

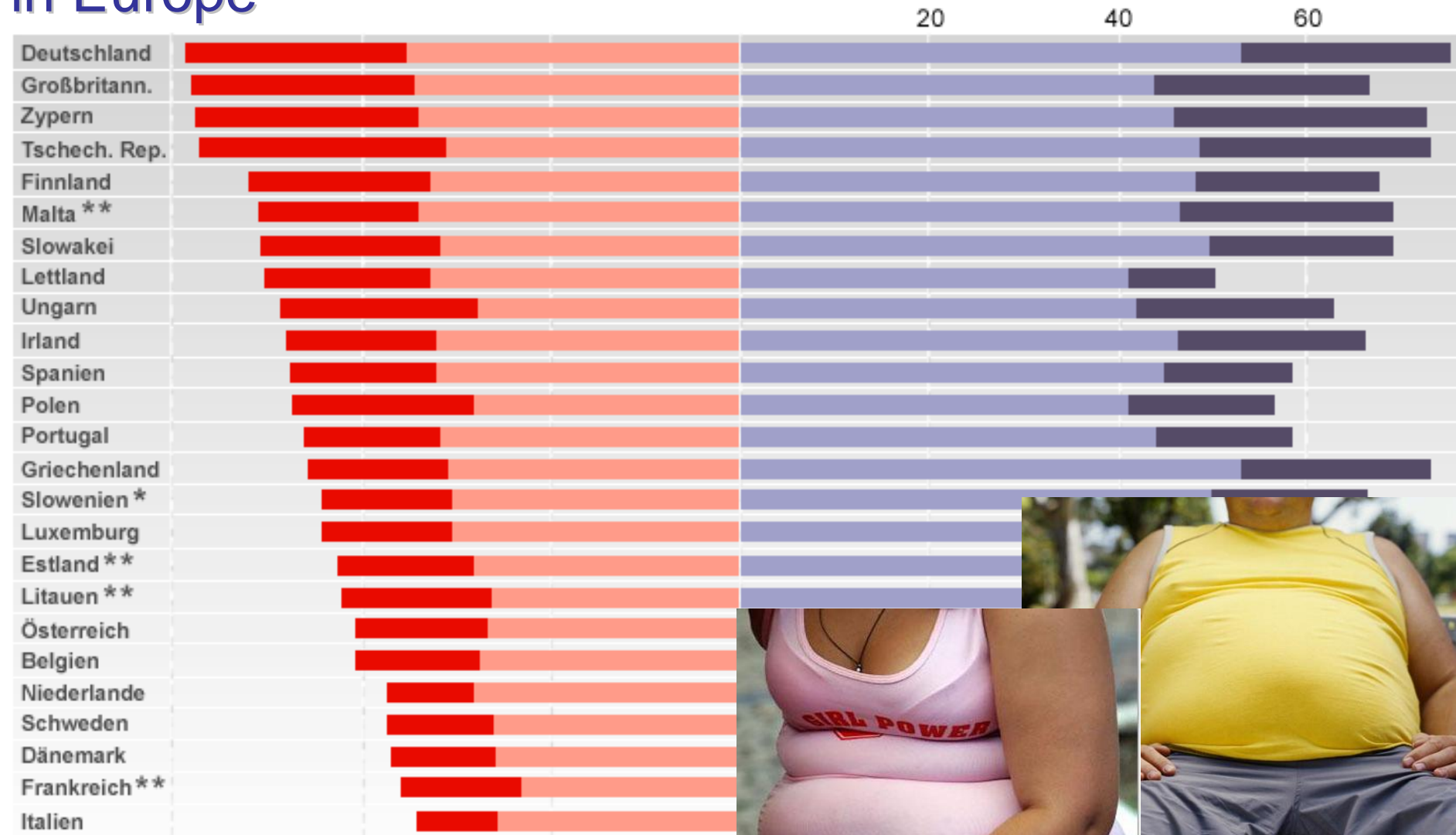
Improving the formation of dietary secondary plant metabolites and their implications for human health

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Leibniz-Institute of Vegetable and Ornamental Crops
Großbeeren & Erfurt e. V., Dept. Quality Research*

