

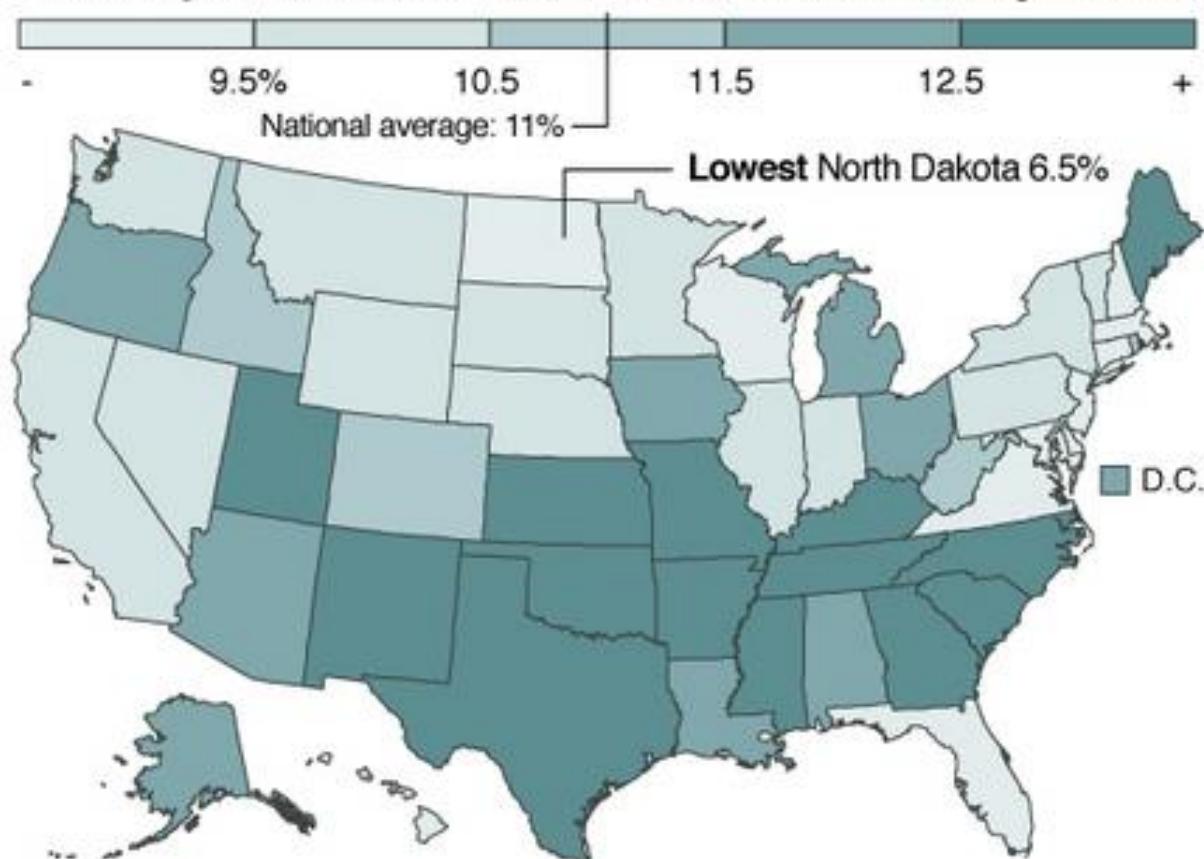
# **Addressing Food Security Through Nutritional Enhancement of Food**

**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



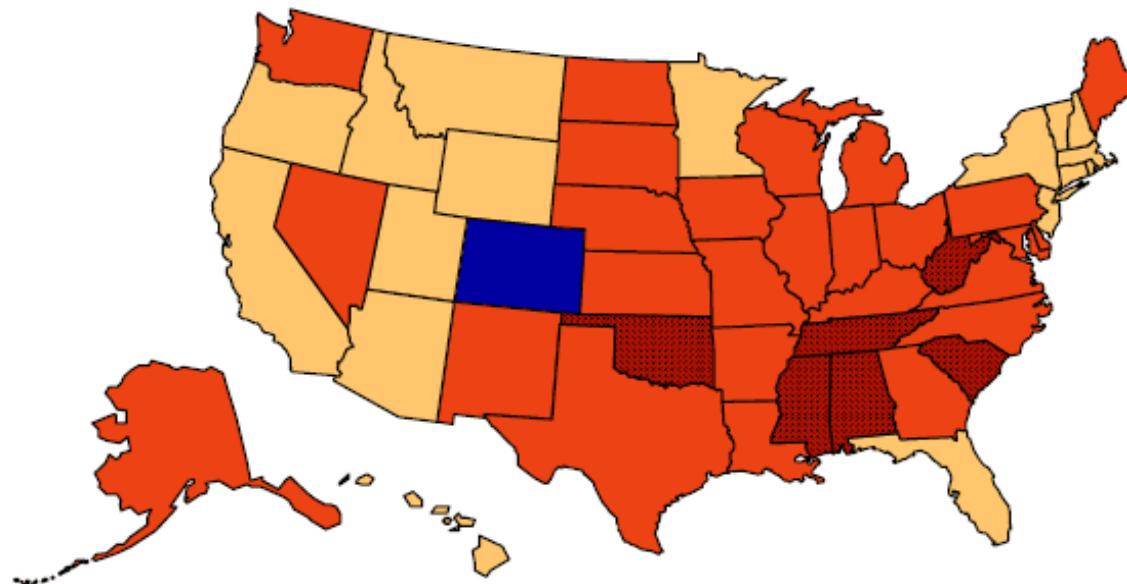
## Obesity Trends Among U.S. Adults between 1985 and 2006

