



Food Chemistry

Food Chemistry publishes original research papers dealing with the **chemistry and biochemistry of foods and raw materials** covering the entire food chain from 'farm to fork.'

Topics include:

– Chemistry...

[View full aims and scope](#)

Editor-in-Chief: G.G. Birch

[View full editorial board](#)

[Guide for Authors](#)

[Submit Your Paper](#)

[Track Your Paper](#)

[Order Journal](#)

[View Articles](#)

Share this page:



ADVERTISEMENT



**SenseAsia
2014**

The Asian
Sensory and
Consumer
Research
Symposium
11–13 May
2014

SingEx
Singapore

Impact Factor:
3.334

5-Year Impact Factor:
4.072

Imprint: ELSEVIER

ISSN: 0308-8146



Publish your article
Open Access in
Food Chemistry

Recent Open Access ScienceDirect
Articles

[Open Access](#)

Most Downloaded
Articles

ScienceDirect

1. DPPH antioxidant assay revisited
Om P. Sharma | Tej K. Bhat

2. Phenolic compounds in plants and agri-industrial by-products: Antioxidant activity, occurrence, and potential uses
Nagendran Balasundram | Kalyana Sundram | ...

Volume 141, Issue 4, Pages 3291-4404 (15 December 2013)

◀ Prev art. 101 - 151 of 151 No next

[Purchase](#) | [E-mail articles](#) | [Export citations](#) | [Open all previews](#)

Analytical Methods: Papers

- | | | |
|-----|--|--|
| 101 | Near infrared spectroscopy for prediction of antioxidant compounds in the honey Original Research Article
Pages 3409-3414
Olga Escuredo, M. Carmen Seijo, Javier Salvador, M. Inmaculada González-Martín
Show preview Purchase PDF - \$35.95 Recommended articles Related reference work articles | |
| 102 | Antioxidant and antimicrobial properties of phenolic rich fraction of Seabuckthorn (<i>Hippophae rhamnoides</i> L.) leaves <i>in vitro</i> Original Research Article
Pages 3443-3450
M.S. Yogendra Kumar, R.J. Tirpude, D.T. Maheshwari, Anju Bansal, Ksipra Misra
Show preview Purchase PDF - \$35.95 Recommended articles Related reference work articles | |
| 103 | Novel ion imprinted polymer magnetic mesoporous silica nano-particles for selective separation and determination of lead ions in food samples Original Research Article
Pages 3459-3465
Forouzan Aboufazel, Hamid Reza Lotfi Zadeh Zhad, Omid Sadeghi, Mohammad Karimi, Ezzatollah Najafi
Show preview Purchase PDF - \$35.95 Supplementary content Recommended articles Related reference work articles | |
| 104 | Evaluation of a simple and fast method for the multi-elemental analysis in commercial fruit juice samples using atomic emission spectrometry Original Research Article
Pages 3466-3472
Anna Szymczycha-Madeja, Maja Wena
Show preview Purchase PDF - \$35.95 Recommended articles Related reference work articles | |
| 126 | Simultaneous determination of caffeine, theophylline and theobromine in food samples by a kinetic spectrophotometric method Original Research Article
Pages 4087-4093
Zhenzhen Xia, Yongnian Ni, Serge Kokot
Show preview Purchase PDF - \$35.95 Recommended articles Related reference work articles | |
| 127 | A novel high throughput method based on the DPPH dry reagent array for determination of antioxidant activity Original Research Article
Pages 4102-4106
Khalid Hamid Musa, Aminah Abdullah, Bambang Kuswandi, M. Amrun Hidayat
Show preview Purchase PDF - \$35.95 Recommended articles Related reference work articles | |
| 128 | Modified sugar adulteration test applied to New Zealand honey Original Research Article
Pages 4127-4131
Russell Frew, Kiri McComb, Linda Croud, Dianne Clark, Robert Van Hale
Show preview Purchase PDF - \$35.95 Supplementary content Recommended articles Related reference work articles | |
| 129 | Untargeted detection and quantitative analysis of poplar balata (PB) in Chinese propolis by FT-NIR spectroscopy and chemometrics Original Research Article
Pages 4132-4137
Lu Xu, Si-Min Yan, Chen-Bo Cai, Xiao-Ping Yu
Show preview Purchase PDF - \$35.95 Recommended articles Related reference work articles | |
| 130 | Validation (in-house and collaborative) of the quantification method for ethyl carbamate in alcoholic beverages and soy sauce by GC-MS Original Research Article
Pages 4161-4165
Zhu Huang, Xiao-Dong Pan, Ping-Gu Wu, Qing Chen, Jian-Long Han, Xiang-Hong Shen
Show preview Purchase PDF - \$35.95 Recommended articles Related reference work articles | |

FOOD CHEMISTRY

Aims and Scope

Food Chemistry publishes original research papers dealing with the chemistry and biochemistry of foods and raw materials covering the entire food chain from 'farm to fork.' Topics include:

- Chemistry relating to major and minor components of food, their nutritional, physiological, sensory, flavour and microbiological aspects;
- Bioactive constituents of foods, including antioxidants, phytochemicals, and botanicals. Data must accompany sufficient discussion to demonstrate their relevance to food and/or food chemistry;
- Chemical and biochemical composition and structure changes in molecules induced by processing, distribution and domestic conditions;
- Effects of processing on the composition, quality and safety of foods, other bio-based materials, by-products, and processing wastes;
- Chemistry of food additives, contaminants, and other agro-chemicals, together with their metabolism, toxicology and food fate.

