ENVIR 202: Lesson No. 13

Food & Health

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Overview

- Food Quantity Problems
- Food Requirements
- Food Quality Problems
  - Foodborne Disease

Food Properties

- Food should be . . .
  - Safe
  - Attractive
  - Abundant
  - Nutritious
Food Quantity

Production:
- World-wide, most suitable land is already under cultivation
- Yield per acre - increasing, but at slower rate
- Yield per unit of energy consumed in production - fishing, livestock are very costly in energy, produce high energy density but low quantity; food webs differ markedly in this respect.
- Effects of over-harvesting: exceed rate of reproduction
- Effects of habitat destruction

Storage:
- Spoilage (oxidation, microbial decay): salting, smoking, refrigeration, chemical antioxidants (preservatives), irradiation
- Damage by vermin: rodents, arthropods
- Other mechanisms: dehydration

Distribution:
- Transportation - dependent on local organization and infrastructure
- Cost to consumer - poverty, influence of intermediate participants
Food Requirements

- **Metabolic (Energy) Demand:**
  - Depends on age, gender, body surface area, physical activity
  - Common units for:
    - measuring energy: joules, ergs, kilowatt-hours, foot-pounds, British Thermal Units, kilocalories;
    - for measuring rate of energy consumption: watts, horsepower

Basal (Resting) Metabolic Rate

<table>
<thead>
<tr>
<th>Kcal/(m²-hr)</th>
<th>Age</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>53.0</td>
<td>51.6</td>
<td></td>
</tr>
<tr>
<td>20-24</td>
<td>41.0</td>
<td>36.9</td>
<td></td>
</tr>
<tr>
<td>40-44</td>
<td>38.3</td>
<td>35.3</td>
<td></td>
</tr>
<tr>
<td>50-54</td>
<td>37.2</td>
<td>34.5</td>
<td></td>
</tr>
</tbody>
</table>

Body Surface Area (m²) = 0.202 x BW(kg)⁰.⁴²⁵ x H(m)⁰.⁷²⁵

Examples

- **Example 1:**
  - 21 year old female, 5'6" tall, 61 kg (134 lbs.)
  - Body surface area = 1.667 m²
  - Resting metabolic rate = 1476 Kcal/day

- **Example 2:**
  - 57 year old male, 6'1.5" tall, 82 kg (180 lbs.)
  - Body surface area = 2.067 m²
  - Resting metabolic rate = 1845 Kcal/day
### Effect of Exercise

<table>
<thead>
<tr>
<th>Activity</th>
<th>Energy Rate* (Kcal/m²-hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping</td>
<td>35</td>
</tr>
<tr>
<td>Sitting</td>
<td>50</td>
</tr>
<tr>
<td>Standing</td>
<td>85</td>
</tr>
<tr>
<td>Walking at 3 mile/hour</td>
<td>140</td>
</tr>
<tr>
<td>Bicycling</td>
<td>250</td>
</tr>
<tr>
<td>Swimming</td>
<td>350</td>
</tr>
<tr>
<td>Running</td>
<td>600</td>
</tr>
</tbody>
</table>

*20 year old male

### Calories in Food

<table>
<thead>
<tr>
<th>Component</th>
<th>Kcal/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>4</td>
</tr>
<tr>
<td>Fat</td>
<td>9</td>
</tr>
<tr>
<td>Protein</td>
<td>4</td>
</tr>
<tr>
<td>Ethanol</td>
<td>7</td>
</tr>
</tbody>
</table>

Note: 1 metabolic Kcal = 1 dietary Calorie

### Example

For a diet including 36% of total calories as fat:
- 500 g of food components (1.10 lb) provides 2500 Kcal.
- The balance between intake of food and energy consumption determines storage and weight stability.
Body Mass Index (BMI)

- BMI (kg/m²) = weight (kg) / height (m²)
  - Underweight: BMI < 20
  - Overweight: BMI > 25
  - Obese: BMI > 30
  - Health risks for those overweight:
    - diabetes
    - heart disease

Food Quantity

- Conditions resulting from deficiencies:
  - Protein (8 essential amino acids) - kwashiorkor
  - Total calories - marasmus
  - Iron - anemia
  - Iodide - goiter
  - Vitamin A - blindness
  - Vitamins B - beri-beri, pellagra
  - Vitamin C - scurvy
  - Vitamin D - rickets
  - Other essential trace components:
    - cobalt, zinc, magnesium, selenium, folic acid

Energy Density in Foods:

- Energy density = total calories/g food
- Includes effects of bone, water, non-digestible components such as fiber
Food Energy Density

- Low energy density foods:
  Contain relatively large amounts of air (popcorn, ice cream), water (soft drinks, fresh fruits and vegetables), or fiber (fruits and vegetables).

- High energy density foods:
  Contain relatively large amounts of fat (animal meats), and are heavily processed to remove air, water, fiber (TV dinners, Powerbars).

- These properties have important considerations for world-wide nutrition and health.

Food Properties

- However, food is susceptible to:
  - Spoilage
  - Contamination
  - Adulteration, which can render it unfit to eat.

