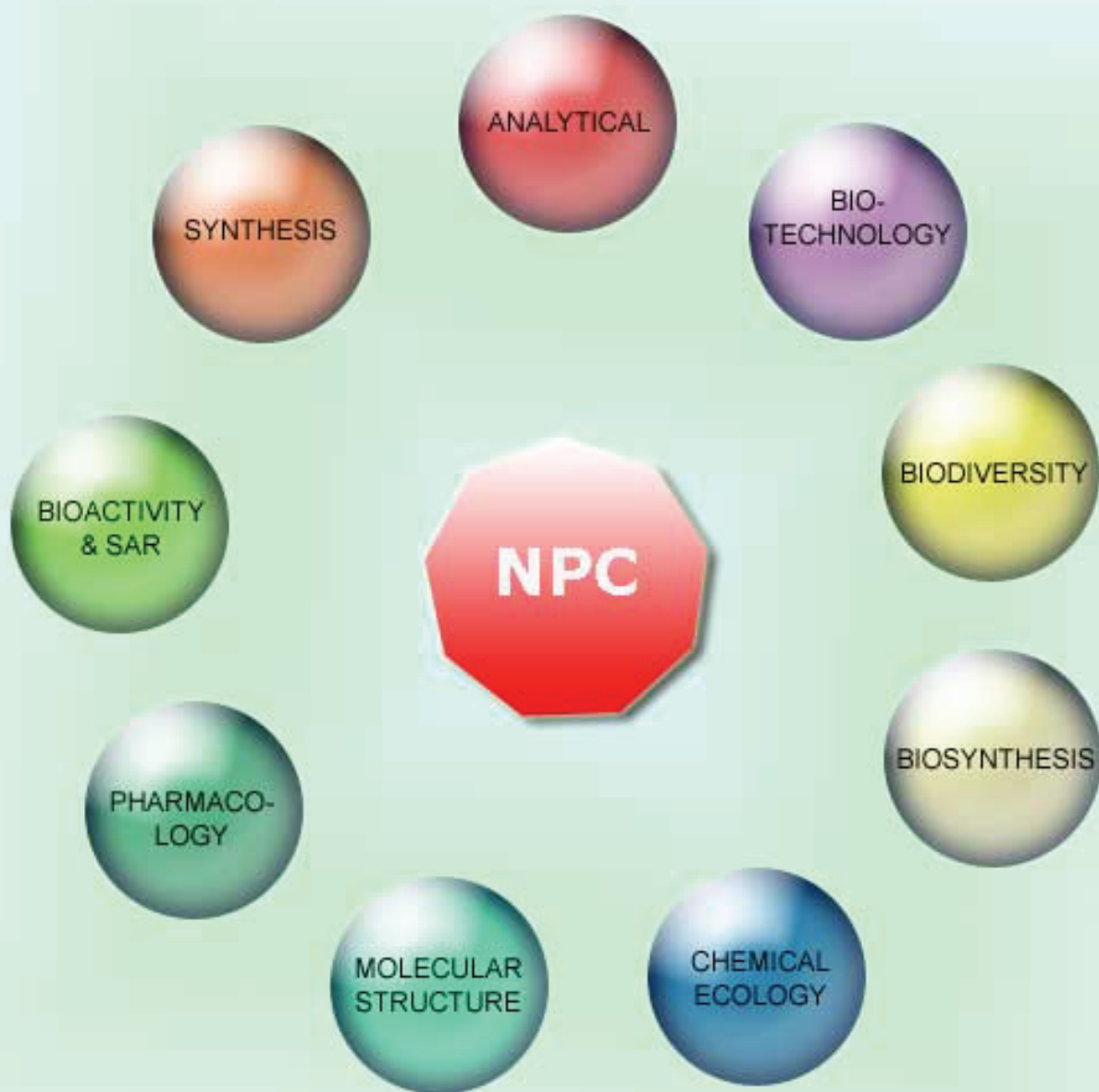


NATURAL PRODUCT COMMUNICATIONS

An International Journal for Communications and Reviews Covering all
Aspects of Natural Products Research



Volume 7. Issue 5. Pages 551-684. 2012
ISSN 1934-578X (printed); ISSN 1555-9475 (online)
www.naturalproduct.us