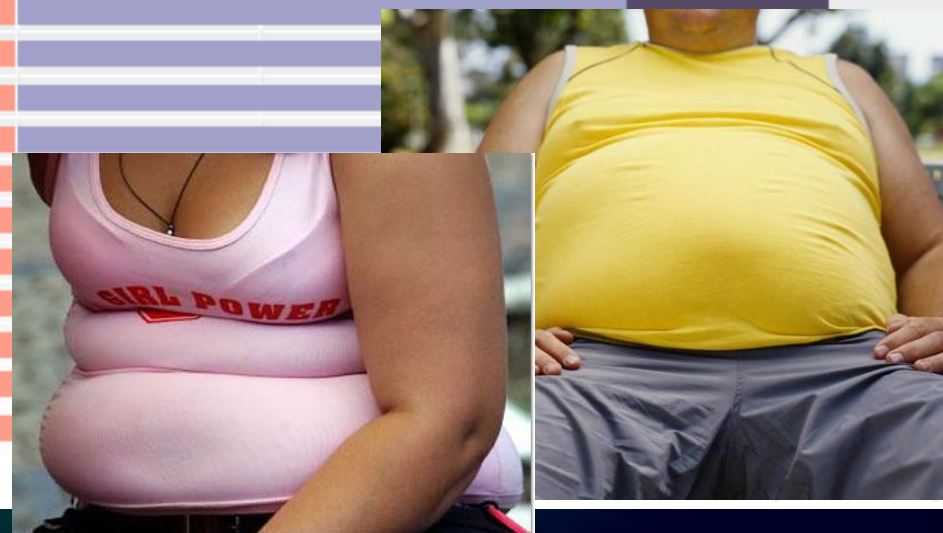


Overweight and obesity in Europe

Obesity: female ■ male ■
 Overweight: female ■ male ■

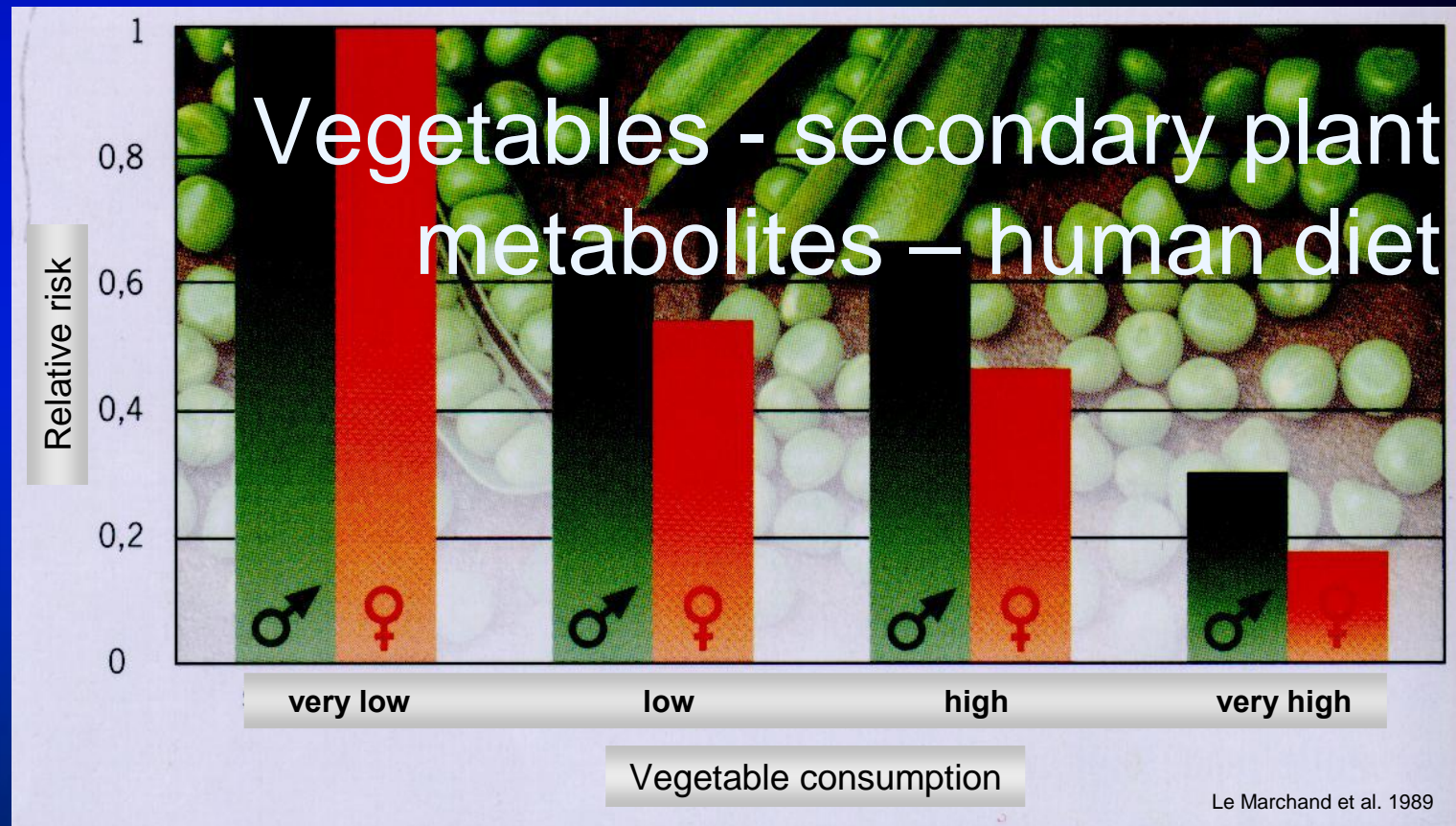


*Stadtbevölkerung **Nach eigenen Angaben



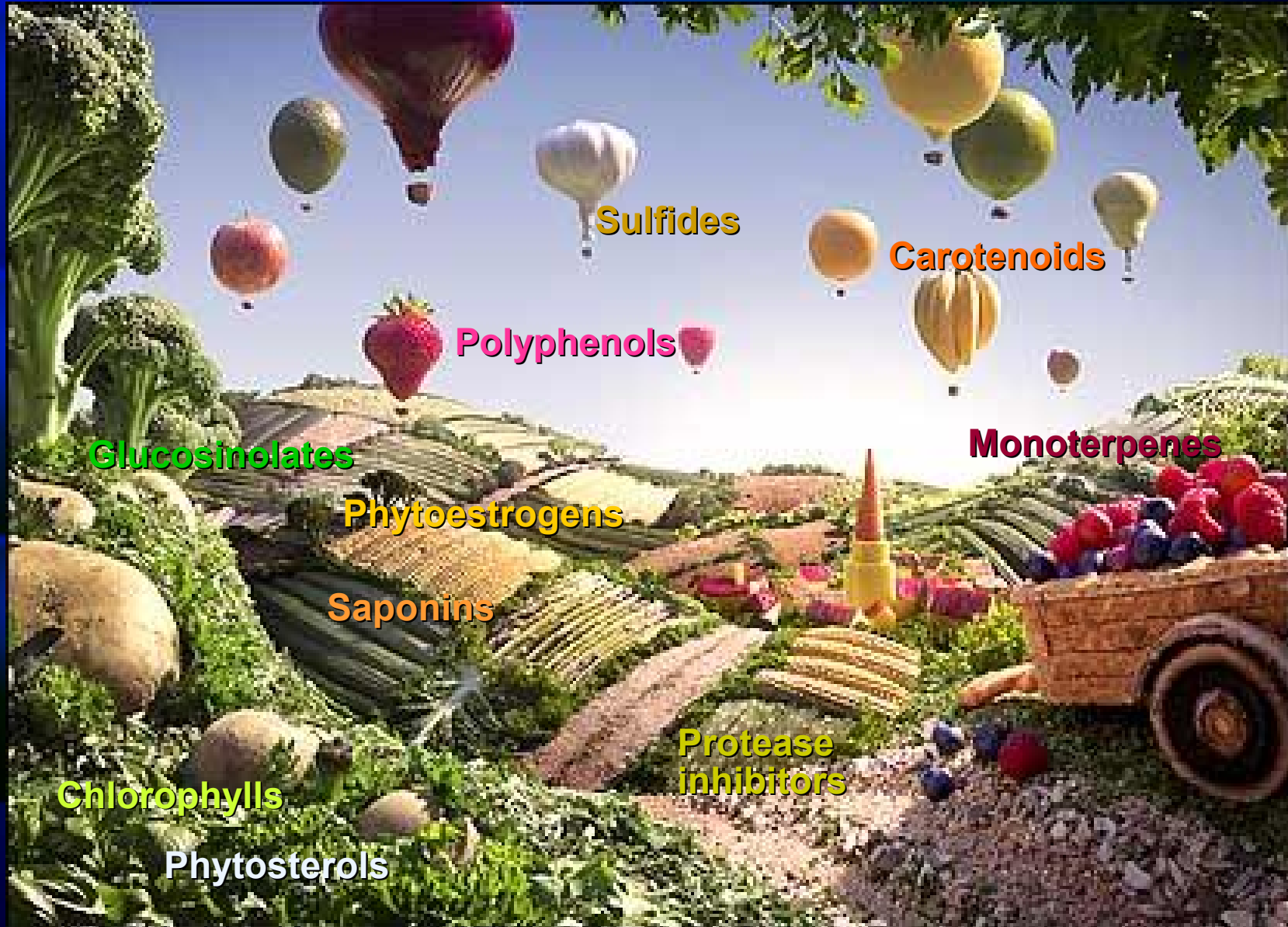
- Cholesterol
- Blood sugar
- Blood pressure
- Cancer
- Cardio-vascular disease



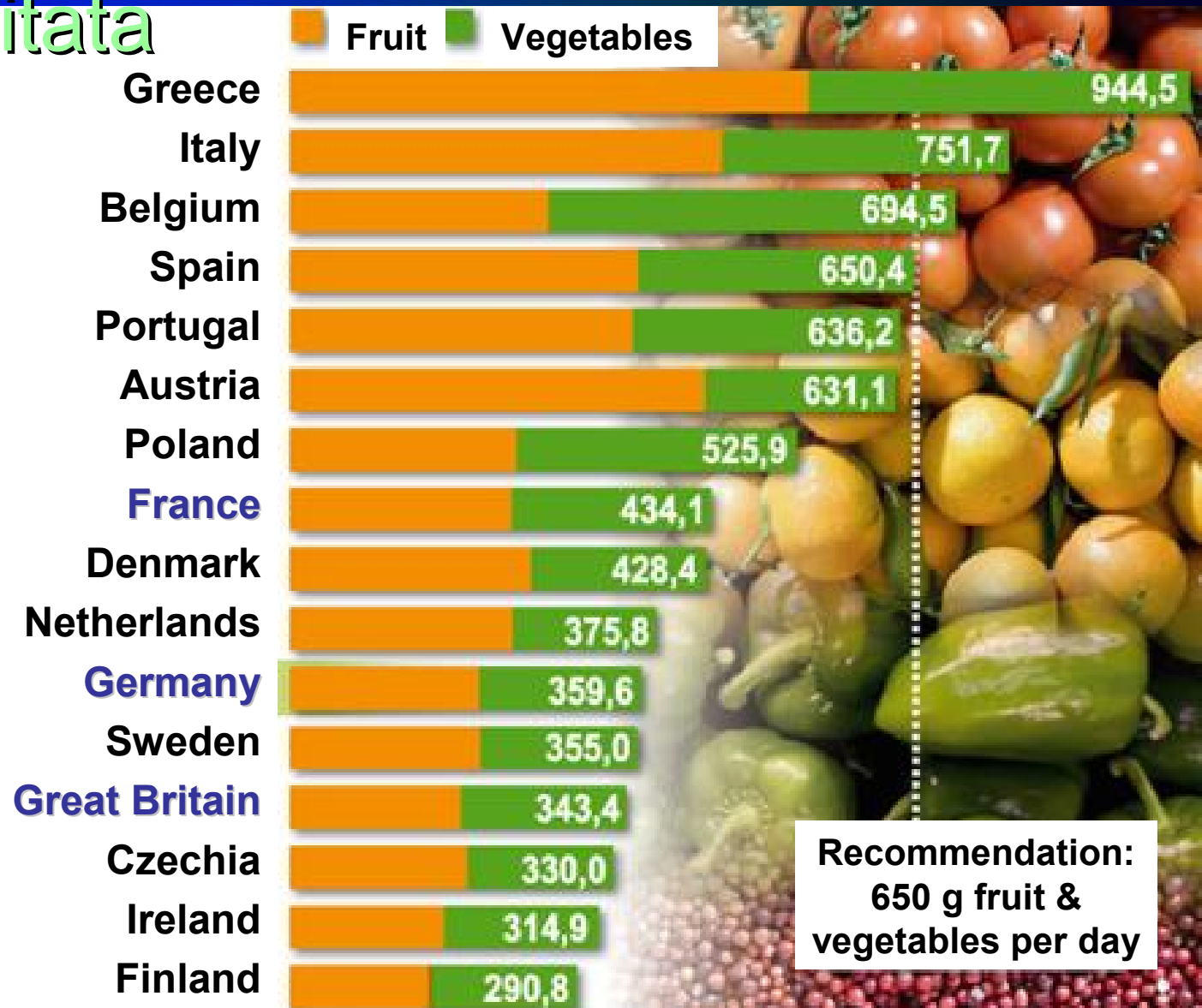


- Epidemiological studies - inverse association between vegetable consumption and cancer
- Secondary plant metabolites with health-promoting properties