### Definitions:

- Obesity: having a very high amount of body fat in relation to height or Body Mass Index (BMI) of 30 or higher
- Body Mass Index (BMI): a measure of an adult's weight in kilograms divided by the square of his or her height in meters

## Obesity Trends\* Among U.S. Adults BRFSS, 2008

(\*BMI  $\geq 30$ , or  $\sim 30$  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

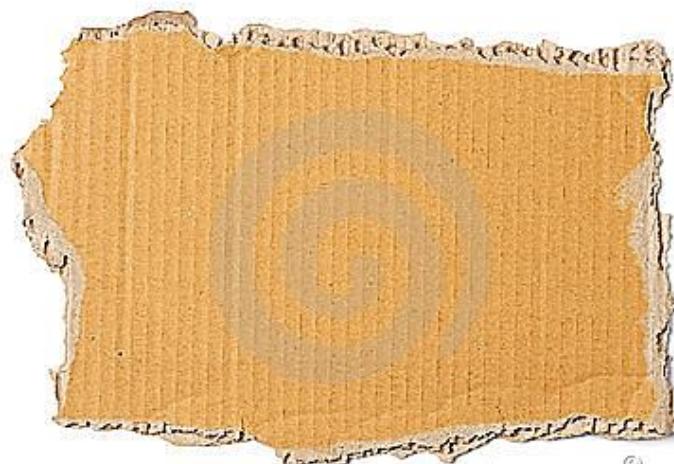
HIGH SUGAR

MED SALT

[eatwell.gov.uk](http://eatwell.gov.uk)

PA

	<b>LOW</b> per 100g Less than...
<b>Fat</b>	3g
<b>Saturates</b>	1.5g
<b>Sugars</b>	5g
<b>Salt</b>	0.3g



