



Biofortified and Functional Food: A Healthy Future?

**Plant natural products and health: from
evidence to implementation**

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Food and health research



Food and health - the two global challenges

- 
- Malnutrition
 - Micronutrient deficiencies

≈ 1 - 2 billion

- Food security
- Iron and Zinc deficiency
- Vitamin A deficiency

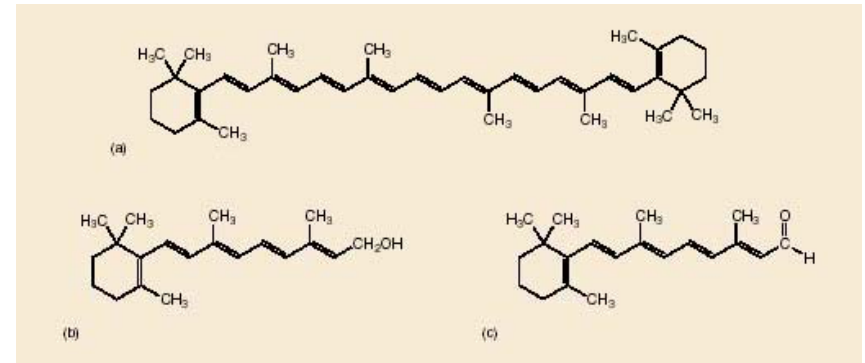
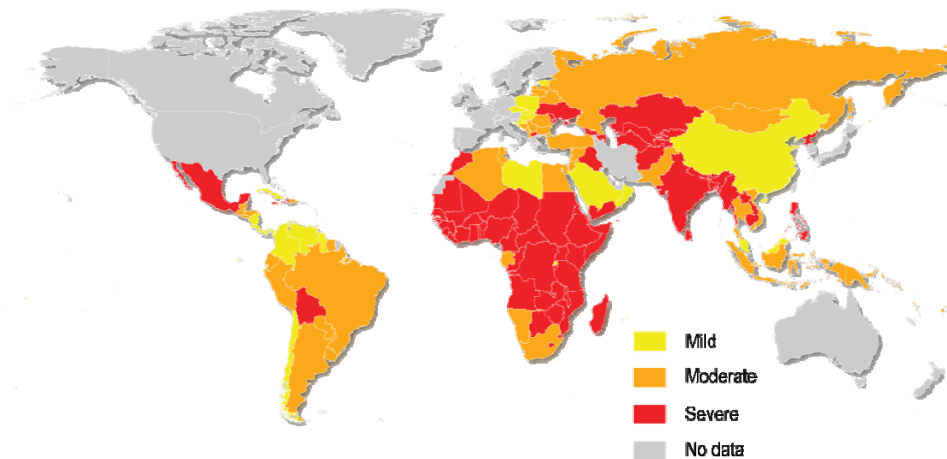
- High calorific diets
- Reduced physical activity
- Non communicable disease

≈ 1 billion

- Plant-based diets
- Fruit and vegetable rich diets
- Complex carbohydrates
- 'Food bioactives'

- Is there a role for biofortified and functional foods?
- What is the evidence that these products could enhance health?
- What are the implementation strategies

Vitamin A deficiency



Leafy vegetables



Golden rice?



Orange flesh sweet potatoes



- An estimated 32% of Africa's population is vitamin A deficient
- Average consumption of sweet potato is 200g/day
- Estimated biofortification contribution: 50% of the mean daily vitamin A requirement
- HarvestPlus biofortified sweet potato varieties were released in 2007
- In 2022, 10 million people will be consuming provitamin A sweet potato in Uganda and 1 million in Mozambique.
- Spillover Countries: Burundi, Rwanda, Ethiopia, Ghana, Kenya, Malawi, Mali, Nigeria, South Africa, Tanzania, Zambia, Zimbabwe

Low et al (2007) A Food-Based Approach Introducing Orange-Fleshed Sweet Potatoes Increased Vitamin A Intake and Serum Retinol Concentrations in Young Children in Rural Mozambique. Journal of Nutrition 137, 1320-1327

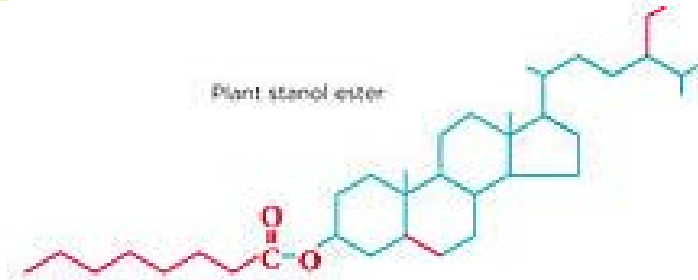
Food bioactives and chronic non communicable disease

What is the evidence that specific or mixtures of plant secondary metabolites may reduce risk of chronic disease such as cardiovascular disease and cancer?