Secondary plant metabolites

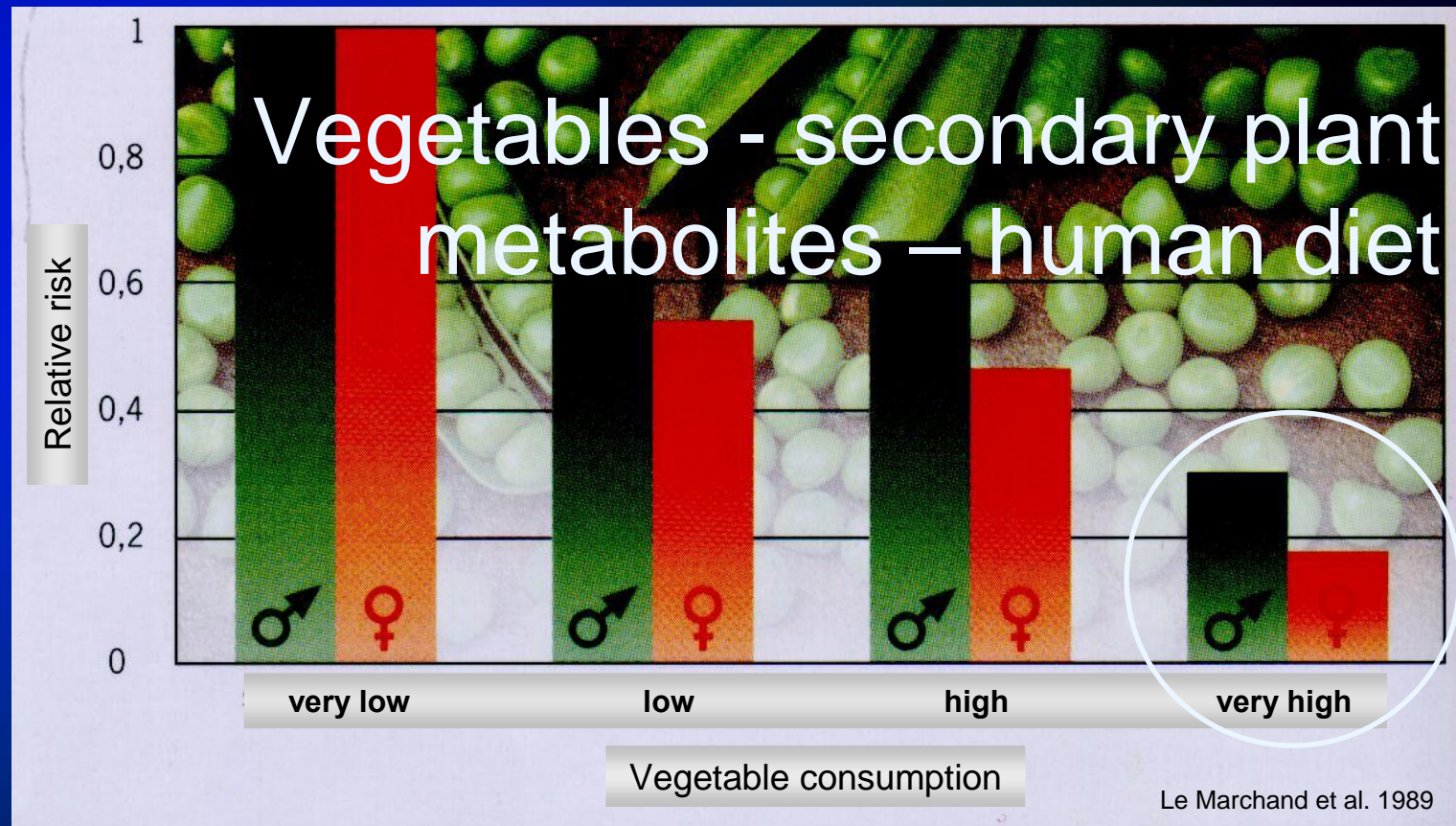


Consumption of fruit and vegetables per capitata



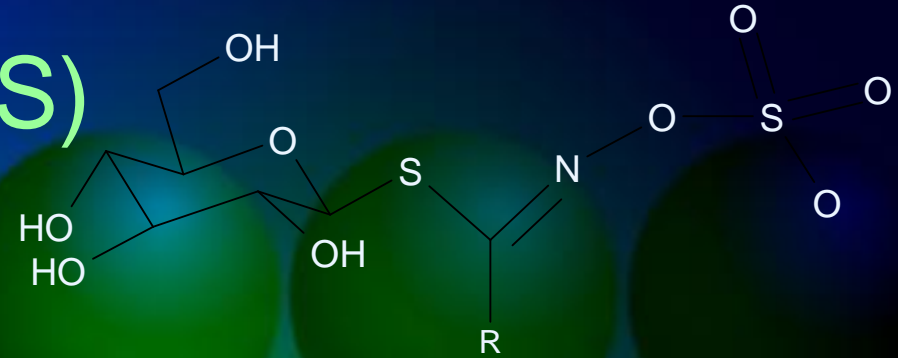
**Recommendation:
650 g fruit &
vegetables per day**

World Cancer Research Fund/
Amer. Institute f. Cancer Research
Health Education Authority (UK)
German Nutrition Society
German Cancer Society



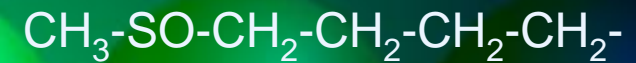
- 500 g broccoli, 400 g cabbage, 85 g water cress per day
- Dietary strategy: increasing levels of secondary plant metabolites

Glucosinolates (GS)



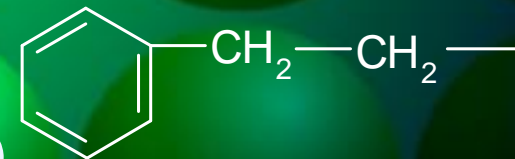
- Aliphatic GS

- **Glucoraphanin** (4-Methylsulfinylbutyl GS)
- **Sinigrin** (2-propenyl GS)



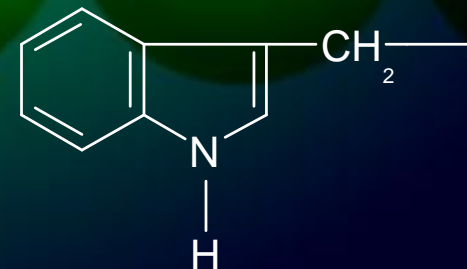
- Aromatic GS

- **Glucotropaeolin** (Benzyl GS)
- **Gluconasturtiin** (2-Phenylethyl GS)



- Indole GS

- **Glucobrassicin** (3-Indolylmethyl GS) + Derivates



Brassicales species with desired glucosinolate



Glucotropaeolin



Glucoraphanin



Gluconasturtiin



Indole GS

Post-grad *Brassica* vegetables



LIBERTY EXCHANGE Kitchen + Bar

Chef Makoto Ono

Shop 103, 206-207, 1/F & 2/F, Two Exchange Square
交易廣場第二座1-2樓103及206-207號舖

T: 2810 8400

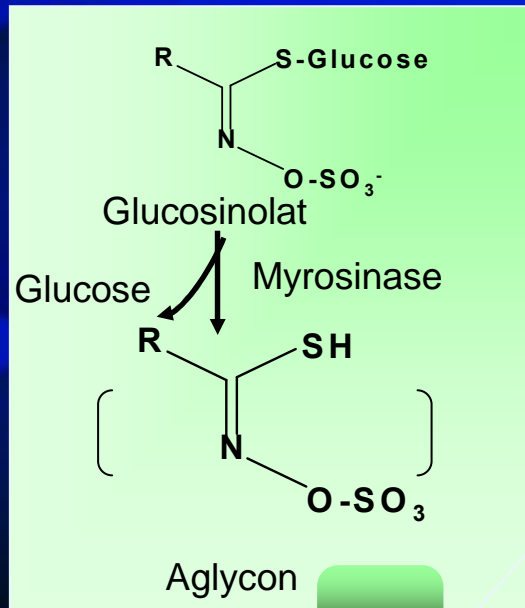
'Mark Twain said "Cauliflower is nothing but a cabbage with a college education." But let's see if we can go post-grad.'