E. coli Bacterium

Food Quality

- Deliberate Additives
  (regulated by Food and Drug Administration and the US Dept. of Agriculture, based on risk assessment)
  - Preservatives - eg, benzoic acid, sorbic acid, propionic acid
  - Flavorings - natural, artificial
  - Texture Modifiers - eg, gums, emulsifiers
  - Genetically Modified Organisms (GMO) - pest resistance, flavor
Food Quality

- Unintentional Contaminants (FDA, USDA, US Environmental Protection Agency, State and Local Health Departments)
  - Pesticides, fertilizers, pollutants in soil and water
  - Antibiotics and other animal feed additives

Unintentional Contaminants

- Microbiological contaminants - from animals, water, human food handlers (preparation, serving)
  - Infectious agents - food borne infection
    - E.g., salmonella, campylobacter, E. coli
  - Microbial toxins - food borne intoxication
    - E.g., botulism, staphylococal enterotoxin, *bacillus cereus* toxin, aflatoxin

Foodborne Disease

- There are two types of foodborne illness
  - Infections
  - Intoxications
Foodborne Disease Continued

- Infections are caused by:
  - The presence of microorganisms in large numbers which multiply in the gut and overwhelm the body’s defenses

Foodborne Infections

- Amebic Dysentery
- Brucellosis
- Campylobacter enteritis
- Diarrhea (Acute)
- Viral gastroenteritis

Foodborne Infections Continued

- Salmonellosis
- Shigellosis
- Trichinosis
- Typhoid Fever
- Infectious Hepatitis
Foodborne Disease

- Intoxications are caused by chemicals or “toxins”
  - Produced by micro-organisms, or by
  - Contamination with natural or manufactured chemicals

Foodborne Intoxications

- Botulism
- Staphylococcal food poisoning
- Clostridium perfringens
- Bacillus cereus

Foodborne Toxins

- Scromroid fish poisoning (Histamine)
- Ciguatera fish poisoning
- Paralytic shellfish poisoning (PSP)
- Amnesic shellfish poisoning (domoic acid)
- Puffer fish poisoning (tetrodotoxin)
Types of Pathogens

- Sporeforming Bacteria
  - Clostridium botulinum
  - Clostridium perfringens
  - Bacillus cereus
- Non-sporeforming Bacteria
  - Salmonella spp.
  - Campylobacter
  - E. coli O157:H7
  - Staphylococcus aureus
  - Listeria monocytogenes

- Viruses
  - Hepatitis A
  - Norwalk Virus

Normal Symptoms of Foodborne Disease

- Nausea
- Vomiting
- Diarrhea
- Cramps
- Headache
- Fever
- Chills
- Body Aches

Complications of Foodborne Illnesses

- Kidney Damage
- Blood Poisoning
- Pneumonia
- Arthritis (2% will trigger)
- HUS (5-20K cases/yr)
- Guillain Barre Syndrome
- Chronic Sporadic Toxoplasmosis
- Neurological Damage
- Pancreatic Infections
- Chronic Illness - likely to occur in 2-3% of FBIs
High Risk Individuals

- Infants
- Children
- Pregnant Women
- Senior Citizens
- People taking medications:
  - Antibiotics
  - Antacids
  - Immuno-suppressive drugs
- Immuno-compromised people:
  - Recent major surgery
  - Pre-existing or chronic illness
  - HIV / AIDS
  - Diabetes
  - Cancer
  - Liver or Kidney Damage
  - Ulcers

Contributing Factors

Factors Contributing to an increased risk of Foodborne Illness
- Aging Populations
- Lifestyles of the Public
- New and Emerging Pathogens
- Increase in High Risk Individuals
- New Processing Methods for Foods
- New Sources of Foods - Geographic

Foodborne Disease Outbreaks

United States, 1993-1997

- Bacteria: 24%
- Viral: 68%
- Chemical: 5%
Foodborne Disease Cases
United States, 1993 – 1997

Foodborne Disease

Reported Incidence
- Believed to be only the tip of the iceberg
- 1% or less are even reported
- 76 million cases annually

Foodborne Disease Outbreaks
United States, 1993-1997
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Deaths from Food
United States, 1988 - 1992

Distribution of Outbreaks
United States, 1995

Foodborne Illness in Washington

- Estimated Annual Number of Foodborne Illnesses in Washington State (extrapolated from CDC U.S. estimates - 2000)
  - 1.5 million illnesses
  - 6500 hospitalizations
  - 100 deaths
Foodborne Outbreaks 1990-2001

Major Factors Associated with FBDO's
WA State 1990-1999

Minor Factors Associated with FBDO's
WA State 1990-1999
Foodborne Disease Outbreaks by Place, 1990–1999, Washington State

Significant Food Ingredients for FBDO's
WA State 1990–1999

CASES of ILLNESS
Significant Food Ingredients Foodborne Disease Outbreaks
WA State 1990–1999
Trends

- In the 80’s…
  - Was beef ……………………
  - Was turkey …………………
  - Was roast beef and turkey …
  - Some viruses …………………
  - Was Salmonella………………
  - Some Mex/Chinese………..
  - Was cooling…………………
  - E. coli emerged……………
  - No Fruit/Veg outbreaks….

- In the 90’s…
  - Now hamburger
  - Now chicken
  - Now RTE foods & Starchy foods
  - Now nearly 1/2 the cases are viral
  - Still Salmonella
  - Increased M/Ch + others
  - Now handwashing
  - O157:H7, Crypto, ETEC,
    - Lots of F/V - sprouts, juice, melons, green leafy, etc…

Disease Causation Factors

- Food Handling Practices:
  - Poor Handwashing
  - Cross Contamination
  - Improper Heating
  - Improper Cooling

Disease Causation Factors

- Diversity in the Food Industry
  - Changes in eating habits
  - More types of foods (ethnic, seasonal)
  - Greater shelf life (transportation)
  - More foods are imported
  - New food products are coming out
  - New food processes