- Epidemiological evidence
- Cell and animal models ?
- Human intervention studies

How can we use this evidence to enhance health?

- Dietary advice and behavioural changes
- Functional and biofortified foods -
 - Processed foods
 - Agronomic practices and food chain
 - New cultivars



The Panel notes that 1.5 - 1.9 g and 2.0 - 2.4 g plant sterols/plant stanols per day was observed to lower blood LDL-cholesterol by an average of 8.5 % and 8.9 %, respectively. The Panel concludes that for an intake of 1.5 - 2.4 g/d an average reduction of between 7 and 10.5 % can be expected. The Panel considers that such a reduction is of biological significance in terms of reduced risk of coronary heart disease.

Benecol & Flora pro active - £7.60/kg

Sunflower spreads – £2.00-4.00/kg

Butter spreads - £5.60/kg

Case-control
retrospective studies

Evidence that diet rich in fruits and vegetables reduced risk of CVD and cancer – underpinned '5-a-day' dietary advice



Just Eat More
(fruit & veg)

Cohort prospective
studies

Evidence that fruit and vegetables reduces risk of CVD, but, in general, less support for reduction in cancer risk.

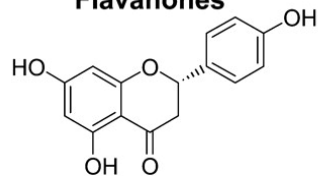
Meta-analyses

Evidence for health promoting effect of certain classes of F&V and dietary components

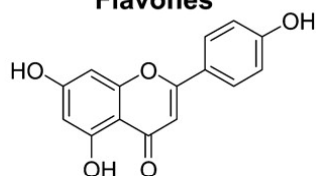
- Leafy green vegetables - Type II diabetes
- Cruciferous vegetables and glucosinolates – certain cancers and CVD
- Flavonoids – hypertension and CVD

