Addressing Food Security Through Nutritional Enhancement of Food

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (FAO)
Limited access to food

At 17.4 percent, Mississippi had the highest average rate of food insecurity in the past three years.

Percentage of households that were food insecure, average, 2005-07

- 9.5%
- 10.5%
- 11.5%
- 12.5%
- +

National average: 11%

Lowest: North Dakota 6.5%
Obesity Trends* Among U.S. Adults
BRFSS, 2008
(*BMI ≥30, or ~30 lbs. overweight for 5’ 4” person)

Source: Behavioral Risk Factor Surveillance System, CDC.
The Near Future:

• Without action deaths from chronic diseases will increase by 17% over the next decade (WHO report)

• Currently, of those with chronic conditions 60% are between the ages of 18 and 64.
FOOD STANDARDS AGENCY

LOW FAT
LOW SATURATES
HIGH SUGAR
MED SALT

eatwell.gov.uk
<table>
<thead>
<tr>
<th></th>
<th>LOW per 100g</th>
<th>Less than...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>3g</td>
<td></td>
</tr>
<tr>
<td>Saturates</td>
<td>1.5g</td>
<td></td>
</tr>
<tr>
<td>Sugars</td>
<td>5g</td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>0.3g</td>
<td></td>
</tr>
</tbody>
</table>

Is there anything in food that is good for us?
Food and health

- Bioactive phytochemicals
- Micronutrients
- Fibre

Metabolic regulators

Metabolic substrates
- Carbohydrates
- Proteins
- Fats

- Micronutrients
- Fibre

Health and well being
Food and health

- **Plant and crop science**
  - Bioactive phytochemicals
  - Micronutrients
  - Fibre

- **Metabolic substrates**
  - Carbohydrates
  - Proteins
  - Fats
  - Micronutrients
  - Fibre

- **Metabolic regulators**

- **Metabolic dysfunction**
  - Cardiovascular disease
  - Type II diabetes
  - Insulin resistance
  - Obesity
  - Cognitive decline
  - Chronic inflammation
  - Cancer
Some foods are good to eat!
## Top six causes of all cancers in men and women

Risk factors of the 158,700 cancers diagnosed in men and 155,600 cancers diagnosed in women each year

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Risk factor</th>
<th>Risk factor %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tobacco</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>Lack of fruit &amp; vegetables</td>
<td>6.1</td>
</tr>
<tr>
<td>3</td>
<td>Occupational hazard</td>
<td>4.9</td>
</tr>
<tr>
<td>4</td>
<td>Alcohol</td>
<td>4.6</td>
</tr>
<tr>
<td>5</td>
<td>Overweight</td>
<td>4.1</td>
</tr>
<tr>
<td>6</td>
<td>Exposure to sun &amp; sunbeds</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Risk factor %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>15.6</td>
</tr>
<tr>
<td>Overweight</td>
<td>6.9</td>
</tr>
<tr>
<td>Infection</td>
<td>3.7</td>
</tr>
<tr>
<td>Exposure to sun &amp; sunbeds</td>
<td>3.6</td>
</tr>
<tr>
<td>Lack of fruit &amp; vegetables</td>
<td>3.4</td>
</tr>
<tr>
<td>Alcohol</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Source: Cancer Research UK
5 A DAY

What’s it all about?

1/2 a can of tinned peaches

1 medium banana

3 heaped tablespoons of peas

1 medium glass of orange juice

7 strawberries

3 heaped tablespoons of mixed vegetables

3 heaped tablespoons of cooked kidney beans

16 okra

Just Eat More (fruit & veg)

nhs.uk/5aday
Percentage of adults that have met the 5 A DAY recommendation

25 years of effort to increase fruit and vegetable consumption has had little effect on habitual diet
Change in food prices, 1985–2000
(real dollars)

Percentage change

- Fresh fruits and vegetables
- Total fruits and vegetables
- Cereal and bakery
- Dairy
- Red meats
- Poultry
- Sugar and sweets
- Fats and oils
- Soft drinks

How can plant science contribute to human health?

• Chronic disease is an increasing problem in both developed and developing countries
• Plants make many non-essential natural products that are beneficial for health
• Plant science can contribute significantly to solutions, including identification and assay of nutrients and nutritional improvements
• For progress we need multidisciplinary interactions (biomedicine, nutrition, plant scientists)
Anthocyanins:

- Protect against:
  - Cardiovascular disease
  - Obesity
  - Certain cancers
Cancer-prone mice live 30% longer on a diet supplemented with purple tomatoes.
<table>
<thead>
<tr>
<th>Fruit</th>
<th>Anthocyanin Content (mg per 100g FW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black raspberry</td>
<td>687</td>
</tr>
<tr>
<td>Blackcurrant</td>
<td>476</td>
</tr>
<tr>
<td>Blueberry</td>
<td>386</td>
</tr>
<tr>
<td>Cranberry</td>
<td>140</td>
</tr>
<tr>
<td>Cherry</td>
<td>122</td>
</tr>
<tr>
<td>Purple tomato</td>
<td></td>
</tr>
<tr>
<td>NZ blackcurrant (Ben Rua)</td>
<td>699</td>
</tr>
<tr>
<td>NZ blackcurrant (Ben Ard)</td>
<td>773</td>
</tr>
</tbody>
</table>

Anthocyanin content of fruit mg per 100g FW
Does consumption of anthocyanin-enriched tomatoes impact cardiovascular disease?