EDITOR-IN-CHIEF

DR. PAWAN K AGRAWAL

Natural Product Inc.
7963, Anderson Park Lane,
Westerville, Ohio 43081, USA
agrawal@naturalproduct.us

EDITORS

PROFESSOR ALEJANDRO F. BARRERO

Department of Organic Chemistry,
University of Granada,
Campus de Fuente Nueva, s/n, 18071, Granada, Spain
afbarr@ugr.es

PROFESSOR ALESSANDRA BRACA

Dipartimento di Chimica Bioorganica e Biofarmacia,
Università di Pisa,
via Bonanno 33, 56126 Pisa, Italy
braca@farm.unipi.it

PROFESSOR DEAN GUO

State Key Laboratory of Natural and Biomimetic Drugs,
School of Pharmaceutical Sciences,
Peking University,
Beijing 100083, China
gda5958@163.com

PROFESSOR YOSHIHIRO MIMAKI

School of Pharmacy,
Tokyo University of Pharmacy and Life Sciences,
Horinouchi 1432-1, Hachioji, Tokyo 192-0392, Japan
mimaki@ps.toyaku.ac.jp

PROFESSOR STEPHEN G. PYNE

Department of Chemistry
University of Wollongong
Wollongong, New South Wales, 2522, Australia
spyne@uow.edu.au

PROFESSOR MANFRED G. REINECKE

Department of Chemistry,
Texas Christian University,
Forts Worth, TX 76129, USA
m.reinecke@tcu.edu

PROFESSOR WILLIAM N. SETZER

Department of Chemistry
The University of Alabama in Huntsville
Huntsville, AL 35809, USA
wsetzer@chemistry.uah.edu

PROFESSOR YASUHIRO TEZUKA

Institute of Natural Medicine
Institute of Natural Medicine, University of Toyama,
2630-Sugitani, Toyama 930-0194, Japan
tezuka@inm.u-toyama.ac.jp

PROFESSOR DAVID E. THURSTON

Department of Pharmaceutical and Biological Chemistry,
The School of Pharmacy,
University of London, 29-39 Brunswick Square,
London WC1N 1AX, UK
david.thurston@pharmacy.ac.uk

HONORARY EDITOR

PROFESSOR GERALD BLUNDEN

The School of Pharmacy & Biomedical Sciences,
University of Portsmouth,
Portsmouth, PO1 2DT U.K.
axuf64@dsl.pipex.com

ADVISORY BOARD

Prof. Berhanu M. Abegaz
Gaborone, Botswana

Prof. Viqar Uddin Ahmad
Karachi, Pakistan

Prof. Øyvind M. Andersen
Bergen, Norway

Prof. Giovanni Appendino
Novara, Italy

Prof. Yoshinori Asakawa
Tokushima, Japan

Prof. Lee Banting
Portsmouth, U.K.

Prof. Julie Banerji
Kolkata, India

Prof. Anna R. Bilia
Florence, Italy

Prof. Maurizio Bruno
Palermo, Italy

Prof. César A. N. Catalán
Tucumán, Argentina

Prof. Josep Coll
Barcelona, Spain

Prof. Geoffrey Cordell
Chicago, IL, USA

Prof. Ana Cristina Figueiredo
Lisbon, Portugal

Prof. Cristina Gracia-Viguera
Murcia, Spain

Prof. Duvvuru Gunasekar
Tirupati, India

Prof. Kurt Hostettmann
Lausanne, Switzerland

Prof. Martin A. Iglesias Arteaga
Mexico, D. F., Mexico

Prof. Jerzy Jaroszewski
Copenhagen, Denmark

Prof. Leopold Jirovetz
Vienna, Austria

Prof. Karsten Krohn
Paderborn, Germany

Prof. Hartmut Laatsch
Göttingen, Germany

Prof. Marie Lacaille-Dubois
Dijon, France

Prof. Shoen-Sheng Lee
Taipei, Taiwan

Prof. Francisco Macias
Cadiz, Spain

Prof. Imre Mathe
Szeged, Hungary

Prof. Joseph Michael
Johannesburg, South Africa

Prof. Ermino Murano
Trieste, Italy

Prof. M. Soledade C. Pedras
Saskatoon, Canada

Prof. Luc Pieters
Antwerp, Belgium

Prof. Peter Proksch
Düsseldorf, Germany

Prof. Phila Raharivelomanana
Tahiti, French Polynesia

Prof. Luca Rastrelli
Fisciano, Italy

Prof. Monique Simmonds
Richmond, UK

Prof. John L. Sorensen
Manitoba, Canada

Prof. Valentin Stonik
Vladivostok, Russia

Prof. Winston F. Tinto
Barbados, West Indies

Prof. Sylvia Urban
Melbourne, Australia

Prof. Karen Valant-Vetschera
Vienna, Austria

INFORMATION FOR AUTHORS

Full details of how to submit a manuscript for publication in Natural Product Communications are given in Information for Authors on our Web site <http://www.naturalproduct.us>.