Flavonoids and health

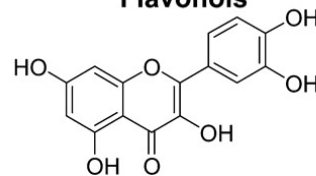
Flavanones



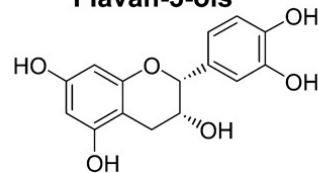
Flavones



Flavonols



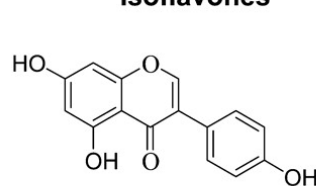
Flavan-3-ols



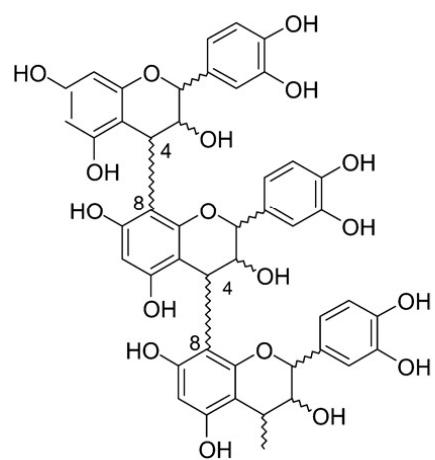
Anthocyanidins



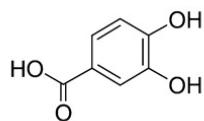
Isoflavones



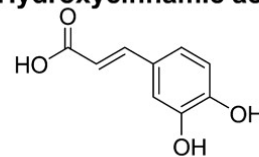
Procyanidins



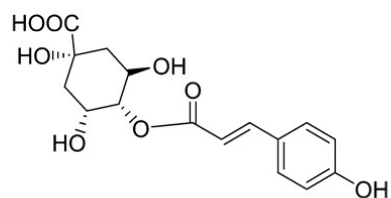
Hydroxybenzoic acids



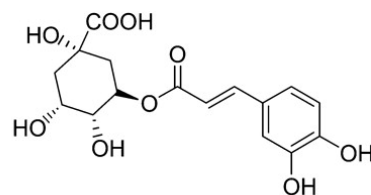
Hydroxycinnamic acids



Coumaroylquinic acids

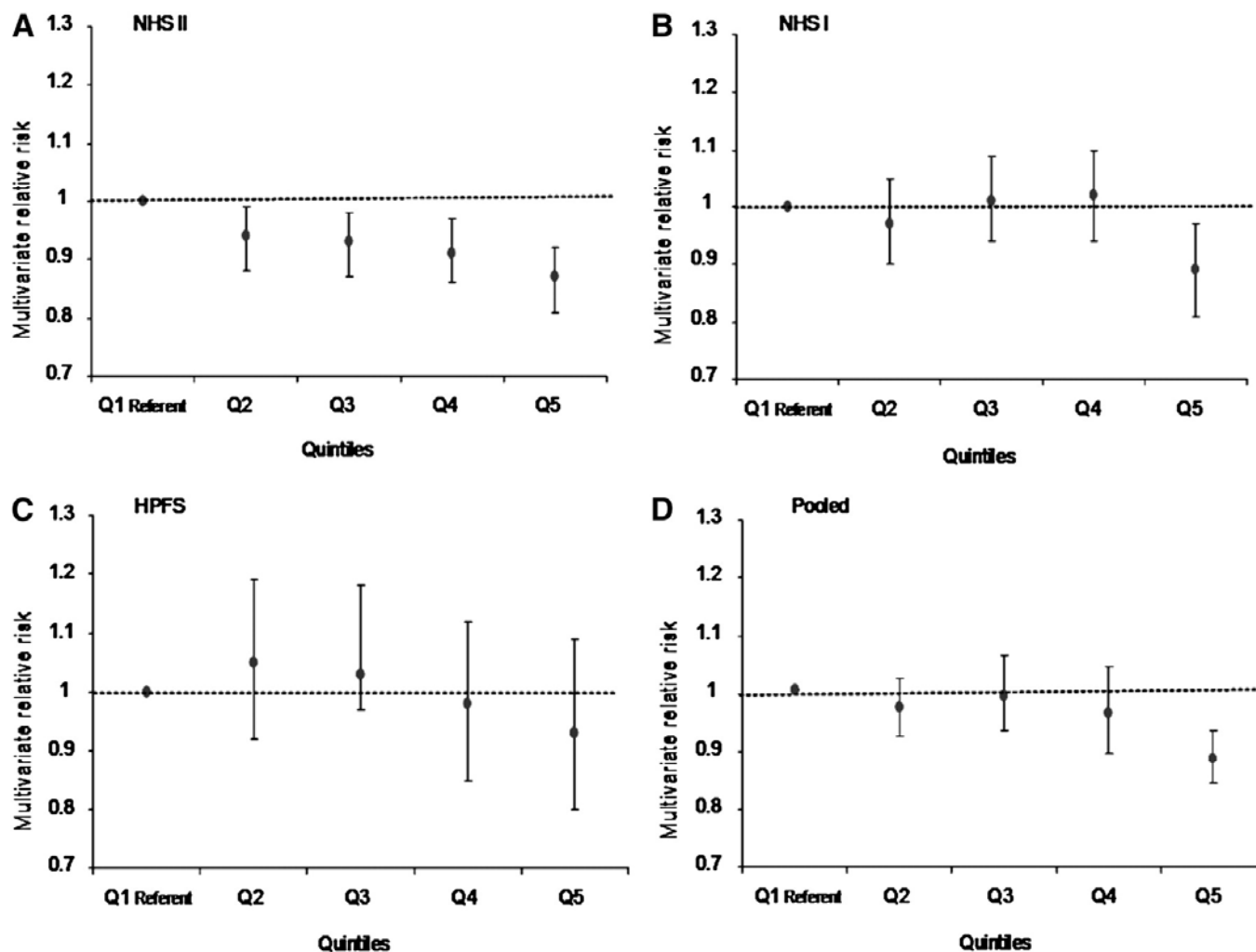


Caffeoylquinic acids



Cassidy et al (2011) Habitual intake of flavonoid subclasses and incident hypertension in adults Am J Clin Nutr 93, 338-47