dreamstime.com

**Is there anything in food that is good for us?**

# Food and health



- Bioactive phytochemicals
- Micronutrients
- Fibre

***Metabolic regulators***

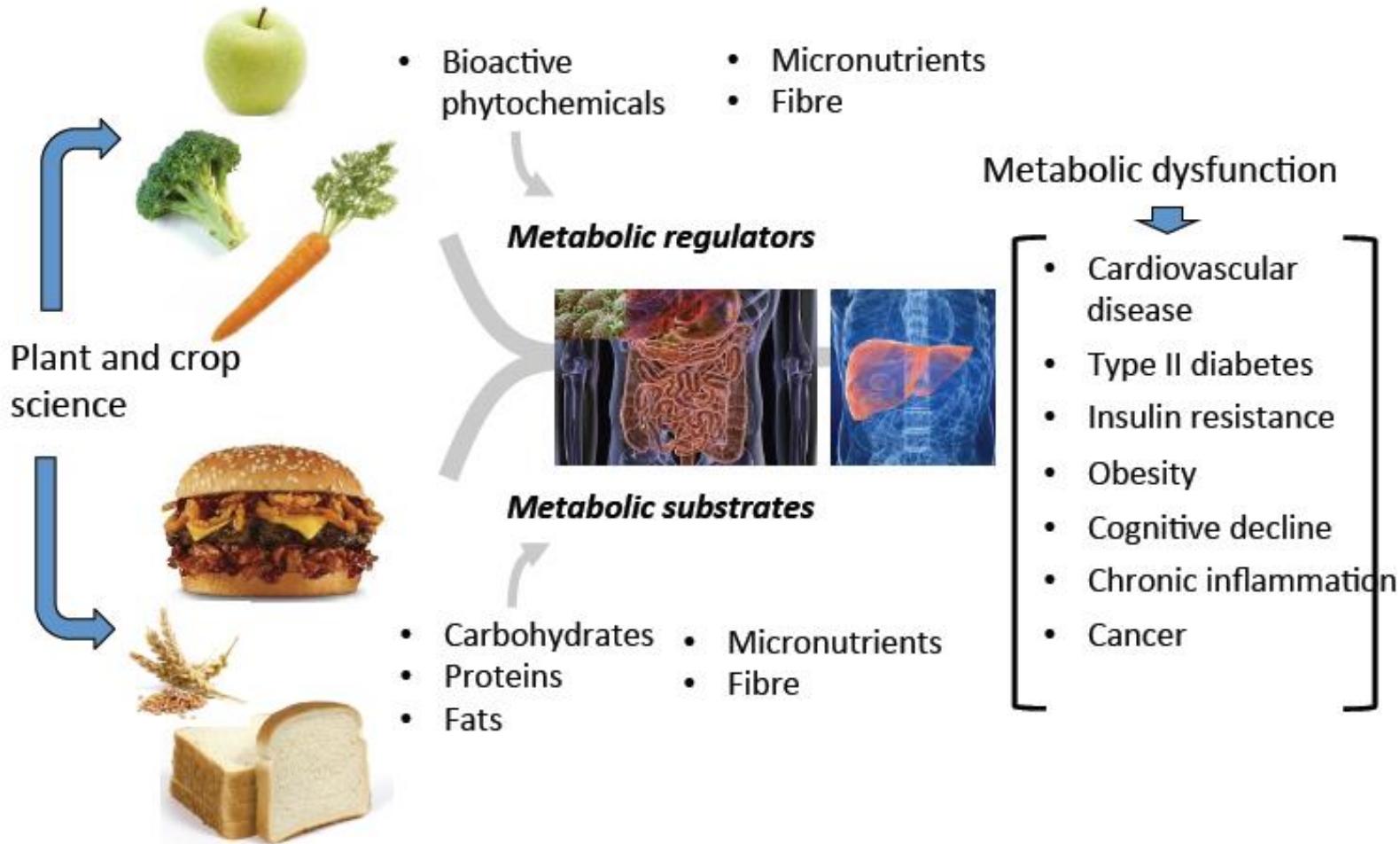


Health and well being

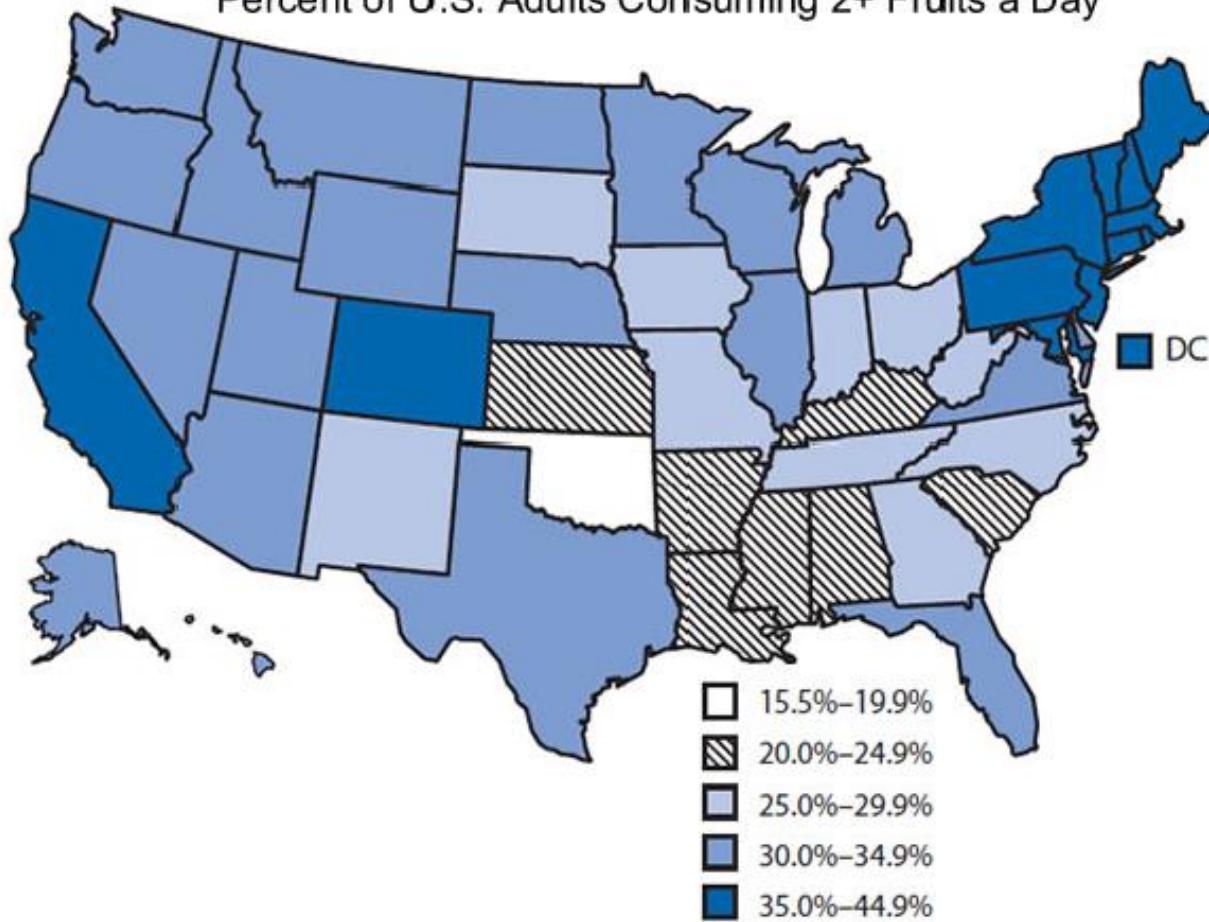
***Metabolic substrates***

- Carbohydrates
- Proteins
- Fats
- Micronutrients