「美國著名小說家馬克·吐溫曾說過：『椰菜花與一般椰菜沒甚麼兩樣，它只是一種較高級的椰菜類而已。』就儘管看看我們能否把椰菜花升格，打造美味滿分的菜式。」

- Breeding
- Transgenic plants
- Elicitor application



Targeted elicitor application for influencing glucosinolate biosynthesis



Temperature

Atmospheric CO₂/O₂

Microorganism

N/S application

Amino acid application

Met

MAM

elong Met

CYP79 F1/F2

Aliphatic aldoxime

CYP83 A1

Aliphatic thiohydroximate

C-S-lyase

Aliphatic thiohydroximic acid

SGT

Aliphatic desulfo GS

S trans

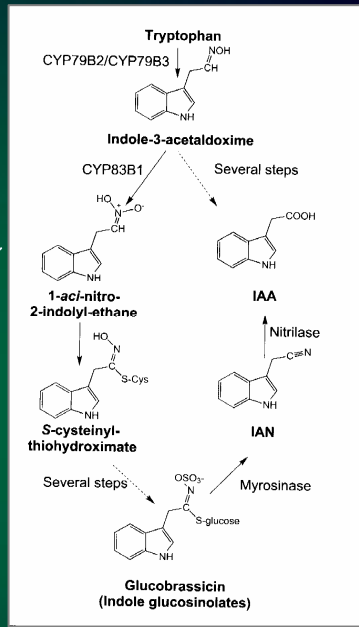
Aliphatic GS

PPFD

UV-B irradiation

gamma irradiation

Signaling molecule application



Schreiner. Eur. J. Nutr. 44, 2005.
 Scheuner, Schmidt, Krumbein, Schonhof & Schreiner. J. Plant Nutr. Soil Sci. 168, 2005.
 Schreiner, Peters & Krumbein. J. Agric. Food Chem. 54, 2006.
 Schreiner & Huyskens-Keil. Crit. Rev. Plant Sci. 25, 2006.
 Schonhof, Kläring, Krumbein, Claußen & Schreiner. Agric. Ecol. Environ. 119, 2007.
 Schonhof, Kläring, Krumbein & Schreiner. J. Chem Ecol 33, 2007.
 Schreiner, Peters & Krumbein. J. Food Sci. 72, 2007.
 Smetanska, Krumbein, Schreiner & Knorr. J. Hort. Sci. Biotechnol. 82, 2007.
 Li, Schonhof, Krumbein, Long, Stützel & Schreiner. J. Agric. Food Chem. 55, 2007.
 Schreiner, Krumbein & Ruppel. J. Mol. Biol. Biotechnol., 2009.
 Schreiner, Krumbein, Mewis, Ulrichs & Huyskens-Keil. Inno. Food Emer. Technol. 10, 2009.
 Verkerk, Schreiner, Krumbein, Ciska, Holst, Rowland, De Schrijver, Hansen, Gerhäuser, Mithen & Dekker. Mol. Nutr. Food Res. 2009.
 Schreiner, Krumbein, Knorr & Smetanska. J. Agric. Food Chem. 59, 2011.

New foods require new plant cultivation systems - Biomanufacturing

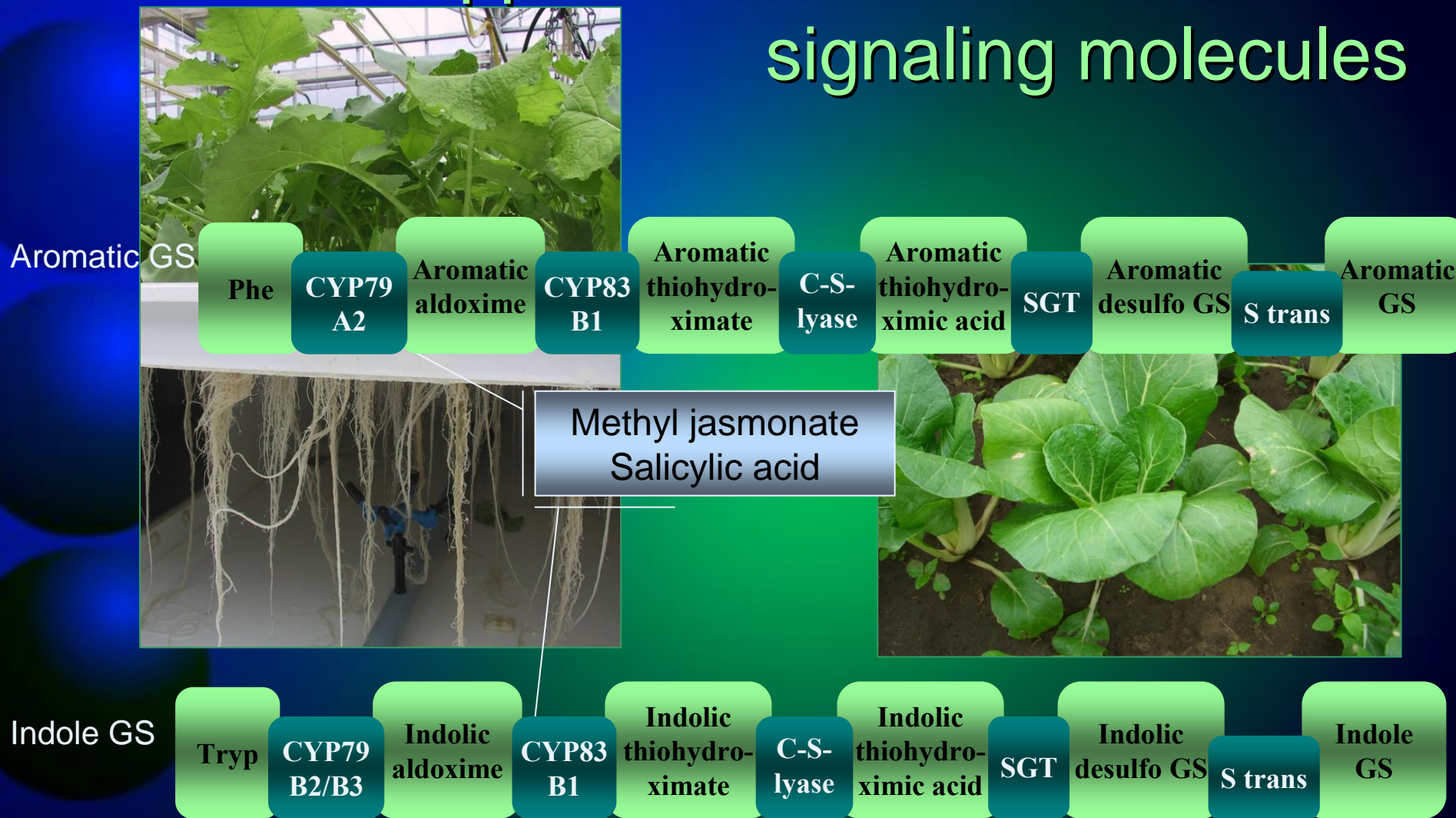


- No extraction from plant
- Continuous collection of glucosinolates



- Highly responsive to elicitor applications

Application chemical elicitors – signaling molecules



**Aeroponics
with defensor,
10 days**



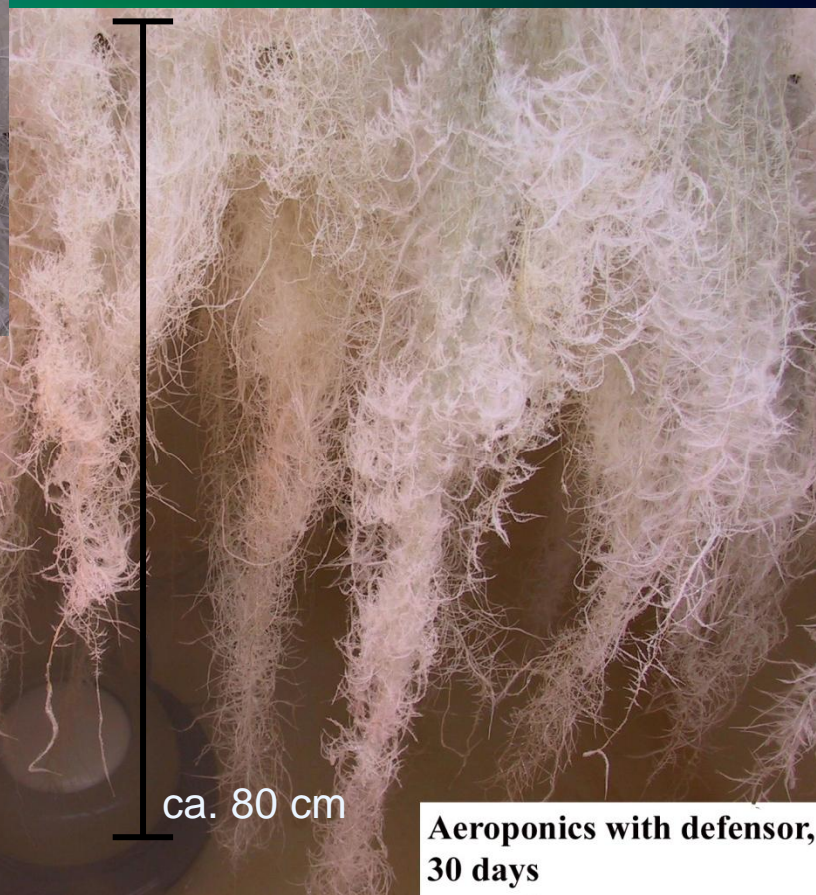
Root development of *B. rapa* in aeroponic system