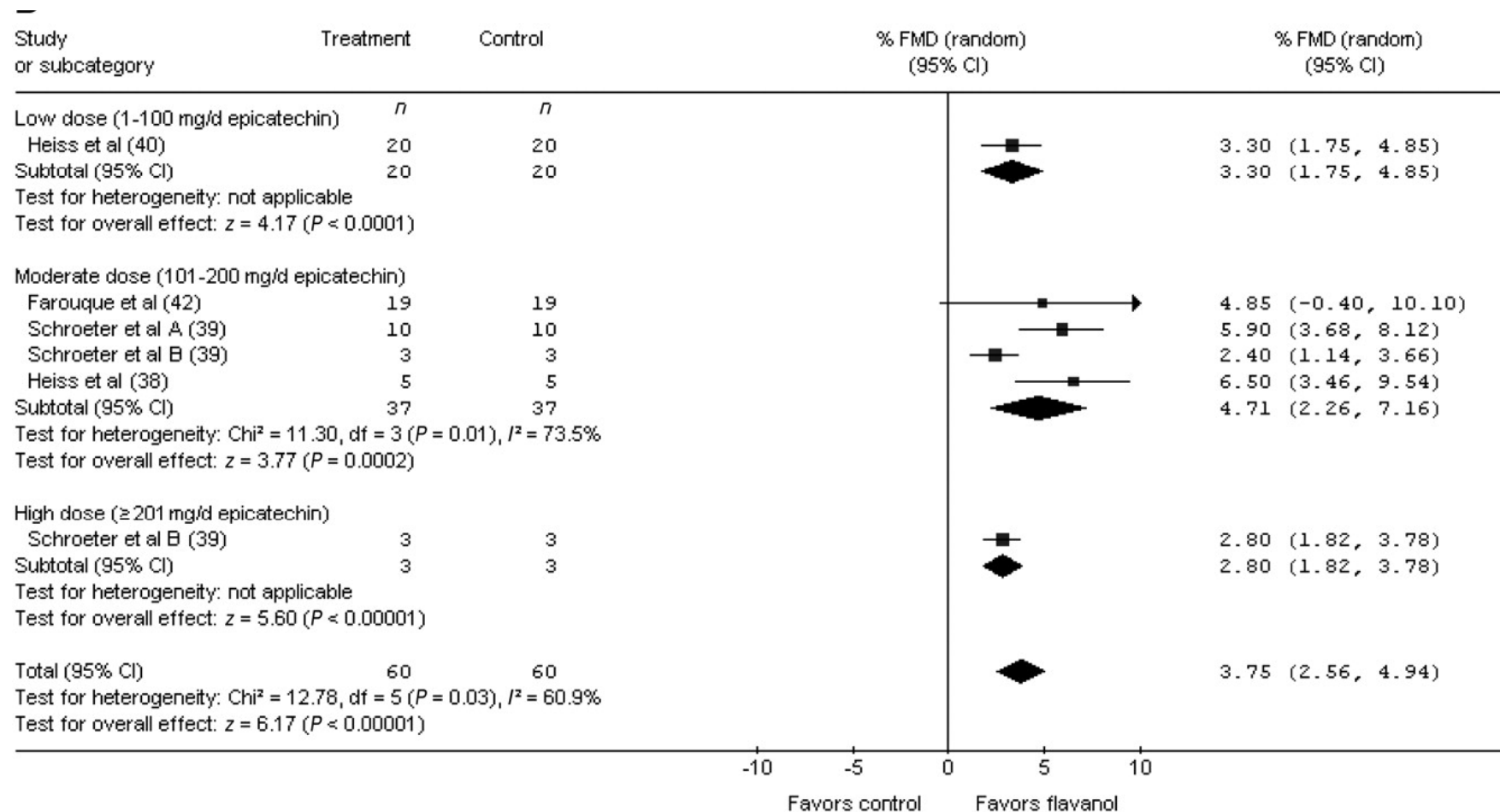
Analysed total flavonoid and subclasses intakes from semi-quantitative food frequency questionnaires and food compositional databases in three cohort studies.





