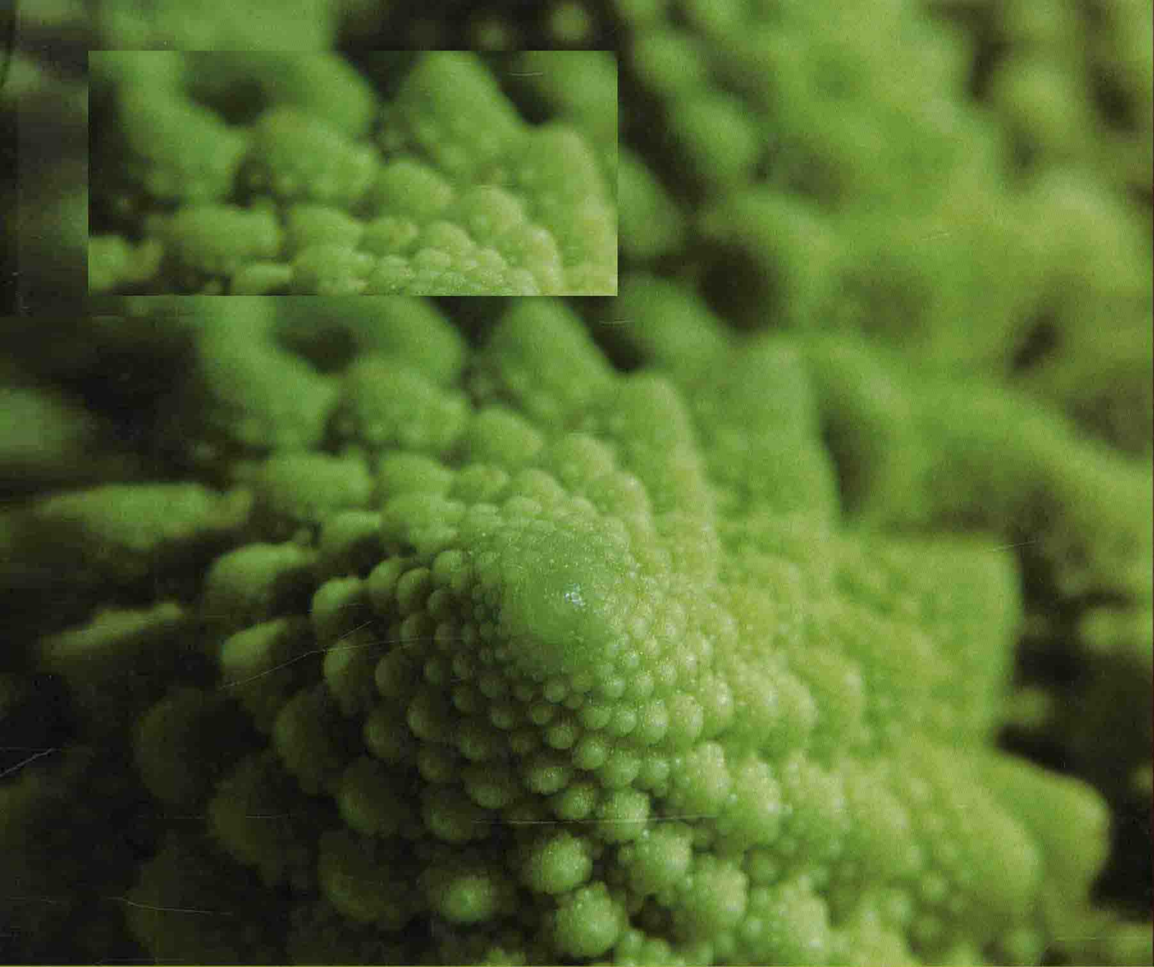

PHYTONUTRIENTS

Edited by Andrew Salter, Helen Wiseman and Gregory Tucker

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Phytonutrients

Preface

Plants have been a major source of nutrition for humans ever since the start of our evolution, although more recently we have become more reliant on animal-based foods. This has led to some challenging situations in terms of diet and health and we are encouraged, through schemes such as the 5-A-Day campaign, to consume more plant-based foods. Plants can provide us with almost all of our dietary requirements and this includes macronutrients such as carbohydrates and lipids as well as the wide range of essential micronutrients such as vitamins and minerals. It is also becoming increasingly evident that many other phytochemicals, whilst perhaps not essential, are nonetheless beneficial to our health. These would include the carotenoids, polyphenols and phytoestrogens.