Authors may reproduce/republish portions of their published contribution without seeking permission from NPC, provided that any such republication is accompanied by an acknowledgment (original citation)-Reproduced by permission of Natural Product Communications. Any unauthorized reproduction, transmission or storage may result in either civil or criminal liability.

The publication of each of the articles contained herein is protected by copyright. Except as allowed under national "fair use" laws, copying is not permitted by any means or for any purpose, such as for distribution to any third party (whether by sale, loan, gift, or otherwise); as agent (express or implied) of any third party; for purposes of advertising or promotion; or to create collective or derivative works. Such permission requests, or other inquiries, should be addressed to the Natural Product Inc. (NPI). A photocopy license is available from the NPI for institutional subscribers that need to make multiple copies of single articles for internal study or research purposes.

To Subscribe: Natural Product Communications is a journal published monthly. 2012 subscription price: US\$1,995 (Print, ISSN# 1934-578X); US\$1,995 (Web edition, ISSN# 1555-9475); US\$2,495 (Print + single site online); US\$595 (Personal online). Orders should be addressed to Subscription Department, Natural Product Communications, Natural Product Inc., 7963 Anderson Park Lane, Westerville, Ohio 43081, USA. Subscriptions are renewed on an annual basis. Claims for nonreceipt of issues will be honored if made within three months of publication of the issue. All issues are dispatched by airmail throughout the world, excluding the USA and Canada.

Antioxidant, Hemolytic and Cytotoxic Activities of *Senecio* Species used in Traditional Medicine of Northwestern Argentina

Emilio Lizarraga^{a,b}, Felipe Castro^c, Francisco Fernández^b, Marina P. de Lampasona^a and César A. N. Catalán^{a*}

^aINQUINOA-CONICET, Instituto de Química Orgánica, Facultad de Bioquímica Química y Farmacia, Universidad Nacional de Tucumán, Ayacucho 471, S. M. de Tucumán, Argentina

^bFacultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán. Miguel Lillo 205, S. M. de Tucumán, 4000 Argentina

^cFundación Miguel Lillo, Miguel Lillo 251, S. M. de Tucumán, 4000, Argentina

ccatalan@fbqf.unt.edu.ar

Received: February 18th, 2012; Accepted: March 10th, 2012

Senecio nutans Sch. Bip., *S. viridis* var. *viridis* Phill. and *S. spegazzinii* Cabrera are native species used in traditional medicine of northwestern Argentina. The total phenolics, flavonoids and caffeoylquinic acids contents, as well as radical scavenging, antioxidant, hemolytic and cytotoxic activities of aqueous extracts (infusion and decoction) of all three species were determined. *S. nutans* was the most active. The extracts did not show antibacterial activity. Alkaloids were not detected in any of the aqueous extracts of the three studied species.

Keywords: *Senecio nutans*, *Senecio viridis*, *Senecio spegazzinii*, Total phenolics, Caffeoylquinic acids, Antioxidant, Radical scavenging, Cytotoxic activity.

Numerous plant species have been demonstrated to exhibit powerful antioxidant properties. About 267 *Senecio* species (Asteraceae) have been reported for Argentina, and among them, 42 are toxic to cattle [1a] and only four are used in traditional medicine [1b]. In this work we analyzed the total phenolics, flavonoids and caffeoylquinic acids contents and also the radical scavenging, antioxidant, hemolytic and cytotoxic activities of aqueous extracts (infusion and decoction) of the three *Senecio* species most frequently employed in traditional medicine of northwestern Argentina. *S. nutans* Sch. Bip is commonly named “chachacoma”. Its leaves are used as a gastric antispasmodic and for the treatment of gastric ulcers. The infusion is claimed to be useful in the treatment of altitude sickness. It is an edible species used as a flavouring agent, and also employed as a veterinary antiparasitic [1b-d]. *S. viridis* var. *viridis* Phil., commonly known as “mocora”, “mocaraca” or “chachacoma del burro”, is an aromatic shrub. The leaves are chewed to alleviate toothache [1b]. *S. spegazzinii* Cabrera, a herbaceous plant, commonly known as “salvia de la puna” or “chachacoma”, is very scarce and used to treat earache and colds [1b].