Human intervention studies – acute effects of chocolate or cocoa on flow mediated dilation

Hooper et al (2008) Flavonoids, flavonoid rich foods and cardiovascular risk: a meta analyses of randomized controlled trials. Am J Clin Nut 88, 38-50



Flavonoid –rich foods may provide health benefits

Plenty of options, and easy to incorporate into processed foods





Minerals

- Calcium
- Potassium
- Magnesium
- Iron
- Manganese
- Zinc
- Selenium

Vitamins

- C, A, E, K, B1, B2
- Folates

Polyphenols

- Quercetin glycosides
- Kaempferol glycosides
- Chlorogenic acid
- Sinapic acid

Organo-sulphur compounds

- S-methyl cysteine sulfoxide
- Glucosinolates

sulphate → APS → sulphite → sulphide → cysteine → Protein

↓
 methionine

Acetyl Co-A

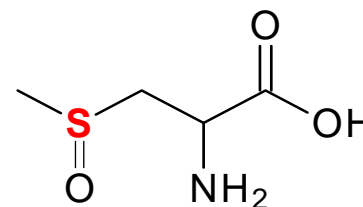
↓
 elongated methionine

↓
 Glutathione

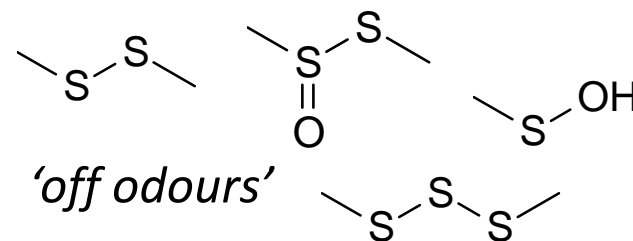
PAPS



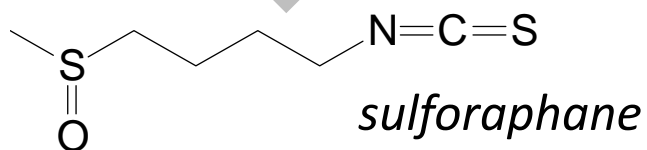
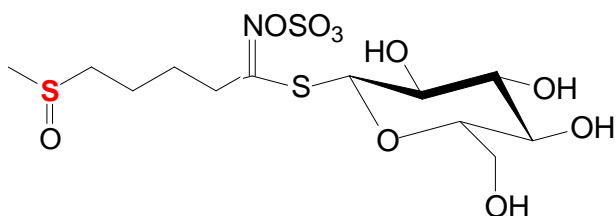
S-methyl cysteine sulfoxide



cooking



Methionine-derived glucosinolates





Germplasm
collection

B.villosa x broccoli Marker-assisted backcrossing

Human dietary studies
Functional analyses

1984

1995

2010



US launch of Beneforte broccoli
2011

UK launch of Beneforte broccoli
2012

www.beneforte.com

Beneforté™ ~ Home - Windows Internet Explorer provided by TOC Computing

http://www.beneforte.com/ Google UK

Google www >> Settings

Beneforté™ ~ Home

Beneforté™ Naturally Better Broccoli

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The superlative
super food.

Why Beneforté

Broccoli is one of the most nutrient-dense foods known; it offers an incredibly high level of nutrition for a very low caloric cost... Beneforté broccoli is even more of a good thing...