- Fibre

# Food and health



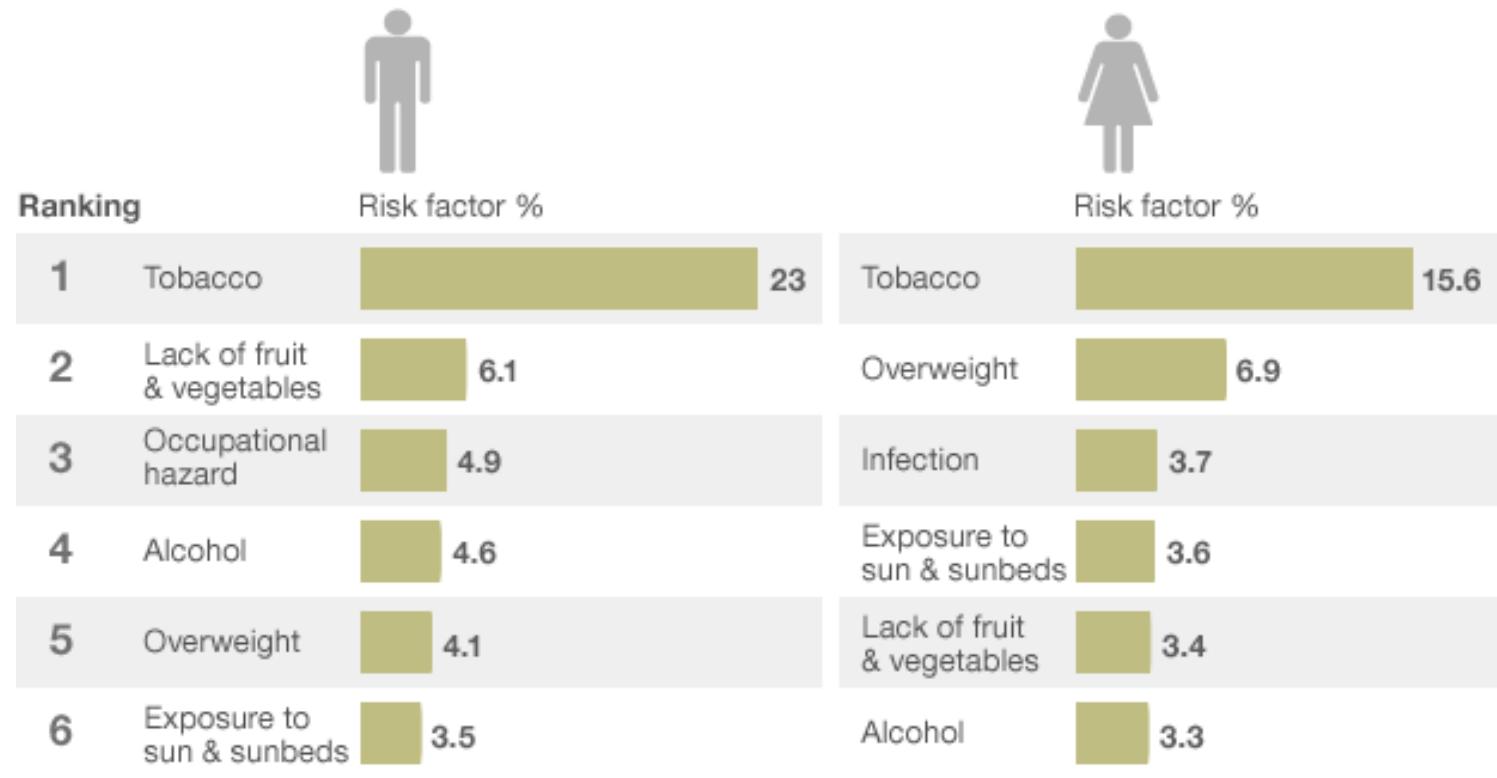
Percent of U.S. Adults Consuming 2+ Fruits a Day



**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



Source: Cancer Research UK

# 5 A DAY

## What's it all about?



**½** 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



**Just Eat More  
(fruit & veg)**