Analytical Section

Analytical papers related to the microbiological, sensory, nutritional, physiological, authenticity and origin aspects of food. Papers should be primarily concerned with new or novel methods (especially instrumental or rapid) provided adequate validation is described including sufficient data from real samples to demonstrate robustness. Papers dealing with significant improvements to existing methods, or data from application of existing methods to new foods, or commodities produced in unreported geographical areas, will also be considered.

- Methods for the determination of both major and minor components of food especially nutrients and non-nutrient bioactive compounds (with putative health benefits) will be considered.
- Results of method inter-comparison studies and development of food reference materials for use in the assay of food components;
- Methods concerned with the chemical forms in food, nutrient bioavailability and nutritional status;
- General authentication and origin [e.g. Country of Origin Labelling (COOL), Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), Certificate of Specific Character (CSC)] determination of foods (both geographical and production including commodity substitution, and verification of *organic*, *biological* and *ecological* labelling) providing sufficient data from authentic samples should be included to ensure that interpretations are meaningful.

Editor-in-Chief

PROFESSOR G.G. BIRCH
Food and Nutritional Sciences,
University of Reading,
Reading, UK

Editors

DR. P.M. FINGLAS (Analytical Methods)
Institute of Food Research,
Norwich Research Park,
Norwich, UK

DR. F. SHAHIDI

Dept. of Biochemistry,
Memorial University of Newfoundland,
St John's, Newfoundland, Canada

DR. J.S. ELMORE

Food and Nutritional Sciences,
University of Reading,
Reading, UK

PROFESSOR J. VAN CAMP

Department of Food Safety and Food Quality,
University of Gent,
Gent, Belgium

DR. R.E. WROLSTAD

Department of Food Science & Technology,
Oregon State University,
Oregon, USA

DR. D. CHARALAMPOPOULOS

Food and Nutritional Sciences,
University of Reading, Reading, UK

DR. S.Y. JIANG

College of Food Engineering and Biotechnology,
Tianjin University of Science & Technology,
Tianjin, China

DR. S. ASTLEY

Institute of Food Research,
Norwich Research Park,
Norwich, UK

Editorial Manager (Submissions)

MÉLANIE LOWE
EuroFIR, Brussels, Belgium
email: foodchem@eurofir.org

Editorial Board

C. Alasavar

Tubitak Marmara Research Centre,
Food Institute, Turkey

A.T. Andrews

University of Wales Institute, UK

J.H. Banoub

Northwest Atlantic Fisheries Centre,
Memorial University of Newfoundland

Y. Bao

University of East Anglia, Norwich, UK

M. Battino

Marche Polytechnic University, Ancona, Italy

R.G. Berger

Universität Hannover, Germany

T. Beta

University of Manitoba, Canada

Y.F. Chu

Kraft Foods, Glenview, IL, USA

P.M. Dey

Royal Holloway, University of London, UK

A.L. Halmos

Department of Food Science, RMIT University,
Melbourne, Australia

A. Ismail

Universiti Putra Malaysia, Salangor, Malaysia

M. Jenner

Welcombe, Devon, UK

Z. Jin

Southern Yangtze University, PR China

M.Y. Jung

Department of Food Science and Technology,
Woosuk University, Jeonbuk, Republic of Korea

S.D. Kelly

School of Environmental Sciences,
University of East Anglia, Norwich, UK

J.F. Kennedy

University of Birmingham, UK

P. Kilmartin

University of Auckland, New Zealand

J. Lakkis

Pfizer Inc., Morris Plains, NJ, USA

G. Lisinska

Agricultural University, Wroclaw, Poland

M. Mathlouthi

University of Reims, France

B. Ou

International Chemistry Testing, Milford
Massachusetts, USA

R.B. Pegg

The University of Georgia, USA

V. Piironen

University of Helsinki, Finland

A. Polesello

Istituto Sperimentale per la Valorizzazione
Tecnologica dei Prodotti Agricoli, Milano, Italy

S. Porretta

Experimental Station for the
Food Preserving Industry, Parma, Italy

P. Puwastien

Institute of Nutrition, Mahidol University
(INMU), Salaya, Phutthamonthon,
Nakhon Pathom, Thailand

E. Risvik

Norwegian Food Research Institute,
Oslo, Norway

A. Ritieni

The University of Naples Federico II, Naples, Italy

B. Saad

School of Chemical Sciences, Universiti Sains,
Malaysia

H.C. Schönfeldt

University of Pretoria, South Africa

K. Thurlow

LGC Ltd, Teddington, UK

F. Toldrá

Institute of Agrochemistry and Food
Technology (CSIC), Valencia, Spain

R. Tsao (Rong Cao)

Food Research Program, Agriculture and
Agri-Food, Ontario, Canada

A.J. Tüdös

Shell Global Solutions International BV,
The Netherlands

C.M. Witthöft

Department of Food Science,
Swedish University of Agricultural Sciences,
Uppsala, Sweden