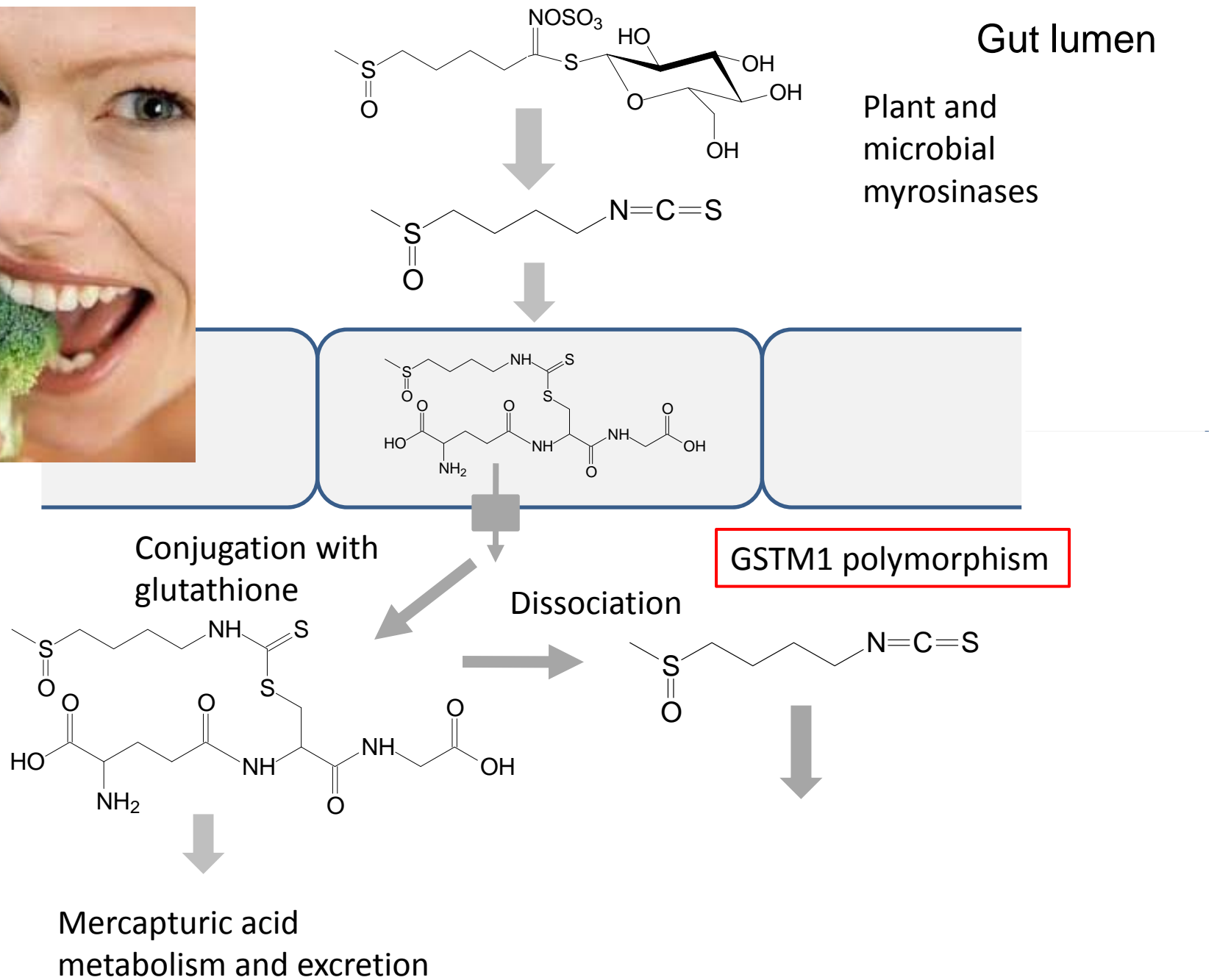
Learn about the Beneforté story

In the early 1980s scientists from the UK's Institute of Food Research traveled to Italy where the earliest broccoli plants first appeared hundreds of years ago.