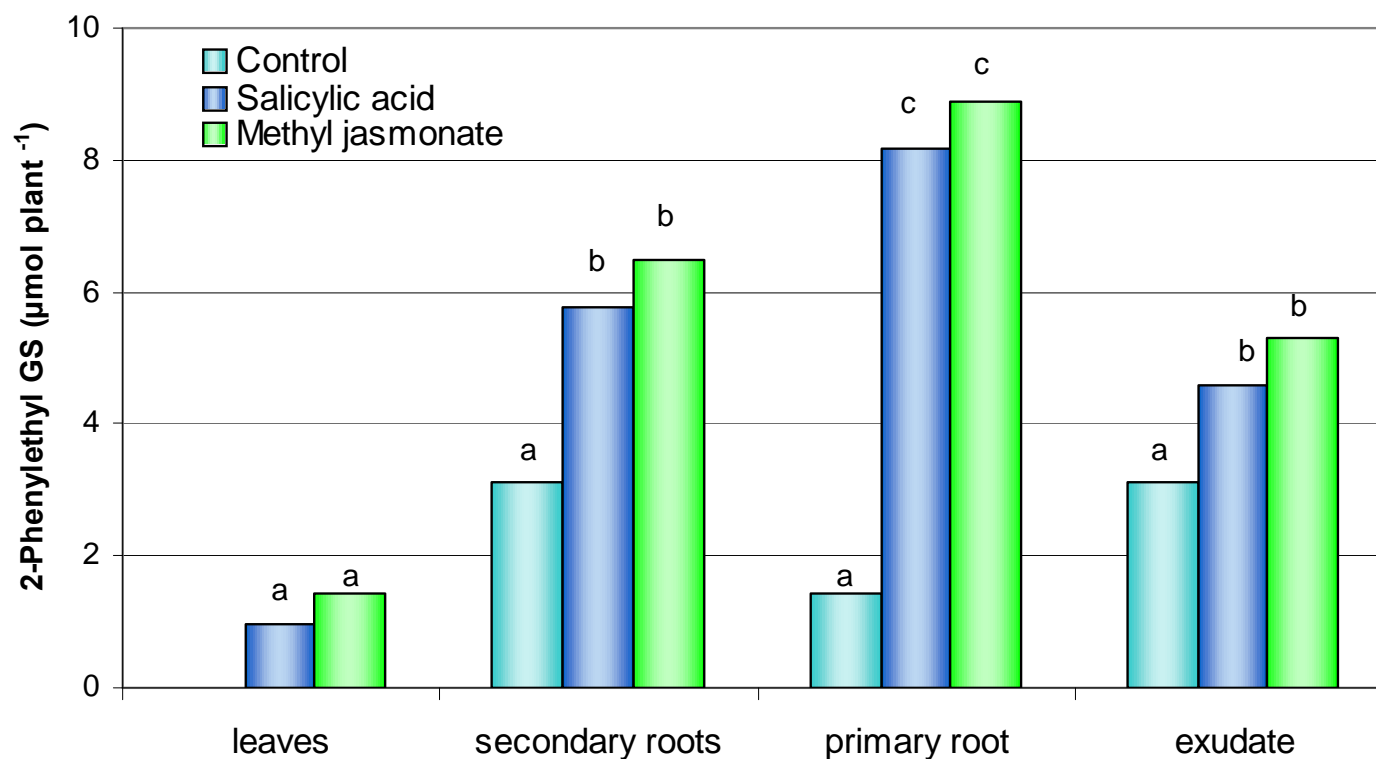
7-10 cm

ca. 80 cm

**Aeroponics with defensor,
30 days**



Effect of signalling molecule application on 2-phenylethyl glucosinolate (gluconasturtiin) in *Brassica rapa*

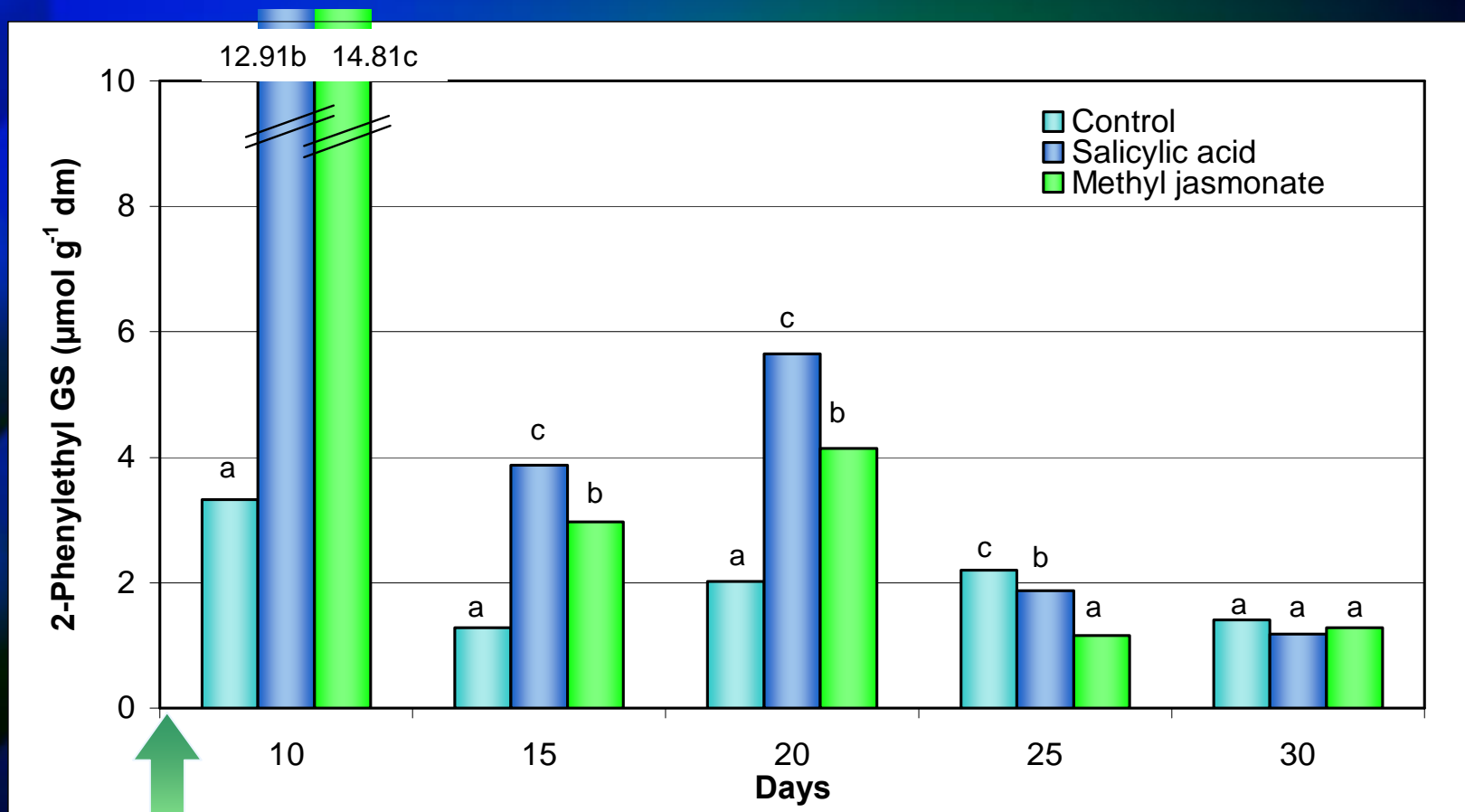


Smetanska , Krumbein, Schreiner & Knorr. J. Hort. Sci. Biotechnol. 82, 2007.

Patent PCT/EP2007/000788

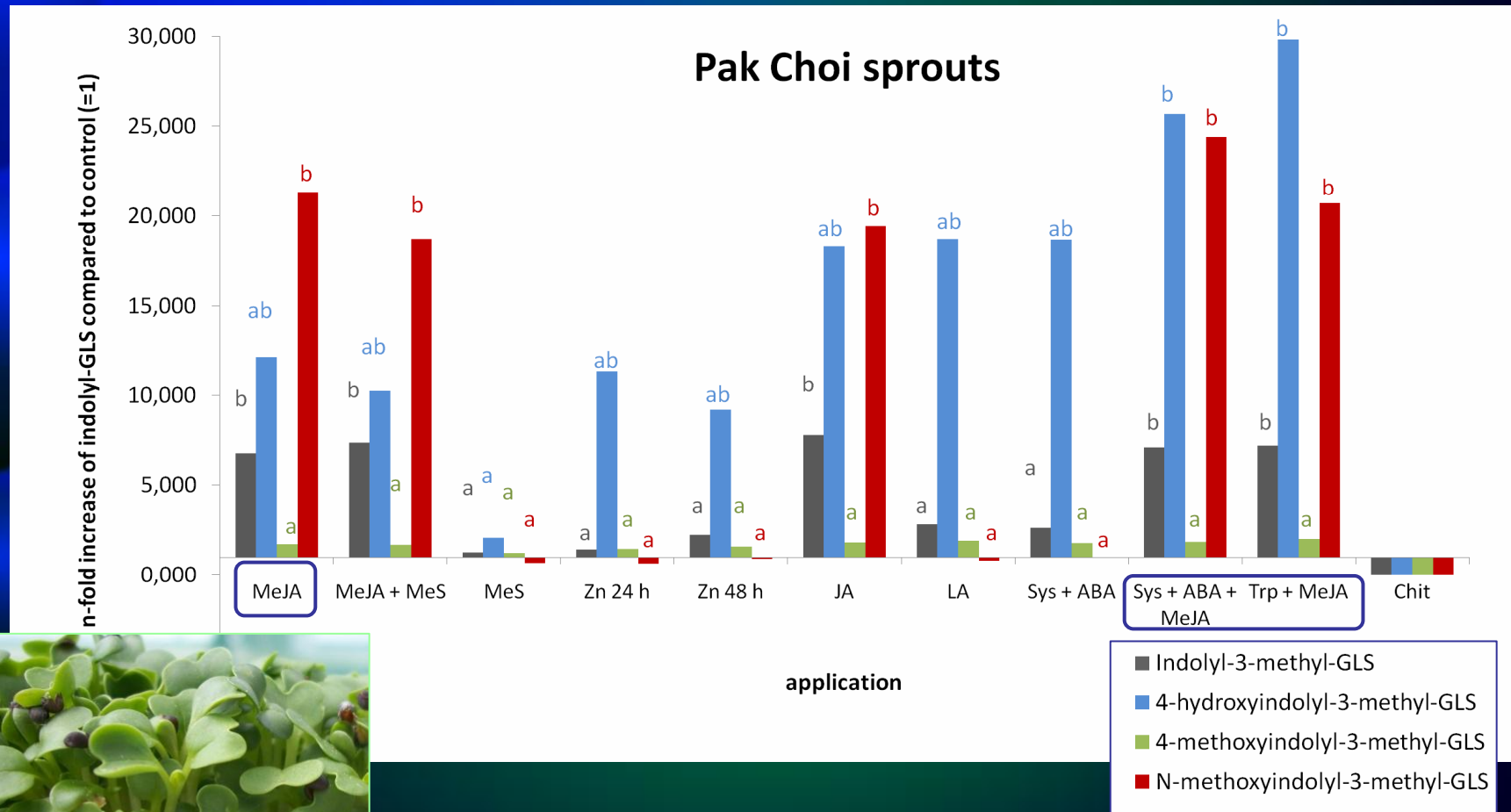
Schreiner, Krumbein, Knorr & Smetanska. J. Agric. Food Chem. 59, 2011.