**ApoE<sup>-/-</sup> mouse model of atherosclerosis**

<table>
<thead>
<tr>
<th>Group</th>
<th>Standard chow (% w/w)</th>
<th>Tomato content (dry, % w/w)</th>
<th>17 weeks dietary intervention</th>
<th>N=20/group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td>10% red tomato</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>90</td>
<td>7.5% 2.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>90</td>
<td>5% 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>90</td>
<td>10% purple tomato</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Paul Kroon and Sebastian Achterfeldt
Measurements

- CVD markers
  - Aortic sinus plaque area
  - Gene expression profile of liver and aortic tissue
- Blood lipids (LDL, HDL, TGs)
  - Inflammatory markers in plasma (TNF-α, IL-6, MCP-1 etc.) in blood
- Presence of anthocyanin metabolites in blood
Data was statistically analysed using one-way ANOVA coupled with Dunnett’s multiple comparison test. Linear regression analysis was undertaken to test for a dose response. All values are given as means ± SD (n=20). *p < 0.05; ***p < 0.001 compared to 10% red tomato diet.

- Significant differences between the 10% red tomato and the 5% and 10% purple tomato groups (p<0.05, p<0.001)
How can the doses be translated to human diet?

• 2.5% purple tomato (mouse: 0.15mg/day, human: 31 mg/day)
  – One plum

• 5% purple tomato (mouse: 0.3mg/day, human: 62 mg/day)
  – 100g strawberries

• 10% purple tomato (mouse: 0.6mg/day, human: 125 mg/day)
  – 70 g blackberries

Reagan-Shaw et al. (2007) The FASEB Journal
http://www.phenol-explorer.eu/
• Comparative nutrition
• Biofortified foods
Published articles on anthocyanins and health each year

The latest 20 years are displayed.
The purple tomatoes with double the shelf life: Compound that helps them stay fresh may also have health benefits

By DAILY MAIL REPORTER

Tomatoes could be made tastier and stay fresh for twice as long, according to a new study. Scientists say that the antioxidants found in purple GM tomatoes can help double their shelf life from 21 days to 40 days.

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UK grows GM superfood in Canada

A genetically modified purple tomato developed by British scientists is being produced in Canada because of European opposition to the technology.

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Purple tomato juice from Canadian GM crop heads for trial in UK

By Clive Cookson, Science Editor

Two thousand litres of purple tomato juice, pressed from genetically modified fruit grown in Canada, are heading for Britain to be tested for their health-promoting properties.

The tomatoes, developed by UK scientists at the John Innes Centre and Sainsbury Laboratory near Norwich, are the latest in a new generation of plants designed to take GM into consumer applications.

Their promoters hope that these will be more acceptable to environmental campaigners than the herbicide resistant and insecticidal crops that have dominated the GM market so far.
UK garden centre grows Britain's first BLACK tomatoes (and they could help fight cancer) Ray Brown came across fruit, which contains antioxidants said to have health benefits

*Yahoo News. – Wed, Oct 9, 2013*

These black tomatoes do give a pretty good yield, and Myers insists that they are not GMO (genetically modified organisms).

*Indigo Rose*
Market Research shows healthiness of juice is an important criterion in consumer choice.
Regulatory Issues

- There are three agencies which are involved in the regulation of GM food crops in USA:
  - Environmental Protection Agency (EPA)
  - Department of Agriculture (USDA)
  - Food and Drug Administration (FDA)

- The EPA is concerned only with GM plants that contain pesticidal genes. Purple tomatoes contain no such genes and there is no need to engage with EPA.

- For USDA approval there is a common assumption that it costs around $20 million and takes at least ten years to be able to grow a commercial crop in USA.

- The business model is to contract out the growing of purple tomatoes, and to use those tomatoes to produce juice. This model gives us control of the whole growing cycle and, importantly, control of the seed at all times.
Early October 2013
Fresh Juice
With thanks to Eugenio Butelli, Lucilla Titta, Marco Giorgio, Dylan Edwards, Chiara Tonelli, Katia Petroni, Angelo Santino, Paul Kroon, Sebastian Achterfeldt and ........

The EU: for PROFOOD (FP5), FLORA (FP6), and ATHENA (FP7)

Jonathan Jones, Eric Ward and Dean Tiessen
The Future?
You are what you eat? Plants, Food and Human Health:

Lecture Outline

• What we get from food
  – Macronutrients, micronutrients and phytonutrients

• How diet affects human health
  – Nutrition research
  – Dietary deficiencies
  – Diet and chronic diseases

• Media and marketing

• What can scientists do?

Mary Williams, Mike Lean, Barry Pogson and Cathie Martin

Image courtesy CDC and Mary Anne Fenley (number 1305)