Beneforté Recipes

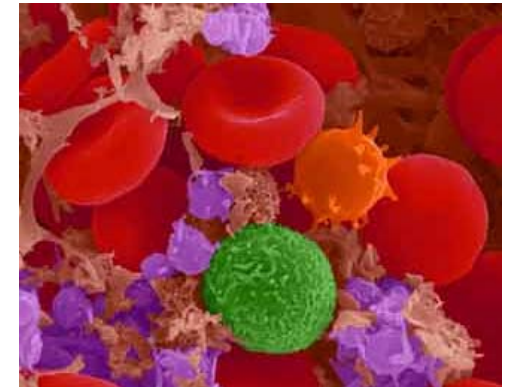
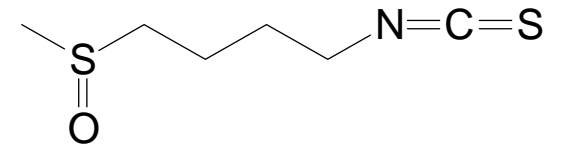
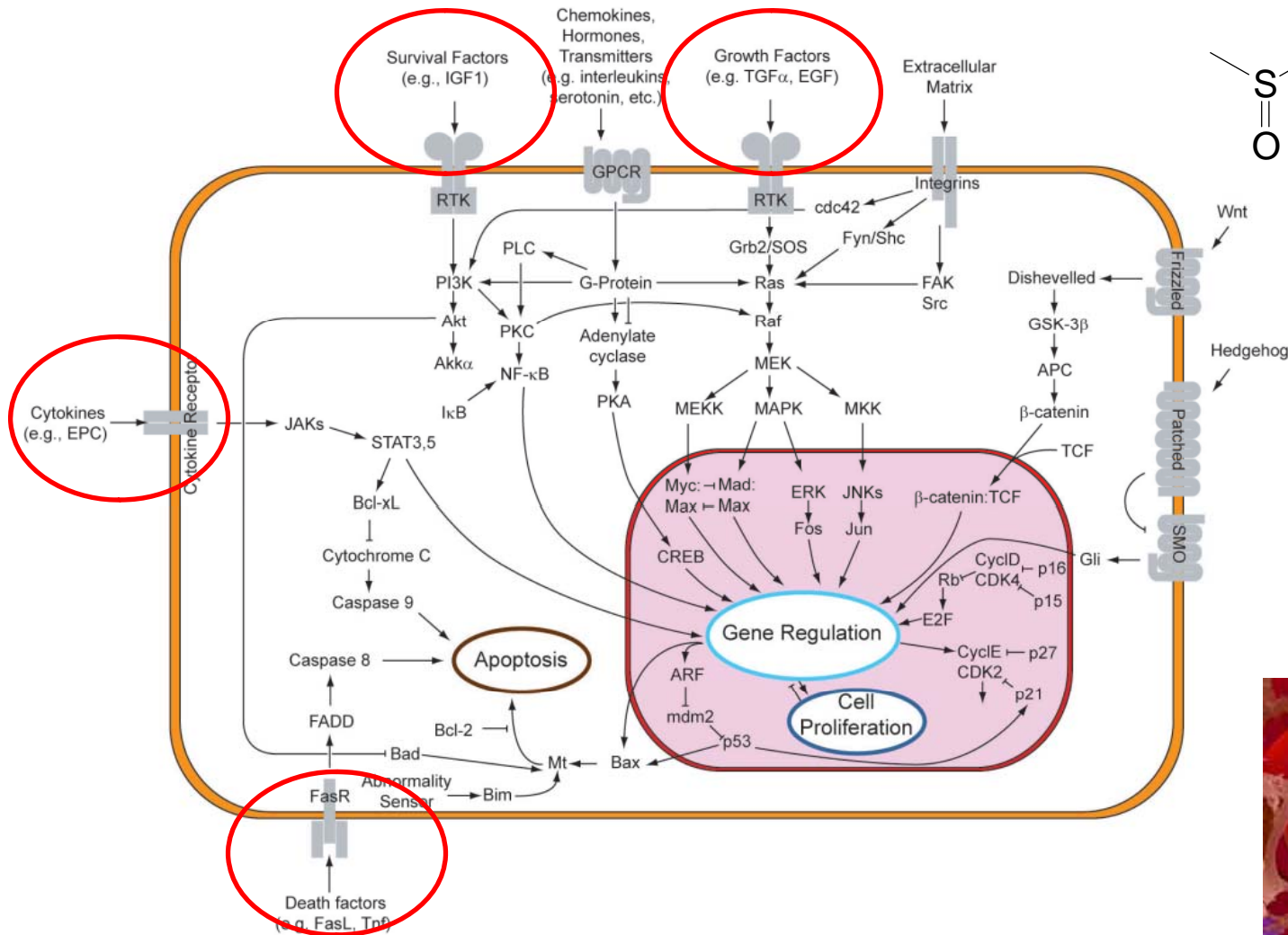
Beneforté broccoli is an even more healthful variety of regular broccoli. Use as a colorful and nutritious addition to quiche, stir fries or vegetable platters. Try roasting Beneforté as a simple method to bring out its natural sweetness

start 4 Microsof... 4 Microsof... 5 Windows... 2 Microsof... Beneforté™... Microsoft Po... Microsoft Po... 100% 09:38