Infusions and decoctions from *S. nutans* showed the highest contents of phenolic compounds (20.5 and 25.2 mg GAE/g dry leaf), flavonoids (8.7 and 7.1 mg QE/g dl) and caffeoylquinic acids (15.9, and 18.6 mg CAE/g dl), respectively. The phenolic contents of *S. viridis* and *S. spegazzinii* were approximately a half of those found for *S. nutans* (Table 1). Four methods have been employed to measure the antioxidant activity: DPPH radical scavenging, ABTS radical scavenging, β -carotene-linoleate bleaching assay and total antioxidant capacity [Mo(VI) to Mo(V) reduction test]. Again, the aqueous extracts of *S. nutans* showed to be the most active in the four methods assayed. The results are summarized in the Table 2 and 3. The infusions and decoctions from the three *Senecio* species assayed showed no hemolytic activity against human and rabbit erythrocytes. Both infusion and decoction of *S. nutans* exhibited low toxicity against *Artemia salina* nauplii. The test showed that lethality (LC₅₀) of brine shrimp larvae was 451.3 μ g/mL and 437.1 μ g/mL for infusion and decoction respectively.

Table 1: Total phenolics, flavonoids and caffeoylquinic acid contents in *Senecio nutans*, *S. viridis* and *S. spegazzinii*.

Extracts	Weight [†] (mg)	Total phenolics (mg GAE/g dl) [#]	Total flavonoids (mg QE/g dl) [#]	Caffeoylquinic acids (mg CAE/g dl) [#]
<i>S. nutans</i> (Inf)	452	20.5 \pm 0.2	8.7 \pm 0.3	15.9 \pm 0.2
<i>S. nutans</i> (Dec)	512	25.2 \pm 0.4	7.1 \pm 0.1	18.6 \pm 0.6
<i>S. viridis</i> (Inf)	513	9.6 \pm 0.2	2.5 \pm 0.2	8.3 \pm 0.2
<i>S. viridis</i> (Dec)	525	11.2 \pm 0.8	3.4 \pm 0.1	9.4 \pm 0.3
<i>S. spegazzinii</i> (Inf)	525	8.6 \pm 0.1	-	6.5 \pm 0.1
<i>S. spegazzinii</i> (Dec)	513	10.7 \pm 0.1	-	8.7 \pm 0.9

[†] Weight of lyophilized residue obtained from 2.0 g of dry leaf (dl) after aqueous extraction; Inf: Infusion; Dec: Decoction; [#]dl: dry leaf.

Table 2: Antiradical activity of aqueous extracts from *Senecio nutans*, *S. viridis* and *S. spegazzinii*.

Extracts	DPPH [†] scavenging IC ₅₀ value (μ g/mL) [#]	ABTS ^{**} scavenging IC ₅₀ value (μ g/mL) [#]
<i>S. nutans</i> (Inf)	22.2	11.8
<i>S. nutans</i> (Dec)	32.6	10.2
<i>S. viridis</i> (Inf)	36.0	20.6
<i>S. viridis</i> Dec	34.2	20.8
<i>S. spegazzinii</i> (Inf)	29.5	40.5
<i>S. spegazzinii</i> (Dec)	24.1	42.8
BHT	20.1	3.9

[†] μ g of lyophilized residue obtained from infusion or decoction.

Table 3: Antioxidant activity of aqueous extracts from *Senecio nutans*, *S. viridis* and *S. spegazzinii*.

Extracts	β -carotene/linoleic acid inhibition at 47 μ g/mL [#]	Total antioxidant capacity Mo(VI) to Mo(V) test	
		μ g AAE [*]	μ g QE ^{**}
<i>S. nutans</i> Inf	67%	28	54
<i>S. nutans</i> Dec	84%	36	71
<i>S. viridis</i> Inf	62%	35	70
<i>S. viridis</i> Dec	83%	46	94
<i>S. spegazzinii</i> Inf	60%	39	77
<i>S. spegazzinii</i> Dec	80%	46	93
BHT	94%	-	-

[#]These μ g refer to micrograms of lyophilized residue obtained from infusion or decoction; ^{*}AAE: ascorbic acid equivalents; ^{**}QE: quercetin equivalents per gram of lyophilized residue.