Effect of signalling molecule application on 2-phenylethyl glucosinolate (gluconasturtiin) in *Brassica rapa*

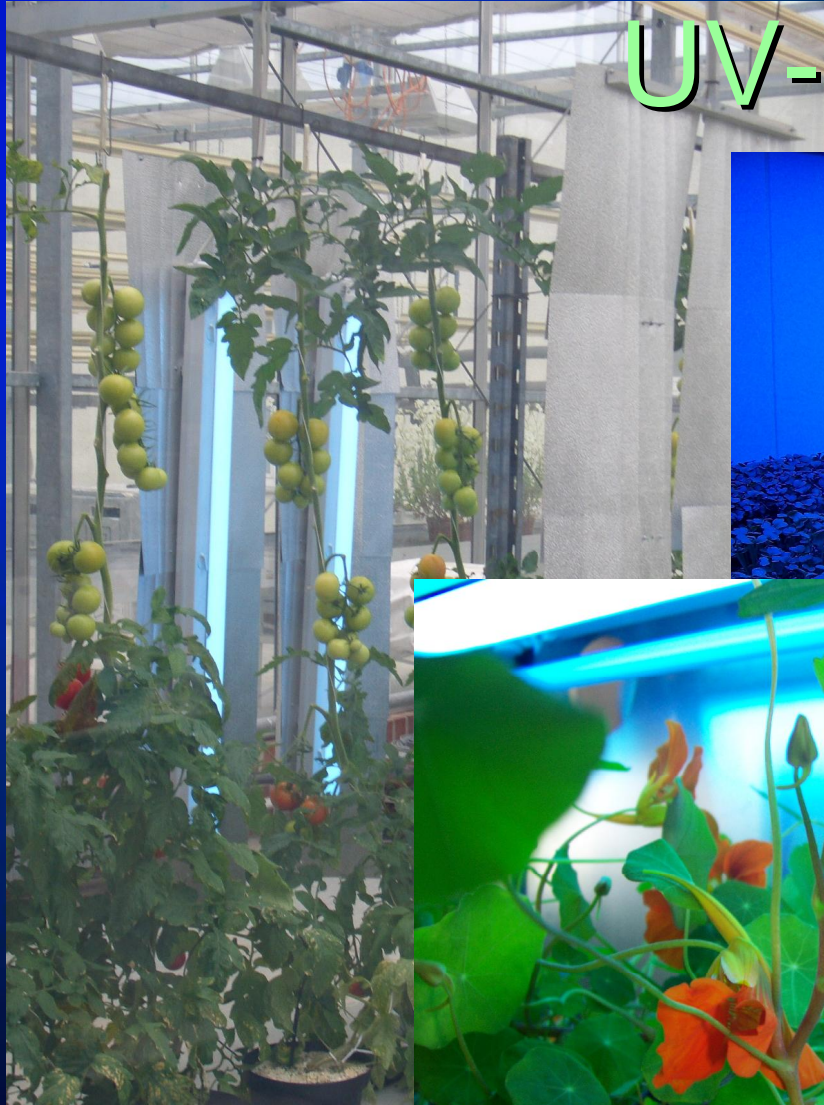


Elicitor application

Application of chemical elicitors – Signal molecule + Amino acid + phytohormone

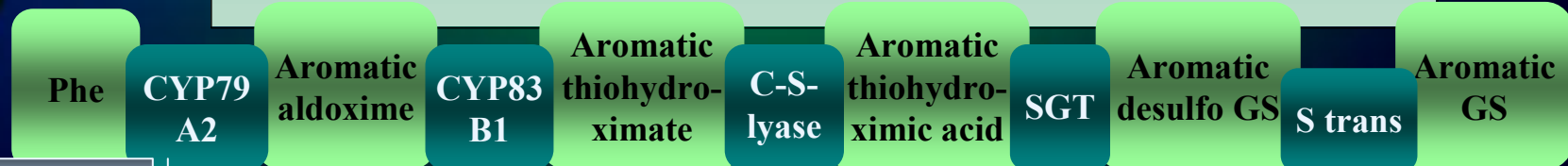
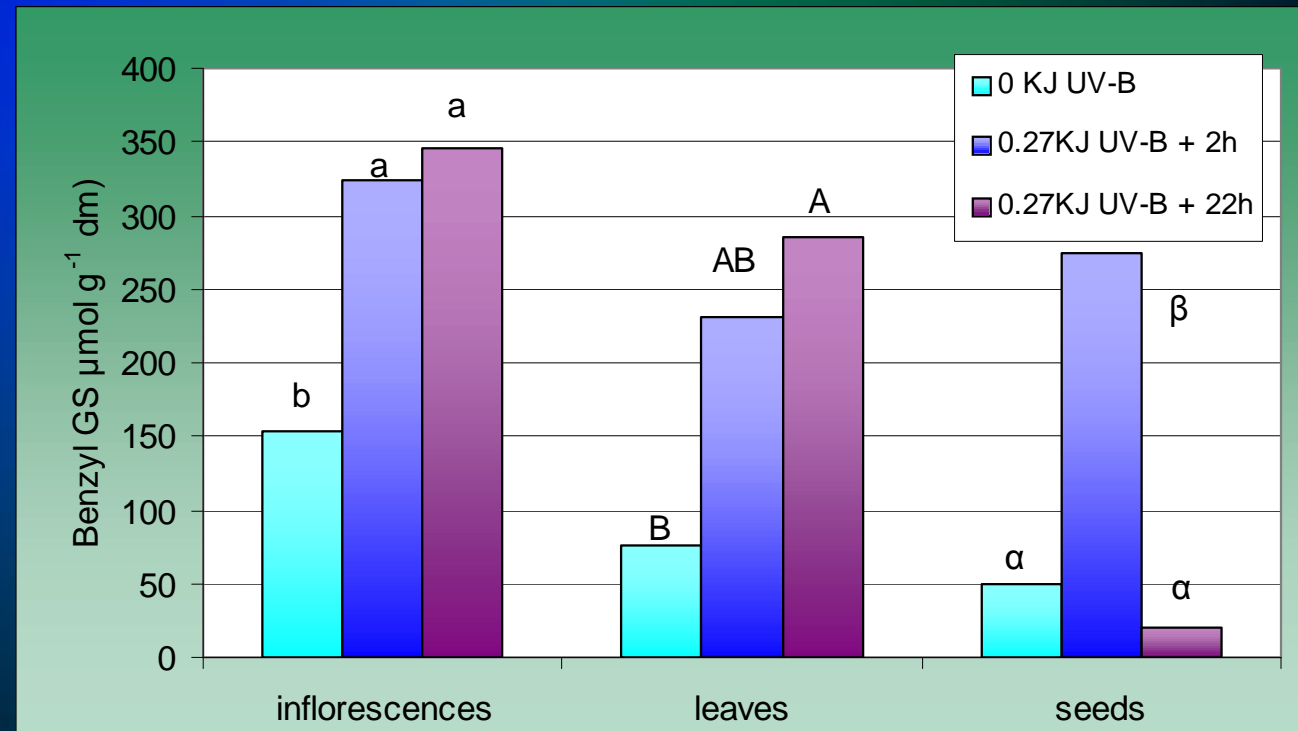


UV-B applications





UV-B application – nasturtium glucosinolates



UV-B irradiation

Schreiner & Huyskens-Keil. Crit. Rev. Plant Sci. 25, 2006.
 Schreiner, Krumbein, Mewis, Ulrichs & Huyskens-Keil. EcoSummit, 2007.
 Schreiner, Krumbein, Mewis, Ulrichs & Huyskens-Keil. Innovative Food Emer. Technol. 10, 2009.