There has long been an interest amongst plant scientists in the enhancement of nutrients within crops. Traditionally this has been brought about by breeding or modifications to agronomic or horticultural practice. More recently this has also been achieved through the application of genetic engineering, for example to enhance levels of vitamins such as vitamin A and folate, or through manipulation of biosynthetic pathways to introduce novel nutrients into plants such as the production of long chain polyunsaturated fatty acids. Such modifications to the plants metabolism often require an intricate knowledge of the metabolic pathways and more specifically their control. Acquisition of this knowledge is greatly facilitated by the rapid progress being made in the areas of transcriptomics, proteomics and systems biology.

These phytonutrients are normally presented in the diet in the form of a complex food matrix. Understanding the interactions between this matrix and the digestive system is a key part of modelling the fate of nutrients in the diet. The plant cell wall for instance can represent a barrier to the release of nutrients and its 'digestibility' in the gastrointestinal tract is a significant factor in determining the bioaccessibility of nutrients. Similarly, the fate of nutrients in terms of how they are able to cross the gut lumen and their subsequent metabolism within the body are also key factors in determining bioavailability and functionality, respectively.

This book contains contributions from both plant scientists and nutritionists. The plant science perspective is primarily about how nutrients are made within the plant and how this may be manipulated to enhance their levels or availability. The nutrition perspective is more on how these food matrices behave during digestion and, more specifically, the functionality of nutrients within the body. It is hoped therefore that this book will be of interest to researchers and students in both of these disciplines. Indeed one of its aims is to encourage understanding, dialogue and collaboration between these two often disparate fields of expertise.

Contributors

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John Brameld is currently Associate Professor of Nutritional Biochemistry at the University of Nottingham. His main interests relate to the regulatory effects of nutrients on gene expression in relation to cell/tissue development, metabolism and function.

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Dr Martin Broadley is a Reader in Plant Nutrition at the University of Nottingham. Martin's research focus is on mineral dynamics in soil-plant systems, including the use of agronomic and genetics-based understanding of mineral improvement of crops (biofortification).

Judith Buttriss
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Professor Judith Buttriss is the Director General at the British Nutrition Foundation, a post she has held since 2007; prior to this she was the Foundation's Science Director since 1998. She is a public health nutritionist with an interest in a broad range of nutrition topics.

David Gray
Food Sciences Division, University of Nottingham, Sutton Bonington Campus, Loughborough, Leicestershire, LE12 5RD, UK.

Dr David Gray gained his PhD in the field of plant lipid biochemistry and is now an Associate Professor in Food Chemistry. His research includes an exploration of novel ways of delivering healthy oils to foods, with minimum loss to oil quality and minimum impact on the environment.

Úrsula Flores-Perez
Centre for Research in Agricultural Genomics (CRAG) CSIC-IRTA-UAB, Campus UAB Bellaterra, 08193 Barcelona, Spain.

Dr. Flores-Perez obtained her PhD degree at CRAG, where she developed her interest in the regulation of plant carotenoid biosynthesis and biotechnology. She is currently a postdoctoral fellow working on plastid import mechanisms at the Department of Biology, University of Leicester, University Road, Leicester LE1 7RH, UK.

Manuel Rodriguez-Concepcion
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Dr. Rodriguez-Concepcion is a Research Professor at CRAG, where he leads a group working on the regulation of isoprenoid and carotenoid biosynthesis. His research has unveiled a number of molecular mechanisms used by plant cells to control the supply of carotenoid precursors and their channelling to the carotenoid pathway at transcriptional and post-transcriptional levels.

Stéphane Ravanel
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Dr Stéphane Ravanel is a plant biochemist and molecular biologist with a long-standing interest in the metabolism of amino acids and folates.

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Dr Fabrice Rébeillé is a plant biochemist and physiologist who has been conducting research on photorespiration before studying folate metabolism.

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Andy Salter is Professor of Nutritional Biochemistry. His major interests lie in the mechanisms whereby dietary fatty acids regulate lipid and lipoprotein metabolism and development of atherosclerosis.

