</tr>
<tr>
<td>Fresh ground beef (n=4)</td>
<td>4.3 ± 0.13</td>
<td>85</td>
</tr>
<tr>
<td>Lamb (n=4)</td>
<td>5.6 ± 0.29</td>
<td>92</td>
</tr>
<tr>
<td>Pork (n=2)</td>
<td>0.6 ± 0.06</td>
<td>82</td>
</tr>
<tr>
<td>Chicken (n=2)</td>
<td>0.9 ± 0.02</td>
<td>84</td>
</tr>
</tbody>
</table>

\(^a\)Samples were from commercially available, uncooked edible portions

\(^b\)Values are means ± standard error for the number of samples indicated.

\(^c\)Values are means for the number of samples indicated. All standard values are less than 3%. Data were expressed as % of total CLA isomers.

J. Food Comp. and Anal. 1992. 5:185
Plants contain very little CLA.
So why is CLA so high in ruminant tissues?

**Ruminal Biohydrogenation**

\[-\text{C=C-C=C=C- (C18:2)} \downarrow \]
\[-\text{C=C-C=C-C- (cis-9, trans-11, CLA)} \downarrow \]
\[-\text{C=C-C-C-C- (C18:1 trans)} \downarrow \]
\[-\text{C-C-C-C-C- (C18:0)} \]
Ruminal Biohydrogenation

C18:2
↓
CLA

C18:1 \textit{trans}
↓
C18:0
Protein
Catabolism of dietary protein $\rightarrow$ ammonium ion and sulfates from sulfur-containing amino acids.

Bone citrate and carbonate are mobilized to neutralize these acids $\rightarrow$ increase in urinary calcium.

Excess dietary protein can increase bone loss.

Milk and meat:
- Milk – amount of calcium in milk can compensate for urinary loss of calcium by milk protein.
- Meat – good amino acid profile and contains available phosphorus which can partially offset the hypercalciuric effect of protein.

Minerals

- Zinc and Iron
**Zinc**

- **Functions**
  - Component of numerous enzymes
    - Carbonic anhydrase
      \[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}^+ + \text{HCO}_3^- \]
    - Alcohol dehydrogenase
    - Malic dehydrogenase (Malate \[\rightarrow\] Ox)
    - Superoxide dismutase
    - Collagenase
  - DNA and RNA polymerase
  - Lipid metabolism
  - Immunity

- **Deficiency signs**
  - Parakeratosis
  - Decreased wound healing
  - Decreased immune function
  - Decreased insulin release
  - Reduction in bone collagen turnover
  - Impaired Vit A metabolism
    (decreased synthesis of retinol-binding protein)
Zinc and gene expression

- Zinc fingers – transcription factors
- DNA replication (replication protein A)
- DNA repair (endonuclease IV)
- Apoptosis (TFp53)
- Antioxidant protection of DNA


[fig.cox.miami.edu/~cmallery/150/gene/mol_gen.htm]
Iron

Functions

- Oxygen transport
- Electron transport (cytochromes)
- Enzymes
  - Catalase
  - Succinate dehydrogenase
PlasmaLumen

Fe+++ (poorly absorbed)

Ferrotransferrin – Fe+++

Paracellular

Fe++ - Transferrin like protein

Mucosal Ferritin

Fe+++ - TFLP

Lysosome

Heme Oxygenase

Heme Fe

Transcellular

Lumene

Fe++

Fe+++ (poorly absorbed)

Heme Fe

Ferrotransferrin – Fe+++
Vitamins

- Functions
  - **Mediators** in biochemical pathways
    - Ex. B vitamins act as co-factors in enzyme systems (Cobalt - B<sub>12</sub> prop. → succ.-CoA)
  - **Antioxidants**
  - **Amino acid** metabolism

- Classifications
  - **Water** or **fat soluble**
Vitamins

- Fat soluble
  - Vitamin A
  - Vitamin D
  - Vitamin E
  - Vitamin K

- Water soluble
  - Vitamin C
  - B vitamins
    a) Thiamin (B-1)
    b) Riboflavin (B-2)
    c) Niacin (B-3)
    d) Pantothenic acid (B-5)
    e) Vitamin B-6 (pyrodoxine)
    f) Biotin
    g) Vitamin B-12 (cobalamin)
    h) Folic acid
Vitamin B$_{12}$

● Functions
  – B$_{12}$ – dependent enzymes
    ● 1) Methylmalonyl-CoA Isomerase requires B$_{12}$ as a coenzyme \(\text{Smith, 1987}\)
      – Propionate-CoA \(\rightarrow\) Methylmalonyl-CoA \(\rightarrow\) Succinyl CoA
    ● 2) 5-methyltetrahydrofolate homocysteine methyltransferase \(\text{Smith, 1987; Matthews, 1999}\)
      – -methyltetrahydrofolate + Homocysteine \(\rightarrow\) Methionine + tetrahydrofolate
Vitamin A

Functions:
- Aids in **vision**
- **Cellular division and differentiation**
  - Growth
  - Reproduction
  - Bone development
  - Immune system
- Direct **antioxidant** (β-carotene)
Vitamin A

- **Deficiencies**
  - Night **blindness**
  - **Xerophthalmia** – deterioration of tissues in eye → **blindness**
  - Decreased growth, reproduction, immune function (increase in infection)

- **Toxicity can occur**
  - Bone abnormalities – **over growth**
  - Impaired vision and motor function
Selenium and Vitamin E

- Both nutrients are involved in the cellular antioxidant defense mechanism
  - Se - Glutathione peroxidase
  - Vitamin E - scavenges free radicals