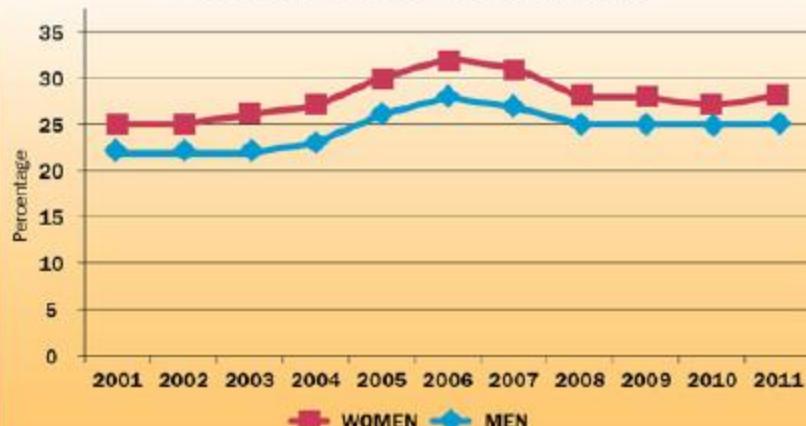
**3** heaped tablespoons of cooked kidney beans



**16** okra

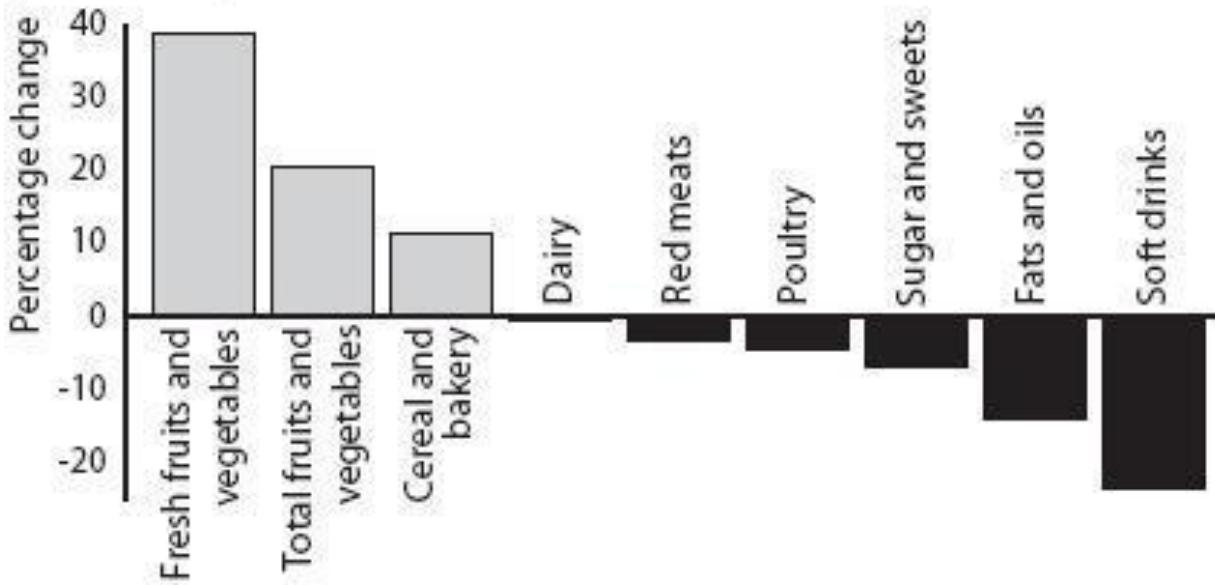


### Percentage of adults that have met the 5 A DAY recommendation



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)**



Source: USDA ERS FoodReview, Vol. 25, Issue 3. Converted to real dollars.