Organ differentiated UV-B response

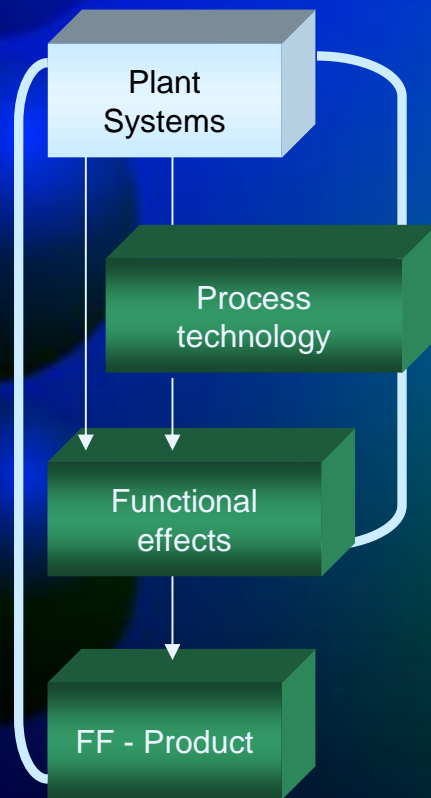
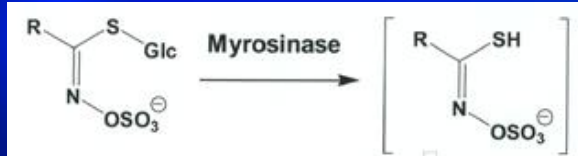


increased expansion of surface area



increased UV-B effect on sustainable benzyl glucosinolate (glucotropaeolin) accumulation

Functional effects of glucosinolates



Aliphatic GS

4-Methylsulfinylbutyl GS
(Glucoraphanin)

4-Methylsulfinylbutyl Isothiocyanat
(Sulforaphane)

DfE Banning, Deubel, Kluth, Zhou, Brigelius-Flohé. 2005 Mol. Cell Biol. 25: 4914-4923.
Brigelius-Flohé & Banning. 2006 Free Radic. Res. 40:775-787.

DfE Haack, Löwinger, Lippmann, Kipp, Pagnotta, Iori, Monien, Glatt, Brauer, Wessjohann, Brigelius-Flohé. 2010 Biol. Chem. 391,1281-1293.

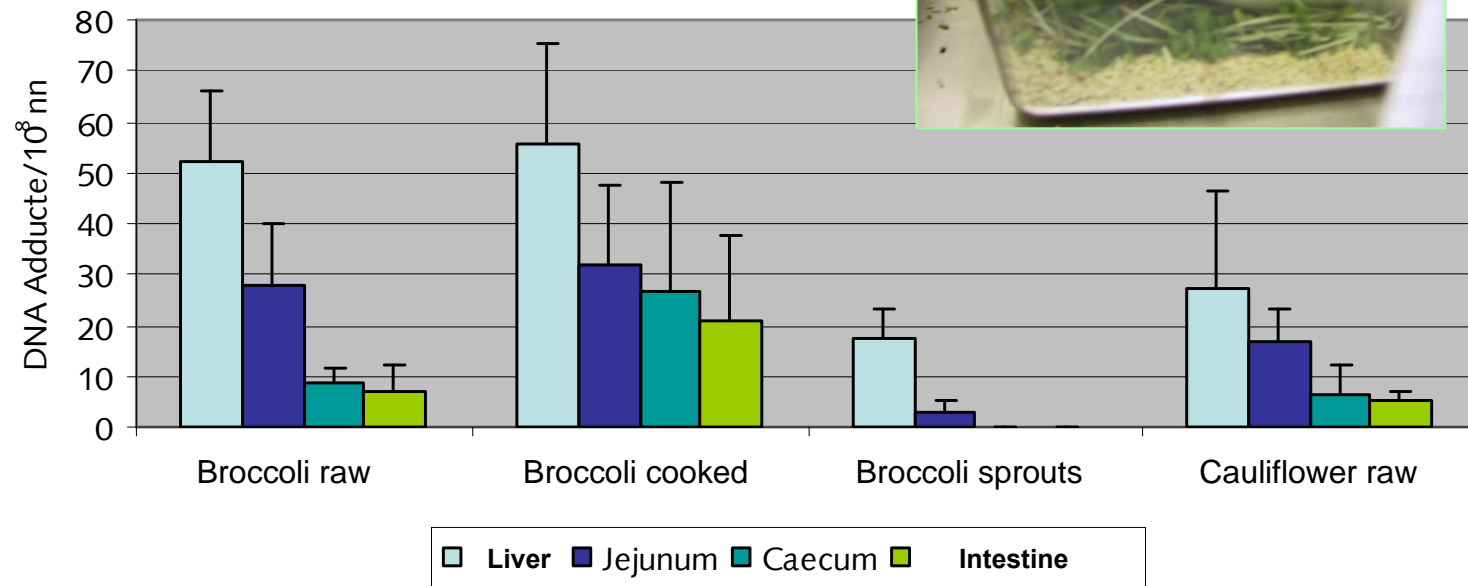
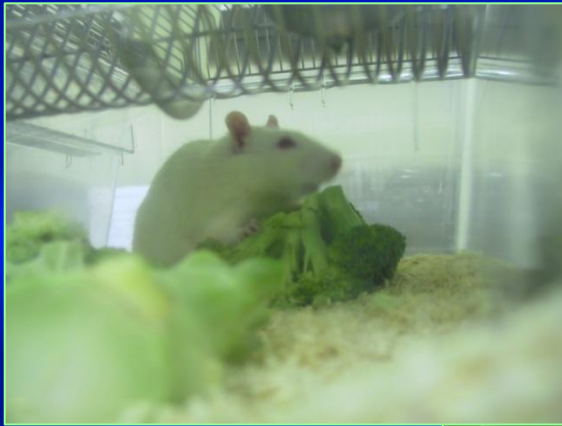
Indole GS

1-Methoxy-3-Indolylmethyl GS
(Neoglucobrassicin)

Indole-3-carbinol (I3C)

Glatt, Baasanjav-Gerber, Schumacher, Monien, Schreiner, Frank, Seidel, Engst. 2011. Chemico-Biological Interactions 192, 81-86.
Baasanjav-Gerber, Monien, Mewis, Schreiner, Barillari, Iori, Glatt. 2011. Mol. Nutr. Food Res. 55, 1-10.

Glucosinolates - Doses

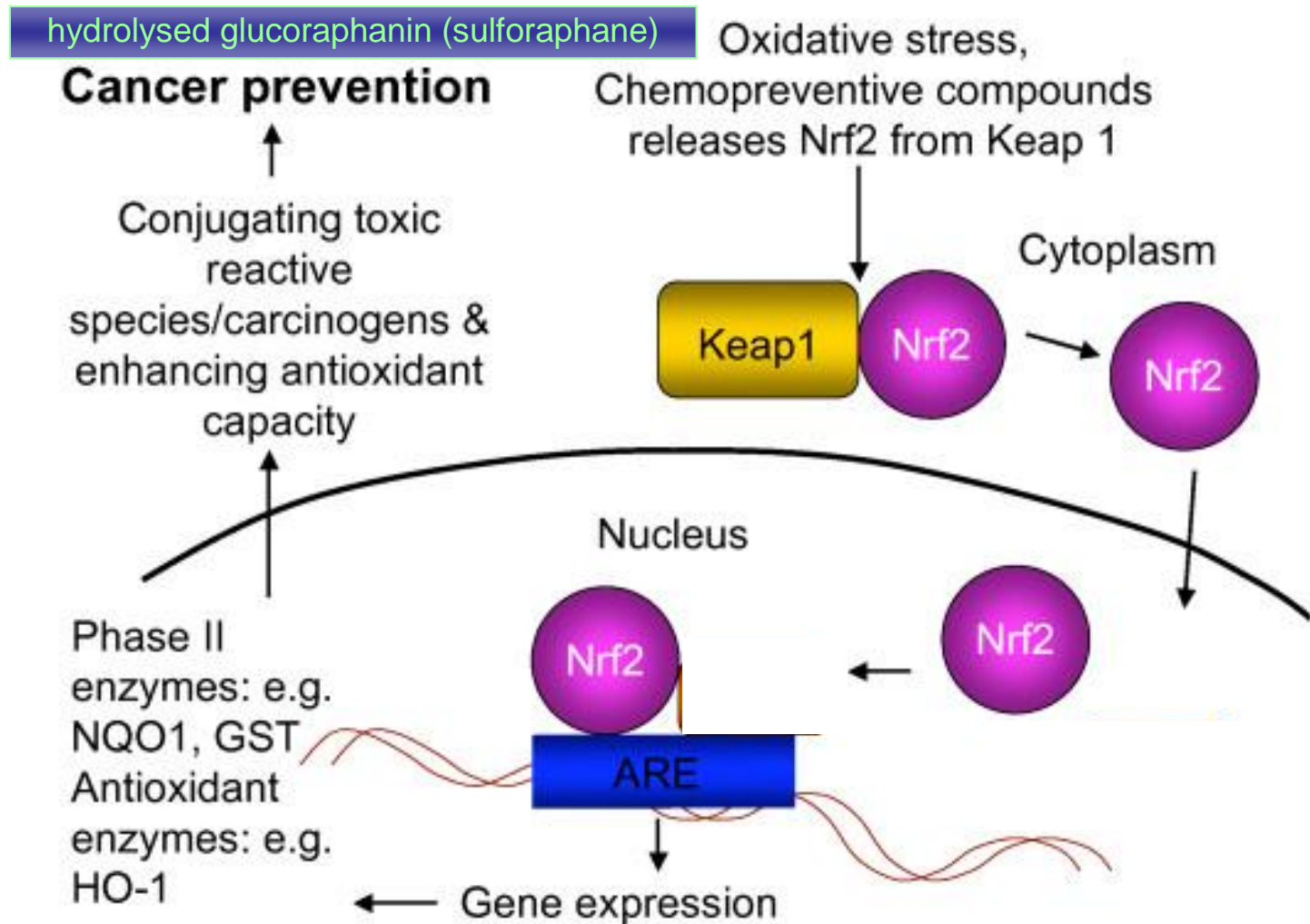


Mutagenic activity of glucosinolates in *Salmonella typhimurium* strain TA104, tested in the presence of myrosinase