On the other hand, the decoction of *S. viridis* var. *viridis* exhibited very low toxicity (LC₅₀ 833.6 μ g/mL), while the infusion showed

Table 4: Toxicity activity against *Artemia salina*.

Extracts	LC ₅₀ (µg/mL)*		
	<i>S. nutans</i>	<i>S. viridis</i>	<i>S. spegazzinii</i>
Infusion	451.3	>1000	>1000
Decoction	437.1	833.6	>1000
K ₂ Cr ₂ O ₇		23.7	

*µg refers to micrograms of lyophilized residue obtained from infusion or decoction.

no toxicity (LC₅₀ > 1000 µg/mL) against *A. salina*. The aqueous extracts of *S. spegazzinii* were non toxic (Table 4).

Alkaloids were not detected in any of the aqueous extracts from the three studied species (Dragendorff and Mayer reagents). The aqueous extracts did not show antibacterial activity against *Staphylococcus aureus* ATCC 25923, *S. aureus* ATCC 29213, *Escherichia coli* ATCC 25922, *E. coli* ATCC 35218, *Enterococcus faecalis* ATCC 29212 and *Pseudomonas aeruginosa* ATCC 27853. As expected, the results obtained show that the antioxidant activity of the aqueous extracts from the *Senecio* species studied here is directly related to the amount of total phenolics, which are mostly constituted by caffeoylquinic acids (Table 1). The brine shrimp lethality assay results, the lack of hemolytic activity and the absence of alkaloids suggest that infusions and decoctions of these three *Senecio* species are essentially devoid of toxicity, in agreement with their ancient use in Andean traditional medicine for which there are no reports of unwanted acute events after their consumption.

Experimental

Preparation of the extracts: The aqueous extracts were prepared as infusions (Inf) and decoctions (Dec). Infusions were prepared by pouring 100 mL of boiling water onto 2.0 g of air-dried leaves. The mixture was left at room temperature for 20 min and filtered. Decoctions were prepared by refluxing 2.0 g of leaves with 100 mL of water for 20 min. After cooling to room temperature, the mixture was filtered. All extracts were lyophilized separately and stored at 4°C until use.

Determination of total phenolic, flavonoid and caffeoylquinic acid contents: The total phenolic, flavonoid and caffeoylquinic acid contents were determined using the methods of Folin–Ciocalteu [2a], Arvouet-Grand et al. [2b], and Martino et al. [3], respectively. Total phenolics, flavonoids and caffeoylquinic acids were expressed as mg gallic acid, quercetin and chlorogenic acid equivalents (mg GAE, mg

QE and mg CAE respectively) per gram of dry leaf (g dl). The values are presented as means of triplicate analyses.

Antioxidant activity: The free radical scavenging activity was determined spectrophotometrically by the DPPH scavenging assay [4a]. The spectrophotometric analysis of ABTS^{•+} scavenging activity was determined according to the method of Re et al., with some modifications [4b]. BHT was used as the antioxidant standard for comparison of the activity. Antioxidant activity of the extracts was determined according to a slightly modified version of the β-carotene-linoleate bleaching method [5a]. The percentage of inhibition was computed according to the formula proposed by Kulisic et al. [5a]. The total antioxidant capacity of the extracts was evaluated by the phosphomolybdate method [5b].

Hemolytic activity: The hemolytic activity was determined by the method proposed by Cantillo et al., with some modifications [6]. Different concentrations of extracts were assayed against human and rabbit erythrocytes. The percentage of hemoglobin dissolved was determined spectrophotometrically. Triton X-100 was employed as a positive control.

Toxicity against *Artemia salina* Leach: The brine shrimp lethality assay was performed by the method of McLaughlin and coworkers [7]. Brine shrimp eggs (*Artemia salina*) were hatched in saline solution (3.8%). The extracts were tested at concentrations of 1000, 500, 100 and 10 µg/mL. Survival was measured after 24 h incubation at 10°C. Potassium dichromate was used as reference. The collected data were computerized and LC₅₀ values determined by Probit analysis.