# **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:**

Pelargonidin



Cyanidin

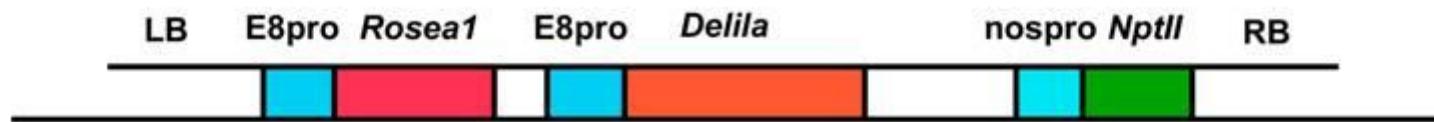


Delphinidin



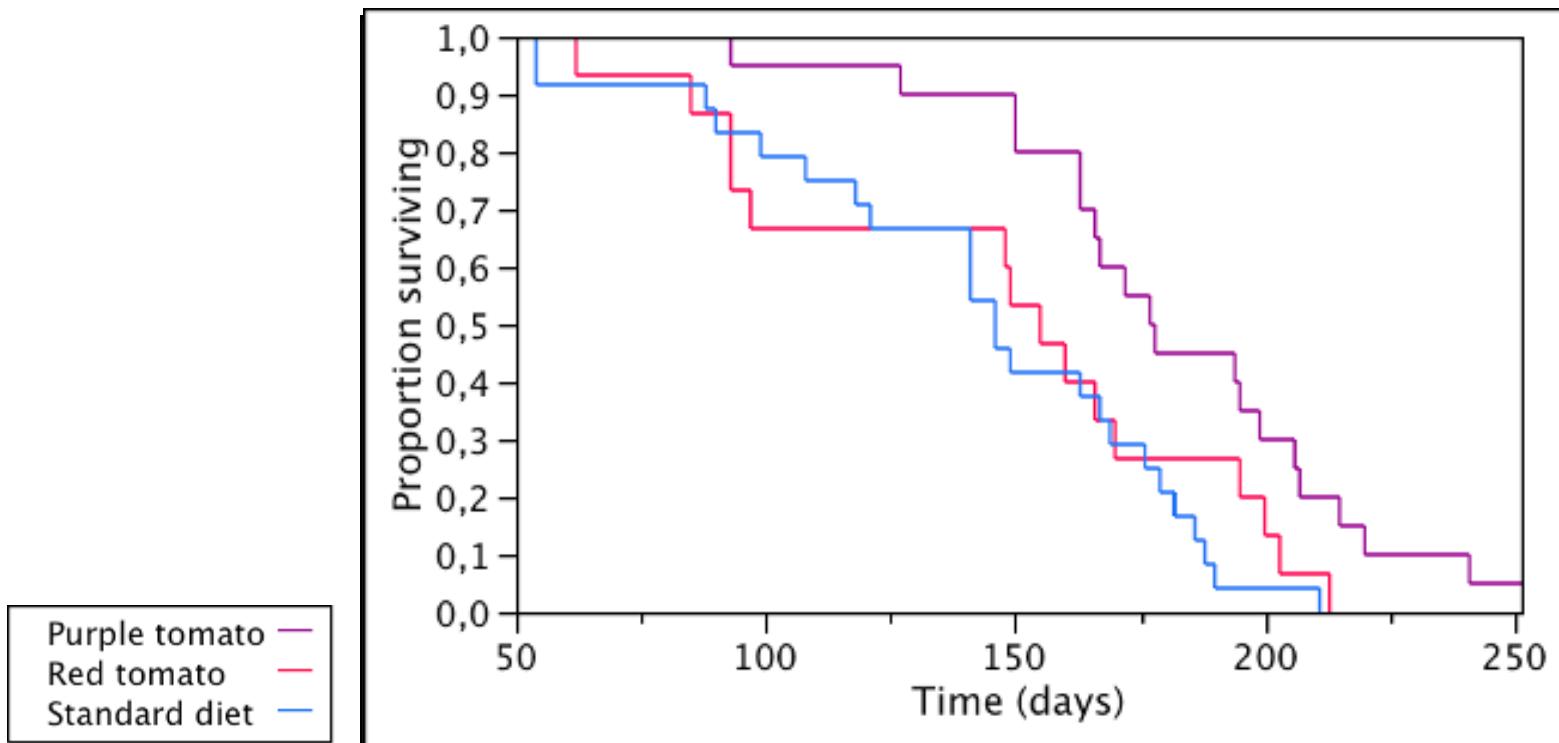
## **Protect against:**

- **Cardiovascular disease**
- **Obesity**
- **Certain cancers**

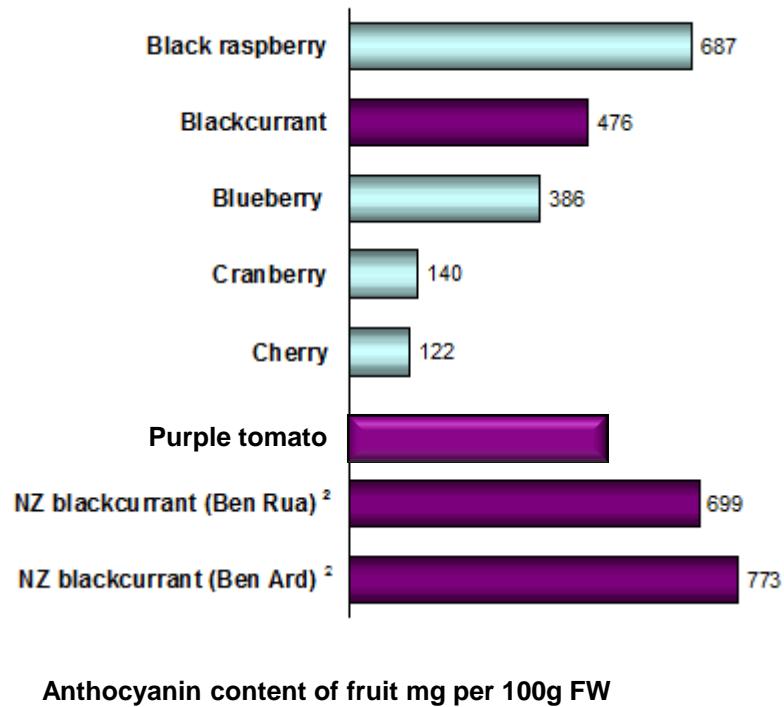




# HOW BETTER NUTRITION CAN HELP FIGHT CANCER



Cancer-prone mice live 30% longer on a diet supplemented with purple tomatoes



# Does consumption of anthocyanin-enriched tomatoes impact cardiovascular disease?



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

Group	Standard chow (% w/w)	Tomato content (dry, % w/w)
1	100	None
2	90	10% red tomato
3	90	7.5% red tomato 2.5% purple tomato
4	90	5% red tomato 5% purple tomato
5	90	10% purple tomato

17 weeks dietary intervention

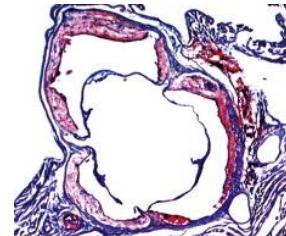
N=20/group

Paul Kroon and Sebastian Achterfeldt

# Measurements

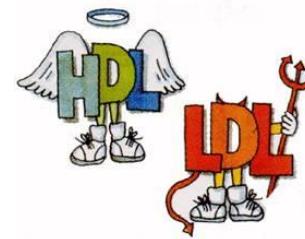
- CVD markers

- Aortic sinus plaque area



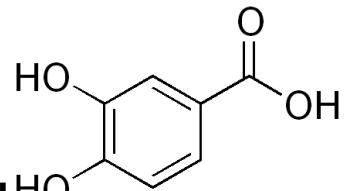
- Gene expression profile of liver and aortic tissue

- Blood lipids (LDL, HDL, TGs)