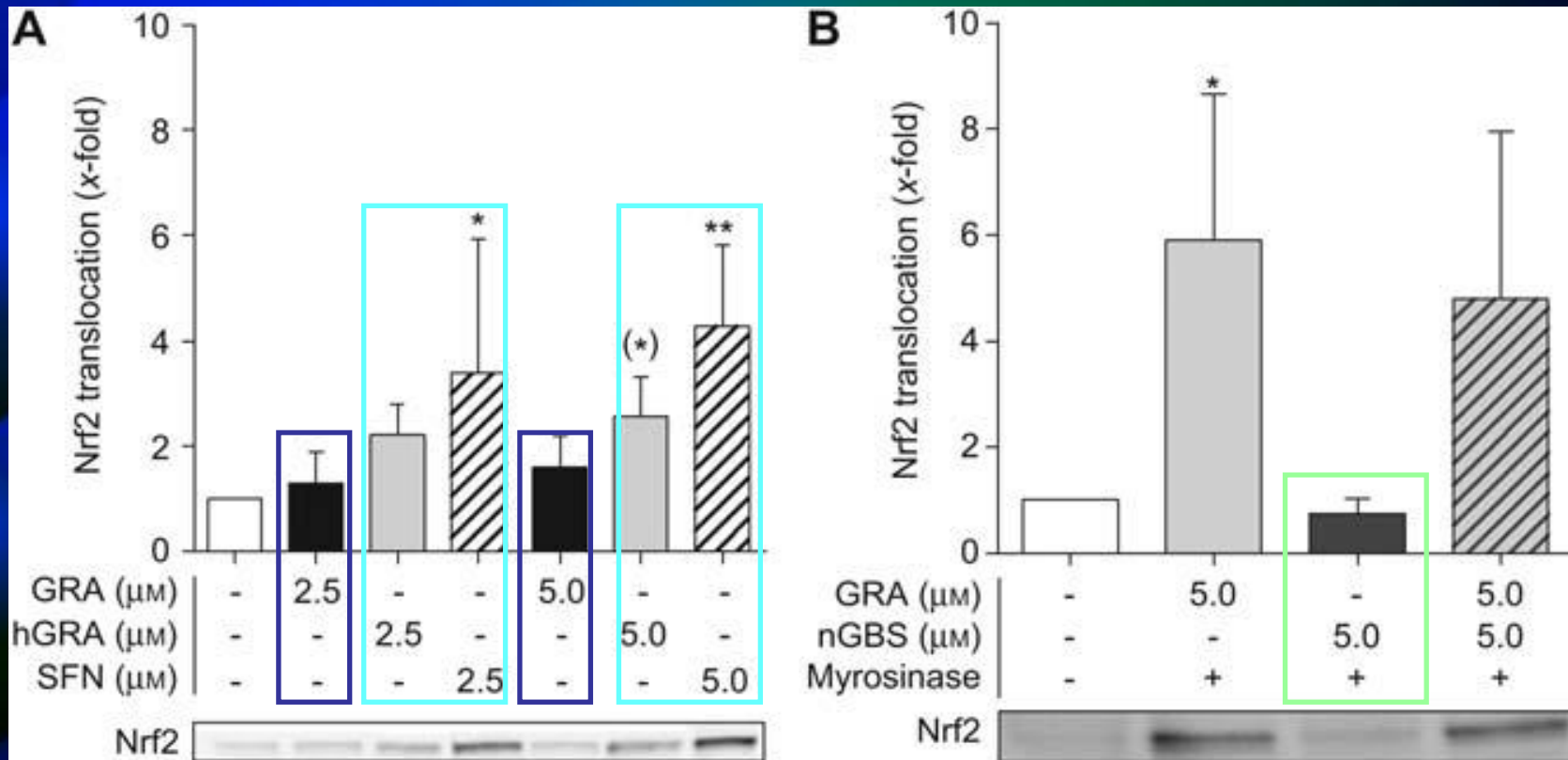
Glucosinolates	Revertants per nmol
Glucoiberin	<1
Glucoraphanin	<0.4
Glucoraphenin	<0.2
Glucorophasatin	0.6
Sinigrin	0.5
Gluconapin	0.2
Glucotropaeolin	4
Sinalbin	3.5
Gluconasturtiin	2
Glucobrassicin	1.5
Neoglucobrassicin	100
4-Methoxyglucobrassicin	0.2

Transcription factor Nrf2

Nuclear factor (erythroid-derived 2) - related factor 2



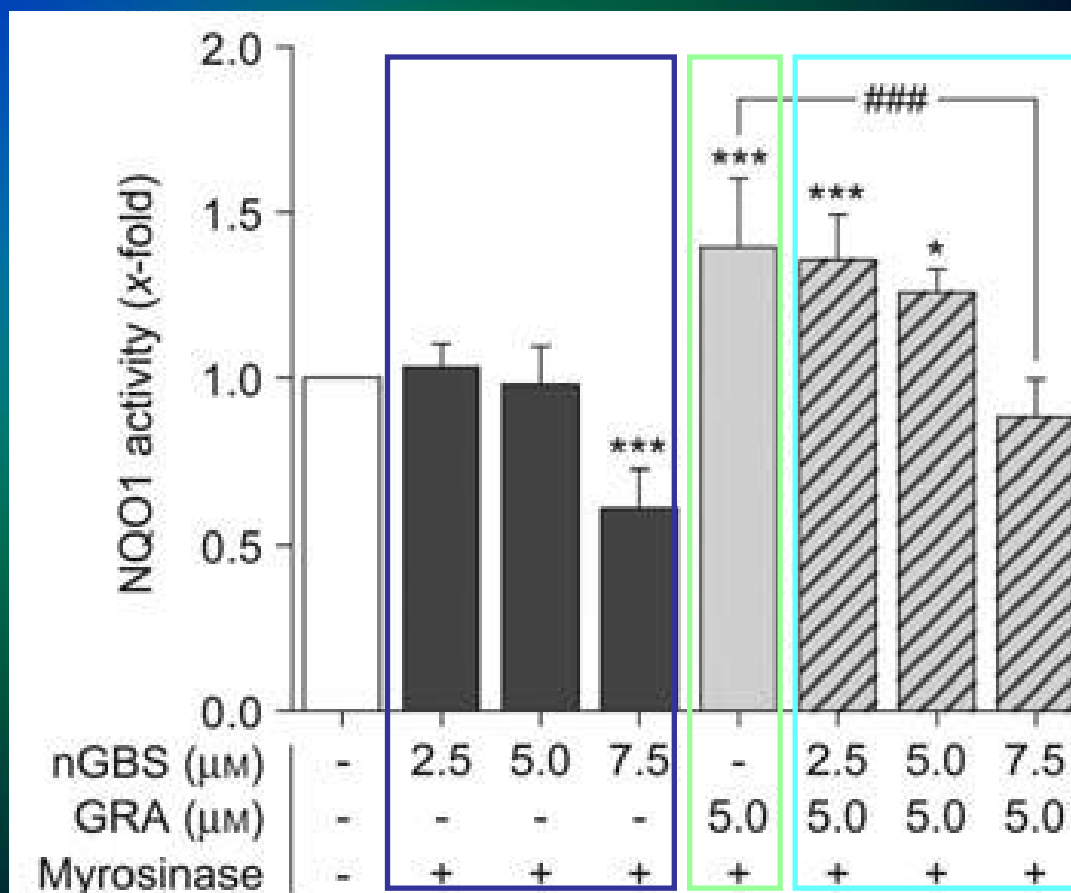
Nuclear translocation of Nrf2 is increased by synthetic sulforaphane and hydrolysed glucoraphanin (GRA) but not by hydrolysed neoglucobrassicin (nGBS)



NQO1 activity is increased by hydrolysed glucoraphanin (GRA) but not by hydrolysed neoglucobrassicin (nGBS)

Phase II enzymes

- NQO1 - NAD(P)H:quinone-oxidoreductase 1
- GPx2 glutathione peroxidase 2



Future view – functional sweets





Thank you for your
attention