The level of toxicity of the extracts was defined according to the following categories: extremely toxic (LC₅₀<10 µg/mL), very toxic (10<LC₅₀<100 µg/mL), moderately toxic (100<LC₅₀<1000 µg/mL) and non toxic (LC₅₀>1000 µg/mL) [8].

Acknowledgments - This work was supported by grants from Consejo Nacional de Investigaciones Científicas y Técnicas de Argentina (CONICET-PIP 00225) and Consejo de Investigaciones de la Universidad Nacional de Tucumán (CIUNT 26/D416).

References

- (a) Gallo GG. (1987) *Plantas toxicas para el ganado en el cono sur de America*. 2nd Ed. Editorial Hemisferio Sur. Buenos Aires. Argentina. pp. 135-139; (b) Giberti GC. (1983) Herbal folk medicine in northwestern Argentina: Compositae. *Journal of Ethnopharmacology*, **7**, 321-341. Note: in this paper *Senecio volckmannii* Phil. and *S. spegazzinii* Cabrera are treated as different taxa, but currently they are considered to be synonymous (see Torosa RD, Bartoli A (2006). *Senecio rosmarinus* y *S. spegazzinii*: Sinónimos de *S. volckmannii*. *Boletín de la Sociedad Argentina de Botánica*, **41**, 123-125; (c) De Feo V, Urrunaga Soria E, Urrunaga Soria R, Senatore F. (2003) Chemical composition and antibacterial activity of *Senecio nutans* essential oil. *Flavour and Fragrance Journal*, **18**, 234-236; (d) Juarez Belaude A, Guerreiro Sandoval J, De Martino L, Senatore F, De Feo V. (2007) Chemical composition and antibacterial activity of *Senecio nutans* essential oil. *Journal of Essential Oil Bearing Plants*, **10**, 332-338.
- (a) Singleton VL, Orthofer R, Lamuela-Raventos RM. (1999) Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin–Ciocalteu reagent. *Methods in Enzymology*, **299**, 152-178; (b) Arvouet-Grand A, Vennat B, Pourrat A, Legret P. (1994) Standardisation d'un extrait de propolis et identification des principaux constituants. *Journal de Pharmacie de Belgique*, **49**, 462-468.
- Martino VS, Ferraro GE, Debenedetti SL, Coussio JD. (1989) Determinación espectrofotométrica del contenido de ácidos cafeoilquínicos en especies Argentinas de compuestas usadas en medicina popular. *Acta Farmacéutica Bonaerense*, **8**, 3-9.
- (a) Wei A, Shibamoto T. (2007) Antioxidant/lipoxigenase inhibitory activities and chemical compositions of selected essential oils. *Journal of Agricultural and Food Chemistry*, **55**, 1737-1742; (b) Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice Evans C. (1999) Antioxidant activity applying an improved ABTS radical cation decoloration assay. *Free Radical Biology & Medicine*, **26**, 1231-1237.
- (a) Kulisic T, Radonic A, Katalinic V, Milos M. (2004) Use of different methods for testing antioxidative activity of oregano essential oil. *Food Chemistry*, **85**, 633-640; (b) Prietto P, Pineda M, Aguilar M. (1999) Spectrophotometric quantification of antioxidant capacity through the formation of phosphomolybdenum complex: specific application to the determination of vitamin E. *Analytical Biochemistry*, **269**, 337-341.
- Cantillo J, Güete J, Baldrís R, Jaramillo B, Olivero J. (2007) Evaluación de la toxicidad aguda (LC₅₀) frente a *Artemia franciscana* y la actividad hemolítica de los extractos acuosos, en diclorometano y metanólico parcial de *Justicia secunda* (Vahl.). *Scientia et Technica XIII*, 257-258.
- McLaughlin JL, Rogers LL, Anderson JE. (1998) The use of biological assays to evaluate botanicals. *Drug Information Journal*, **32**, 513-524.
- Solis PN, Wright CW, Anderson MM, Gupta MP, Phillipson JD. (1993) A microwell cytotoxicity assay using *Artemia salina*. *Planta Medica*, **59**, 250-252.