Jeremy P E Spencer
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Professor Spencer is Leader of the Food Chain and Health sub-theme "Plant Bioactives and Health" within Food and Nutritional Sciences at Reading University. His interests are focused on investigating the molecular mechanisms that underlie the accumulating body of epidemiological, and medical anthropological evidence, on a positive correlation between the consumption of diets rich in fruits and vegetables and a decreased risk of neurodegenerative disorders.

Gregory Tucker
Nutritional Sciences Division, University of Nottingham, Sutton Bonington Campus, Loughborough, Leicestershire, LE12 5RD, UK.

Greg Tucker is Professor of Plant Biochemistry at Nottingham University. A major area of interest is the molecular basis of quality in fruit and vegetables. This includes methods to extend the shelf life of these commodities and the impact that this may have on nutritional composition.

Katerina Vafeiadou
Molecular Nutrition Group, School of Chemistry, Food and Pharmacy, University of Reading, Reading, RG2 6AP, UK.

Dr Katerina Vafeiadou is a research fellow at the Hugh Sinclair Unit of Human Nutrition, University of Reading. Dr Vafeiadou has previously carried out research on the effects of dietary flavonoids on both cardiovascular and neurodegenerative diseases, with main focus on flavonoids role in the prevention of inflammation and endothelial dysfunction. Dr Vafeiadou is currently working for a Food Standards Agency project which investigates the impact of replacing dietary saturated fats with either monounsaturated fats or polyunsaturated fats on cardiovascular risk.

David Vauzour
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Dr David Vauzour is a Senior Research Associate at Norwich Medical School, University of East Anglia. Dr Vauzour has carried out many investigations on the influence of phytochemicals on brain health through their interactions with specific cellular signalling pathways pivotal in protection against neurotoxins, in preventing neuroinflammation and in controlling memory, learning and neuro-cognitive performances.

Philip J. White
The Scottish Crop Research Institute, Invergowrie, Dundee, DD2 5DA, UK.

Professor Philip J. White is a Senior Research Scientist at Scottish Crop Research Institute (which became The James Hutton Institute w.e.f. April 2011). Philip's research comprises a wide range of subjects within the field of plant mineral nutrition, ranging from molecular genetic through to agronomic scales. He has previously held positions at the Universities of Edinburgh and Cambridge, and Horticulture Research International. He is a Special Professor in Plant Ion Transport at the University of Nottingham, and a Visiting Associate Professor at the Comenius University, Bratislava.

Helen Wiseman
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Dr Helen Wiseman leads the Phytochemical Research Group at King's College London. Dr Wiseman has carried out numerous investigations of the potential health effects of dietary phytochemicals, such as flavonoids, including possible protection against cardiovascular disease, cancer and loss of cognitive function, which may be exerted via a wide range of mechanisms including effects on gene expression, regulatory microRNA and post-translational modification and modulation of cell signalling pathways.

Abbreviations

AA	ascorbic acid
ACP	acyl carrier protein
ADC	4-amino-4-deoxychorismate
AdoMet	*S*-adenosylmethionine
AICAR	aminoimidazole carboxamide ribonucleotide
AICART	aminoimidazole carboximide ribonucleotide transformylase
ALA	alpha linolenic acid
ANR	anthocyanidin reductase
ANS	anthocyanidin synthase
BCO	β-carotene-15,15′-oxygenase
cAMP	cyclic AMP
CHD	coronary heart disease
CHI	chalcone flavanone isomerase
CHS	chalcone synthase
CHYB	carotenoid β-ring hydroxylase
CHYE	carotenoid ε-ring hydroxylase
CI	confidence interval
COMT	catechol-*O*-methyltransferases
CRTISO	carotenoid isomerase
CYP	cytochrome P450
CVD	cardiovascular disease
DAG	diacylglycerol
DAHP	D-arabino-heptulosonic acid 7-phosphate
DFE	dietary folate equivalents
DFR	dihydroflavonol reductase
DHA	docosahexaenoic acid
DHA	dehydroascorbate (Chapter 5)
DHAA	dehydroascorbic acid
DHF	dihydrofolate
DHFR	dihydrofolate reductase
DHPS	dihydropteroate synthase
DHQ	3-dehydroquinic acid
DMAPP	dimethylallyl diphosphate
DMPBQ	dimethylphytylbenoquinol
E-4-P	D-erythrose-4-phosphate