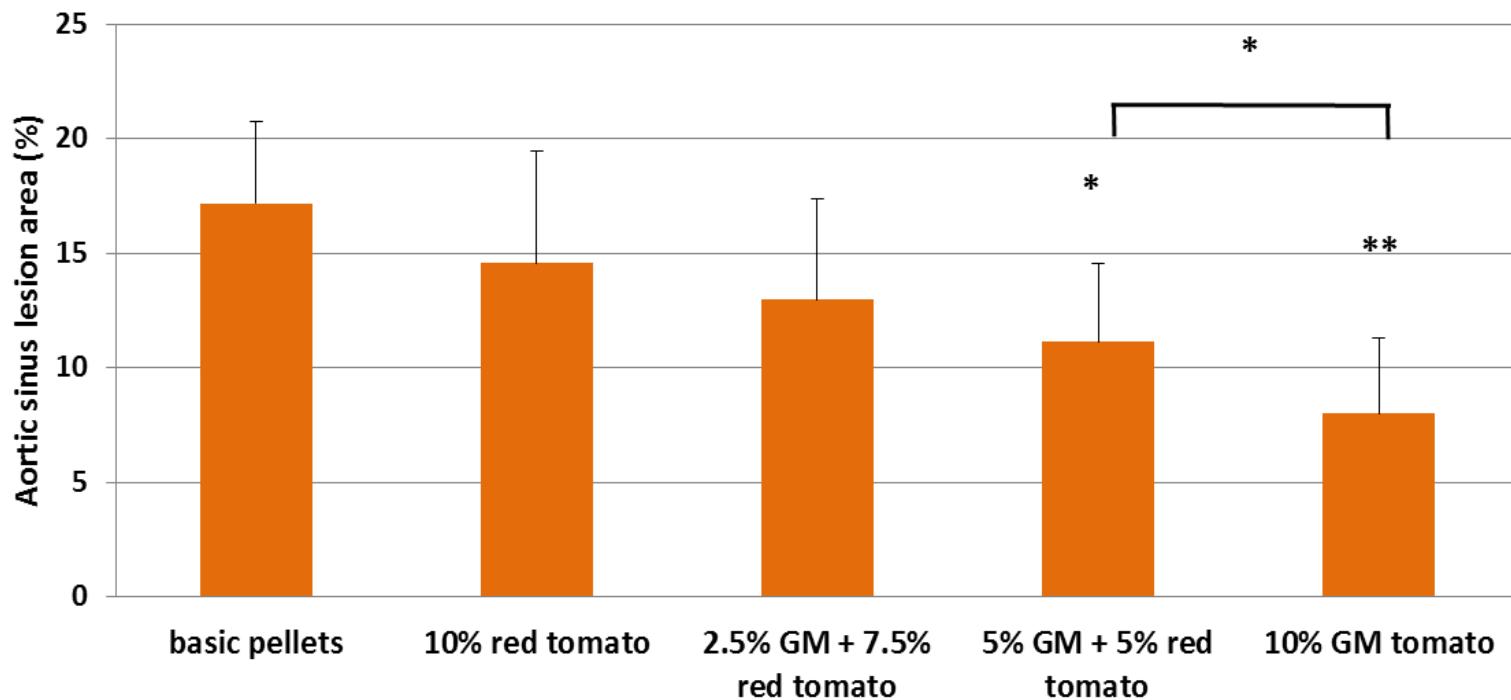


- Inflammatory markers in plasma (TNF- $\alpha$ , IL-6, MCP-1 etc.) in blood

- presence of anthocyanin metabolites in blood



## Effect of diets on aortic sinus lesion area



- Significant differences between the 10% red tomato and the 5% and 10% purple tomato groups ( $p<0.05$ ,  $p<0.001$ )

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  $\pm$  SD (n=20). \* $p < 0.05$ ; \*\* $p < 0.001$  compared to 10% red tomato diet.

# 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

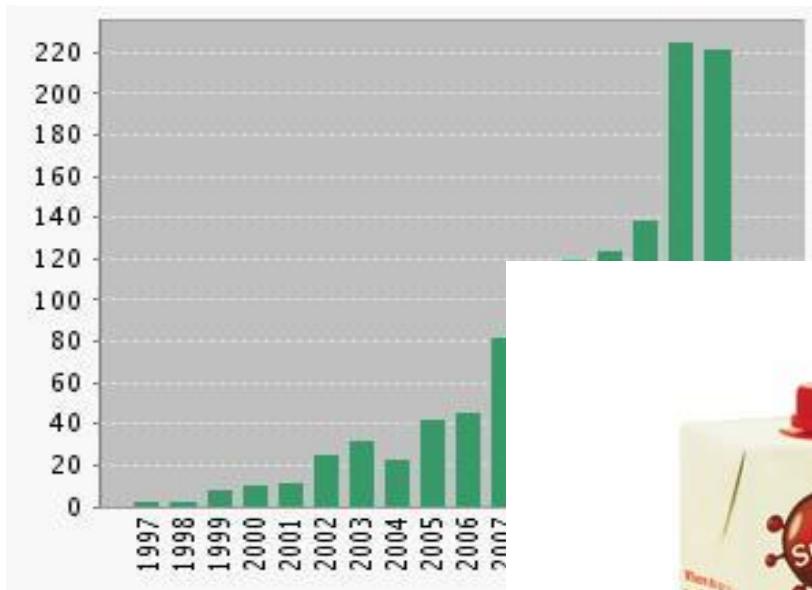




WT (flavonols)	High delphinidin	High pelargonidin	High flavonols	High resveratrol	High genistin	High anthocyanin High flavonols
0.1 mg/g FW	2.5 mg/g FW	1.0 mg/g FW	7.0 mg/g FW	1.5 mg/g FW	1.6 mg/g FW	6.0 mg/g FW 1.0 mg/g FW

- Comparative nutrition
- Biofortified foods

## Published articles on anthocyanins and health each year



The latest 20 years are displayed





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**SPARKLING  
CLEAN**



## The purple tomatoes with double the shelf life: Compound that helps them stay fresh may also have health benefits

By DAILY MAIL REPORTER

PUBLISHED: 01:27, 24 May 2013 | UPDATED: 16:52, 24 May 2013

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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 more than double their shelf life from 21 days to 48 days.



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January 24, 2014 10:05 pm

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

By Clive Cookson, Science Editor



New Energy Farms' purple tomatoes

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.

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Saturday, March 8 | London | Max 15C



Welcome to your preview of The Times

## UK grows GM superfood in Canada



Hannah Devlin Science Editor  
Published at 12:01AM, January 25 2014

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

Juice from GM purple  
tomatoes will be  
shipped to Britain next  
month

[Post a comment](#)



Behind the story:

New GM plants could help to feed world – if Luddites don't interfere, say farmers

The technology involves  
transferring genes from  
closely related plant species  
rather than genetically  
modifying...  
Last updated at January 7  
2014