Composition of the Essential Oil of Wild Growing <i>Artemisia vulgaris</i> from Erie, Pennsylvania Jack D. Williams, Ayman M. Saleh and Dom N. Acharya	637
Chemical Composition of the Essential Oils from the Flower, Leaf and Stem of <i>Lonicera japonica</i> Nenad Vukovic, Miroslava Kacaniová, Lukas Hleba and Slobodan Sukdolak	641
<i>Jasminum sambac</i> Flower Absolutes from India and China – Geographic Variations Norbert A. Braun and Sherina Sim	645
<i>In vitro</i> Bioactivity of Essential Oils and Methanol Extracts of <i>Salvia reuterana</i> from Iran Javad Safaei Ghomi, Reihaneh Masoomi, Fereshteh Jookar Kashi and Hossein Batooli	651
Investigation of the Volatile Constituents of Different <i>Gynura</i> Species from Two Chinese Origins by SPME/GC-MS Jian Chen, An Adams, Sven Mangelinckx, Bing-ru Ren, Wei-lin Li, Zheng-tao Wang and Norbert De Kimpe	655
Volatiles from <i>Michelia champaca</i> Flower: Comparative analysis by Simultaneous Distillation-Extraction and Solid Phase Microextraction Disnelys Báez, Diego Morales and Jorge A. Pino	659
Chemical Composition and Antibacterial Activity of the Essential Oil of <i>Espeletia nana</i> Alexis Peña, Luis Rojas, Rosa Aparicio, Libia Alarcón, José Gregorio Baptista, Judith Velasco, Juan Carmona and Alfredo Usubillaga	661
The Composition and Antimicrobial Activities of <i>Cyperus conglomeratus</i>, <i>Desmos chinensis</i> var. <i>lawii</i> and <i>Cyathocalyx zeylanicus</i> Essential Oils Abdulkhader Hisham, Koranappallil B. Rameshkumar, Neelam Sherwani, Salim Al-Saidi and Salma Al-Kindy	663
Composition, Antimicrobial and Free-radical Scavenging Activities of the Essential Oil of <i>Plectranthus marrubatus</i> Kaleab Asres, Solomon Tadesse, Avijit Mazumder and Franz Bucar	667
Constituents and Antimicrobial Activity of the Essential Oils from Flower, Leaf and Stem of <i>Helichrysum armenium</i> Khodam-Ali Oji and Ali Shafaghat	671
<u>Review/Account</u>	
Plant Essential Oils and Mastitis Disease: Their Potential Inhibitory Effects on Pro-inflammatory Cytokine Production in Response to Bacteria Related Inflammation Ibrahim Taga, Christopher Q. Lan and Illimar Altosaar	675

Natural Product Communications

2012

Volume 7, Number 5

Contents

Gerald Blunden Award (2011)

On-line (HPLC-NMR) and Off-line Phytochemical Profiling of the Australian Plant, <i>Lasiopetalum macrophyllum</i> Michael Timmers and Sylvia Urban	551
--	-----