V.A. Yaylayan

McGill University, Canada

L. Yu

University of Maryland, USA

R. Zeleny

European Commission,
DG Joint Research Centre, Geel, Belgium



Analytical Methods

A novel high throughput method based on the DPPH dry reagent array for determination of antioxidant activity

Khalid Hamid Musa^{a,*}, Aminah Abdullah^a, Bambang Kuswandi^b, M. Amrun Hidayat^b^aSchool of Chemical Sciences & Food Technology, Faculty of Science & Technology, 43600 UKM, Bangi Selangor, Malaysia^bChemo and Biosensors Group, Faculty of Pharmacy, University of Jember, Jl. Kalimantan 37, Jember 68121, Indonesia

ARTICLE INFO

Article history:

Received 24 April 2012

Received in revised form 21 April 2013

Accepted 22 June 2013

Available online 3 July 2013

Keywords:

Antioxidant activity

DPPH free radicals

96 well microplate

Dry reagent array

ABSTRACT

A stable chromogenic radical 2,2-diphenyl-1-picrylhydrazyl (DPPH) is commonly used for the determination of antioxidant activity. In this paper, DPPH was dried into 96 well microplate to produce DPPH dry reagent array plate, based on which the highly sensitive and high throughput determination of antioxidant activities was achieved. The spectrophotometric characterization of the microplate containing dried or fresh DPPH free radicals was reported. The response of the DPPH dry reagent array towards different standard antioxidants was studied. The reaction for DPPH in fresh or dry reagent array with Trolox was reported and compared. The DPPH dry reagent array was used to study the antioxidant activity of banana, green tea, pink guava, and honeydew and the results were compared to the samples reacted with freshly prepared DPPH. The proposed method is comparable to the classical DPPH method, more convenient, simple to operate with minimal solvent required and excellent sensitivity.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Oxidation is one of the most important processes of food deterioration because it may affect food safety, colour, flavour and texture. There is an increasing interest in antioxidants, particularly in those intended to prevent the presumed deleterious effects of free radicals in the human body, and to prevent the deterioration of fats and other constituents of foodstuffs (Molyneux, 2004).

A number of assays have been developed to determine the antioxidant activity based on different chemical and biological mechanisms. These include; Trolox equivalent antioxidant capacity (TEAC; Miller, Rice-Evans, Davies, Gopinathan, & Milner, 1993), oxygen radical absorption capacity (ORAC; Cao, Alessio, & Cutler, 1993), ferric reducing antioxidant power (FRAP; Benzie & Strain, 1999), and free radical scavenging (DPPH; Brand-Williams, Cuvelier, & Berset, 1995). Among these assays that measure radical scavenging capacity, the 2,2-diphenyl-1-picrylhydrazyl (DPPH) is one of the most widely employed. The capacity to scavenge the stable DPPH free radical can be expressed as a measure of antioxidant activity. During this assay, the purple chromogen radical is reduced by antioxidant/reducing compounds to the corresponding pale yellow hydrazine. The reduction of the purple chromogen radical by hydrogen-donating antioxidants is monitored by the decrease of optical density at long wavelengths (515–520 nm). The reaction

is shown in Fig. 1, where AH is donor molecule, and A. is free radical produced.

DPPH assay is simple, does not require any special preparation (Arnao, 2000), sensitive, independent of sample polarity and does not require sophisticated equipment such as HPLC or GCMS (Ozcelik, Lee, & Min, 2003). The DPPH assay requires mild experimental conditions, which is an advantage compared to other commonly used methods that require preliminary sample treatment such as high temperatures and or oxygen supply (Koleva, van Beek, Linsen, de Groot, & Evstatieva, 2002).

However, the DPPH assay is influenced by factors such as the type and amount of solvent used, water content, and hydrogen or metal ion concentration (Dawidowicz, Wianowska, & Olszowy, 2012). The strong absorption of some pigments, such as anthocyanins, at the same wavelength as DPPH (500–550 nm) is a limitation of the assay, which may result in undetected changes by colorimetric methods. To overcome this problem, Sun et al. (2012) used HPLC–DAD to determine changes in rabbit eye blueberry (*Vaccinium virgatum*). However, the use of HPLC–DAD makes the determination of the antioxidant activity more complicated and time consuming.

In the DPPH assay, a large volume of freshly prepared DPPH solution (2.9–3.9 ml) is required daily (Rufino et al., 2011; Villano, Fernandez-Pachon, Moya, Troncoso, & Garcia-Parrilla, 2007). To avoid this limitation, storage of the DPPH stock solution at low temperature has been reported (Shian, Abdullah, Musa, Maskat, & Ghani, 2012). However, DPPH prepared and stored at low temperatures undergoes rapid decomposition (Deng, Cheng, & Yang,

* Corresponding author. Tel.: +60 163335540; fax: +60 389213232.

E-mail address: khalid.hamid@ukm.my (K.H. Musa).