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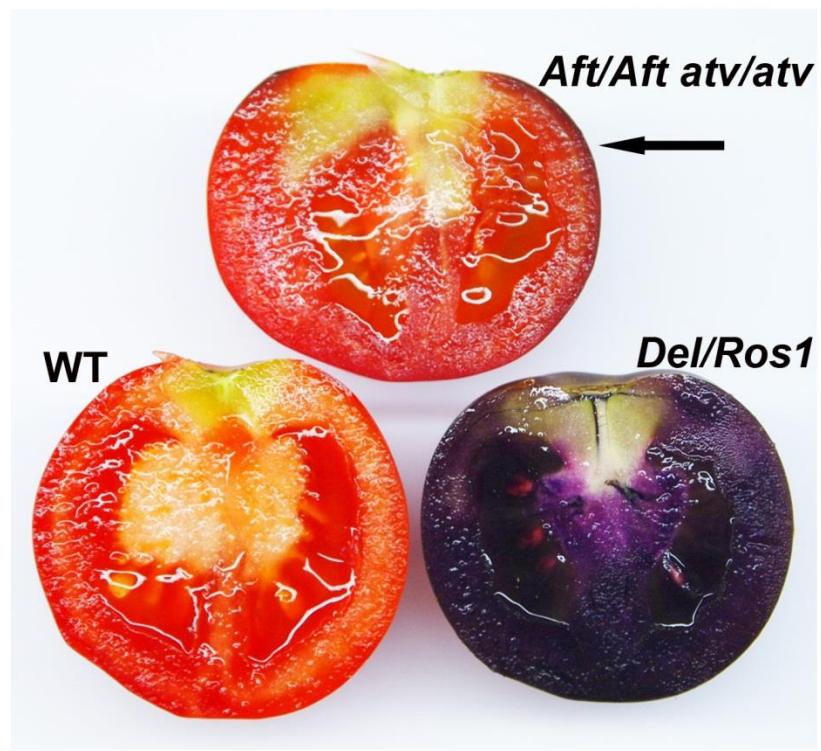
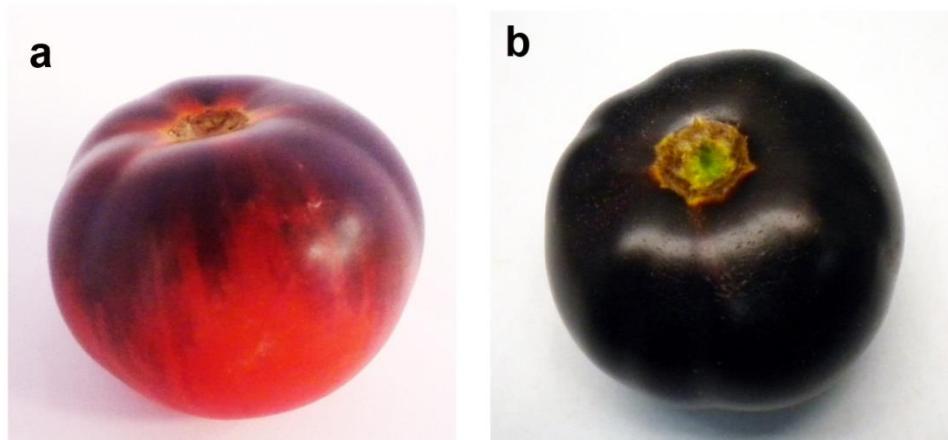
**UK garden centre grows Britain's first BLACK tomatoes (and they could help fight cancer)**  
**Ray Brown came across fruit, which contains antioxidants said to have health benefits**

*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).**

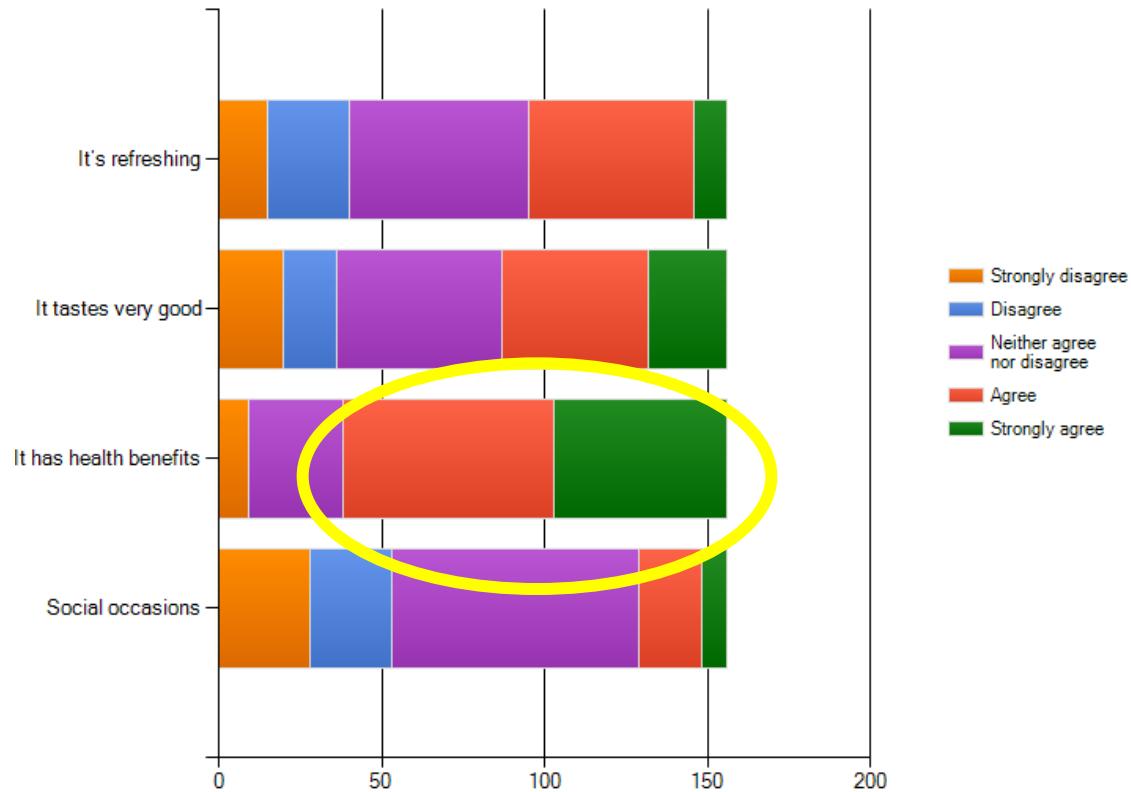


**Indigo Rose**





If you consume tomato juice, please agree or disagree with the following statements:



**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



Pasteurized 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).