Original Paper

Iridoid and Phenolic Glycosides from the Roots of <i>Prismatomeris connata</i> Shixiu Feng, Jijiang Bai, Shengxiang Qiu (Samuel), Yong Li and Tao Chen	561
Effect of some <i>ent</i>-Kaurenes on the Viability of Human Peripheral Blood Mononuclear Cells Yndra Cordero, Grecia M. Corao, José A. Cova and Alfredo Usabillaga	563
Steroidal Glycosides from <i>Veronica chamaedrys</i> L. Part I. The Structures of Chamaedrosides C, C₁, C₂, E, E₁ and E₂ Alexandra Marchenko, Pavel Kintya, Bożena Wyrzykiewicz and Elena Gorincioi	565
Identification of the Plant Origin of the Botanical Biomarkers of Mediterranean type Propolis Milena Popova, Boryana Trusheva, Simone Cutajar, Daniela Antonova, David Mifsud, Claude Farrugia and Vassya Bankova	569
Alkaloids from Some Amaryllidaceae Species and Their Cholinesterase Activity Lucie Cahliková, Nina Benešová, Kateřina Macáková, Radim Kučera, Václav Hrstka, Jiří Klimeš, Luděk Jahodář and Lubomír Opletal	571
Phytochemical and Biological Activity Studies of the Bhutanese Medicinal Plant <i>Corydalis crispera</i> Phurpa Wangchuk, Paul A. Keller, Stephen G. Pyne, Thanapat Sastraruji, Malai Taweechotipatr, Roonglawan Rattanajak, Aunchalee Tonsomboon and Sumalee Kamchonwongpaisan	575
On the Biosynthetic Pathway of Papaverine via (S)-Reticuline – Theoretical vs. Experimental Study Bojidarka Ivanova and Michael Spiteller	581
Diversification of Exudate Flavonoid Profiles in Further <i>Primula</i> spp. Tshering Doma Bhutia and Karin M. Valant-Vetschera	587
Three New Biflavonoids from Chinese Dragon's Blood, <i>Dracaena cochinchinensis</i> Jing Guan and Shun-Xing Guo	591
Secondary Metabolites from Polar Fractions of <i>Piper umbellatum</i> Turibio Kuate Tabopda, Anne-Claire Mitaine-Offer, Tomofumi Miyamoto, Chiaki Tanaka, Bonaventure Tchaleu Ngadjui and Marie-Aleth Lacaille-Dubois	595
A New Antimycobacterial Furanolignan from <i>Leucophyllum frutescens</i> Blanca Alanís-Garza, Ricardo Salazar-Aranda, Rosalba Ramírez-Durón, Elvira Garza-González and Noemi Waksman de Torres	597
Water-soluble Constituents of the Heartwood of <i>Streblus asper</i> Jun Li, Mao-Tong Tang, Qiang Wu, Hong Chen, Xiao-Tao Niu, Xin-Lan Guan, Jian Li, Sheng-Ping Deng, Xiao-Jian Su and Rui-Yun Yang	599
Lichen Depsides and Depsidones Reduce Symptoms of Diseases Caused by Tobacco Mosaic Virus (TMV) in Tobacco Leaves Ingrid Ramírez, Soledad Araya, Marisa Piovano, Marcela Carvajal, Alvaro Cuadros-Inostroza, Luis Espinoza, Juan Antonio Garbarino and Hugo Peña-Cortés	603
Antioxidant, Hemolytic and Cytotoxic Activities of <i>Senecio</i> Species used in Traditional Medicine of Northwestern Argentina Emilio Lizarraga, Felipe Castro, Francisco Fernández, Marina P. de Lampasona and César A. N. Catalán	607
Isolation of Antitrypanosomal Compounds from <i>Vitis repens</i>, a Medicinal Plant of Myanmar Khine Swe Nyunt, Ahmed Elkhateeb, Yusuke Tosa, Kensuke Nabata, Ken Katakura and Hideyuki Matsuura	609
Evaluation of Analgesic Activities of Tremetone Derivatives Isolated from the Chilean Altiplano Medicine <i>Parastrephia lepidophylla</i> Julio Benites, Eunices Gutierrez, José López, Mauricio Rojas, Leonel Rojo, Maria do Céu Costa, Maria Pilar Vinardell and Pedro Buc Calderon	611
Ajuganane: A New Phenolic Compound from <i>Ajuga bracteosa</i> Javid Hussain, Naeema Begum, Hidayat Hussain, Farman Ullah Khan, Najeeb Ur Rehman, Ahmed Al-Harrasi and Liaqat Ali	615
Base-mediated Transformations of 3,5-Dibromoverongiaquinol from the Sponge <i>Aplysina</i> sp. to Cavernicolins-1, -2 and a Subereatensin Analogue Elena A. Santalova	617
The Origin of Virgin Argan Oil's High Oxidative Stability Unraveled Saïd Gharby, Hicham Harhar, Dominique Guillaume, Aziza Haddad and Zoubida Charrouf	621
Chemical Composition of Essential Oils from a Multiple Shoot Culture of <i>Telekia speciosa</i> and Different Plant Organs Anna Wajs-Bonikowska, Anna Stojakowska and Danuta Kalemba	625
Evaluation of Volatile Constituents of <i>Cochlospermum angolense</i> Michele Leonardi, Silvia Giovanelli, Pier Luigi Cioni, Guido Flamini and Luisa Pistelli	629
GC-MS Analysis of Aroma of <i>Medemia argun</i> (Mama-n-Khanen or Mama-n-Xanin), an Ancient Egyptian Fruit Palm Arafa I. Hamed, Michele Leonardi, Anna Stochmal, Wiesław Oleszek and Luisa Pistelli	633

Continued inside backcover