EGCG	epigallocatechin gallate
EPSP	3-enolpyruvylshikimic acid 3-phosphate
ER	endoplasmic reticulum
ERK	extracellular signal-related kinase
EPA	eicosapentoenoic acid
F3H	Flavanone 3-hydroxylase
FAS	fatty acid synthase complex
FCL	5-formyl-THF cycloligase
FGGH	folylpolyglutamate γ-glutamyl hydrolase
FPGS	folylpolyglutamate synthetase
FS	flavone synthase
FTCD	glutamate formiminotransferase/formimino-THF cyclodeaminase
FTHFS	10-formyl-THF synthetase
GAR	glycinamide ribonucleotide
GART	glycinamide ribonucleotide transformylase
GBSS	granule bound starch synthase
GDC	glycine decarboxylase
GI	gastrointestinal tract
GGPP	geranylgeranyl pyrophosphate
GGR	geranylgeranyl reductase
GH	glycosyl hydrolase
GLA	gamma linolenic acid
GLUT	glucose transporter
GSH	glutathione
GSHPx	glutathione peroxidise
GT	glycosyl transferase
GTPCHI	GTP-cyclohydrolase I 7,8-dihydroneopterin (DHN) triphosphate
HBA	hydroxybenzoic acids
HCA	hydroxycinnamic acids
HDL	high density lipoproteins
HO-1	haem oxygenase 1
HPPK	hydroxymethyldihydropterin pyrophosphokinase
IFS	isoflavone synthase
IMP	inosine monophosphate
IPP	isopentenyl diphosphate
JNK	c-jun amino-terminal kinase
KPHMT	ketopantoate hydroxymethyl transferase
LA	linoleic acid
LAR	leucoanthocyanidin reductase
LCYB	lycopene cyclase B
LCYE	lycopene cyclase E
LDL	low density lipoprotein
MAPK	MAP kinase signalling pathway
MATE	multidrug and toxin extrusion transporter
MDHA	monodehydroascorbate

MEP	methylerythritol 4-phosphate pathway
MGGBQ	2-methy-6-phytylbenzoquinol
MPBQ	2-methy-6-phytylbenzoquinol
MRP	multidrug resistance-associated proteins
MS	methionine synthase
MTF	methionyl-tRNA transformylase
MTHFC	5,10-methenyl-THF cyclohydrolase
MTHFD	5,10-methylene-THF dehydrogenase
MUFA	monounsaturated fatty acid
NSP	non starch polysaccharide
NTD	neural tube defects
ODA	octadecatetraenoic acid
pABA	para-aminobenzoic acid
pABAGlu$_n$	*p*-aminobenzoyl(poly)glutamate
PAL	phenylalanine ammonia lyase
PC	phosphatidylcholine
PDP	phytyl pyrophosphate
PDS	phytoene desaturase
PE	phosphatydyl ethanolamine
PEP	phosphoenolpyruvate
PMP	phytol monophosphate
PPAR	peroxisome proliferator activated receptor
PS1	photosystem 1
PSY	phytoene synthase
PUFA	polyunsaturated fatty acid
QTL	quantitative trait loci
RALDH	NAD^+-dependent retinal dehydrogenase
RDA	recommended dietary allowance
RDH	retinol dehydrogenase
ROS	reactive oxygen species
RR	relative risk
SBE	starch branching enzyme
SDE	starch debranching enzyme
SFA	saturated fatty acid
SHMT	serine hydroxymethyl transferase
SVCT	sodium vitamin C co-transporters
TAG	triacyl glycerol
TAL	tyrosine ammonia lyase
TG	triglycerides
THF	tetrahydrofolates
TS	thymidylate synthase
UFGT	UDP glucose-flavonoid 3-*O*-glucosyl transferase
UGT	UDP-glucuronosyltransferases
VAD	vitamin A deficiency
VDE	violaxanthin de-epoxidase

VLDL very low density lipoproteins
XET xyloglucan endo transglycosylase
ZDS ζ-carotene desaturase
ZEP zeaxanthin eopxidase

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