Mechanistic studies

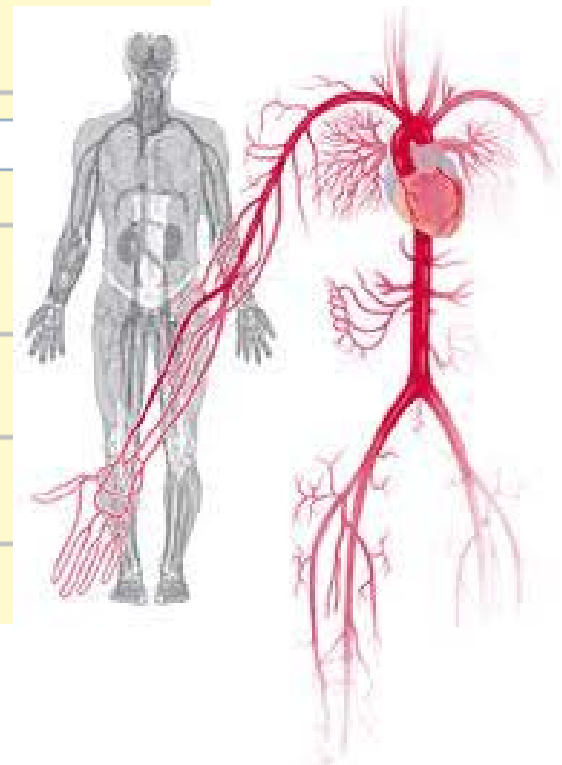
Perturbation of cell signalling pathways by food bioactives – integration of cell and animal models with human studies.



Cardiovascular Risk Calculator For Primary Prevention

This calculator should not be used if patient has known CVD or Diabetes (already known to be at high risk)

Age (30-74)	<input type="text" value="57"/>	Smoking Status	<input type="text" value="Non Smoker"/>
Sex	<input type="text" value="Male"/>	Glucose	<input type="text" value="Normal"/>
Systolic BP	<input type="text" value="141"/>	LVH	<input type="text" value="No LVH"/>
Diastolic BP	<input type="text" value="92"/>	Central Obesity	<input type="text" value="No"/>
Total Cholesterol	<input type="text" value="6.7"/>	South Asian Origin	<input type="text" value="No"/>
HDL Cholesterol	<input type="text" value="1.55"/>	Family History of CVD (Men <55 and women <65 years)	<input type="text" value="No FH"/>
Total /HDL Ratio	<input type="text" value="4.32"/>	<input type="button" value="Calculate"/>	<input type="button" value="Clear Fields"/>
Serum TG mmol/l	<input type="text" value="2.05"/>		
Using Systolic BP prediction, the 10 year risk of <input type="text" value="JBS CVD Risk"/> is <input type="text" value="19"/> %			
The equivalent risk calculation with diastolic BP is <input type="text" value="20"/> %			



Nutrition and Health claims

EFSA's work includes providing scientific advice on:

- **General function health claims under Article 13.1 of the EU regulations**

4637 applications, 263 opinions

- **New function health claims under Article 13.5**

48 applications (13 withdrawn) 27 opinions

- **Claims regarding disease risk reduction and child development or health under Article 14**

264 applications (103 withdrawn) 75 opinions

New function health claims under Article 13.5

Scientific opinions give on:

- Lactobacillus or Bifidobacter containing products – 8
- Plant extracts – 8
- Products involving fish oils – 2
- Others - 4



ProveXis[®]
plc



“Helps maintain normal platelet aggregation, which contributes to healthy blood flow ”

“Frequent consumption of typical juice drinks and sugar-containing, acidic, non-alcoholic beverages may contribute to tooth demineralisation; consumption of 'toothkind' juice drinks in replacement of typical juice drinks and sugar-containing, non-alcoholic beverages may help to reduce tooth demineralisation.”

