

From the Director's Desk

India is one of the richest and most diversified countries as far as biodiversity, natural products and resources are concerned. Dissemination of information on various topics related to these subjects has acquired unprecedented prominence in the last two decades as every field, be it science, technology or engineering, look to natural resources as a safe source, both environmentally as well as technologically.

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Gangan Prathap
(Former Director)
CSIR-NISCAIR

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(A Quarterly Electronic Repository of Current Information on Natural Products and Resources)

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NATURAL PRODUCTS AND RESOURCES REPOSITORY (NPARR)

(A Quarterly Electronic Repository of Current Information on Natural Products and Resources)

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NATURAL PRODUCTS AND RESOURCES REPOSITORY (NPARR)

BEVERAGES (incl. Juices, Tea /Coffee, Yoghurt and other natural soft drinks)

NPARR, 6(3 & 4), 2015-102 Green tea decoction improves glucose tolerance and reduces weight gain of rats fed normal and high-fat diet

Green tea containing polyphenols exerts antidiabetic and antiobesity effects, but the mechanisms involved are not fully understood. In this study, we first analyzed and compared polyphenol compounds [epigallocatechin gallate (EGCG), epigallocatechin (EGC)] in decoction of green tea leaves versus usual green tea extracts. Second, the effects of acute (30 min) or chronic (6 weeks) oral administration of green tea decoction (GTD) on intestinal glucose absorption were studied *in vitro* in Ussing chamber, *ex vivo* using isolated jejunal loops and *in vivo* through glucose tolerance tests. Finally, we explore in rat model fed normal or high-fat diet the effects of GTD on body weight, blood parameters and on the relative expression of glucose transporters SGLT-1, GLUT2 and GLUT4. GTD cooked for 15 min contained the highest amounts of phenolic compounds. In fasted rats, acute administration of GTD inhibited SGLT-1 activity, increased GLUT2 activity and improved glucose tolerance. Similarly to GTD, acute administration of synthetic phenolic compounds (2/3 EGCG+1/3 EGC) inhibited SGLT-1 activity. Chronic administration of GTD in rat fed high-fat diet reduced body weight gain, circulating triglycerides and cholesterol and improved glucose tolerance. GTD-treated rats for 6 weeks display significantly reduced *SGLT-1* and increased *GLUT2* mRNA levels in the jejunum mucosa. Moreover, adipose tissue *GLUT4* mRNA levels were increased. These results indicate that GTD, a traditional beverage rich in EGCG and EGC reduces intestinal SGLT-1/GLUT2 ratio, a hallmark of regulation of

glucose absorption in enterocyte, and enhances adipose GLUT4 providing new insights in its possible role in the control of glucose homeostasis [Chahira Snoussi, Robert Ducroc, Mohamed Hédi Hamdaoui, Karima Dhaouadi, Houda Abaidi, Françoise Cluzeaud, Corinne Nazaret, Maude Le Gall, André Bado* (Inserm UMRS1149, UFR de Médecine Paris 7, Université Paris Diderot, Sorbonne Paris Cité, Paris, France), *The Journal of Nutritional Biochemistry*, 2014, **25**(5), 557–564].

NPARR, 6(3 & 4), 2015-103 Impact of native and chemically modified starches addition as fat replacers in the viscoelasticity of reduced-fat stirred yogurt

Three reduced-fat stirred yogurts were prepared from reconstituted milk (12.5 g L⁻¹ of milk-fat) added with native maize (Y_{NMS}), and chemically modified maize (Y_{MS}) or tapioca (Y_{TS}) starches (10 g L⁻¹). The chemical composition, syneresis, flow and viscoelastic properties of the reduced-fat yogurts were evaluated and compared with those of a full-fat control yogurt (Y_C; 25 g L⁻¹ of milk-fat) without starch. The rheological analysis showed that the Y_C exhibited lower apparent viscosity-shear rate profiles and dynamic viscoelastic moduli, but higher syneresis than the reduced-fat yogurts. The reduced-fat yogurts showed little variation in their flow and viscoelastic properties with storage time (15 days). The addition of native or chemically modified starches from different origin to reduced-fat yogurts contributed to the formation of more stable dispersed acidified milk gelled systems[C. Lobato-Calleros*, C. Ramírez-Santiago, E.J. Vernon-Carter, J. Alvarez-Ramirez (Departamento de Preparatoria Agrícola, Universidad Autónoma Chapingo, Km 38.5 Carretera México–Texcoco, Texcoco 56230, México, Mexico), *Journal of Food Engineering*, 2014, **131**, 110–115].

NPARR, 6(3 & 4), 2015-104 **Development of a new rice beverage by improving the physical stability of rice slurry**

“Rice slurry” made from brown rice with wet stone milling, which was developed as a new liquid food material. Raw brown rice is hard to be chewed and eaten unlike cooked rice. Therefore, “rice milk”, a beverage made from rice slurry, was developed to ingest raw brown rice. The rice particles in the rice slurry settled to the bottom when the slurry was allowed to remain for several hours. Two conditions, overly fine particles or an increase in the viscosity, suppress the sedimentation velocity of the particles. A separated milling method was established, which reduced the particle size to less than 20 μm . Moreover, the sedimentation velocity decreased exponentially with the viscosity and was steady at more 80 mPa s when the concentration of xanthan gum exceeded 0.1 wt%. A sensory evaluation indicated a favorable rate of 55.6% for the rice slurry containing 0.3 wt% xanthan gum [Masaru Koyama, and Yutaka Kitamura (Graduate School of Life and Environmental Sciences, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba City, Ibaraki Pre 305-8572, Japan), *Journal of Food Engineering*, 2014, **131**, 89-95].

NPARR, 6(3 & 4), 2015-105 **Cross-cultural acceptance of a traditional yoghurt-like product made from fermented cereal**

Akpan is a traditional ready-to-drink fermented yoghurt-like cereal beverage consumed in urban and rural areas in Benin. With the aim of adapting the product to new local and export markets, this work maps African and European consumer preferences for different types of Akpan. A sensory profile of Akpan was created and consumer tests were conducted with 103 consumers of African origin and 74 consumers of European origin. Consumer acceptance was significantly correlated with

fermented odour ($r = -0.94$) and milky taste ($r = 0.92-0.97$) attributes. Cluster analysis revealed different behaviour by African and European consumers with respect to acceptability of Akpan; European consumers did not like the sour taste and African consumers liked an intense sweet milky taste. This study provides information on how Akpan, and other fermented yoghurt-type cereal products, could be adapted to African and European consumer preferences [Noël H Akissoé*, Carole Sacca, Anne-Laure Declémy, Aurelie Bechoff, Victor B nihouvi, Générose Dalodé, Dominique Pallet, Gèneviève Fliedel, Christian Mestres, Joseph D Hounhouigan and Keith I Tomlins (Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 01 BP 526, Cotonou, Benin), *Journal of the Science of Food and Agriculture*, 2015, **95**(9), 1876–1884, July 2015].

NPARR, 6(3 & 4), 2015-106 **Effects of processing sorghum and millets on their phenolic phytochemicals and the implications of this to the health-enhancing properties of sorghum and millet food and beverage products**

Sorghum and millet grains are generally rich in phytochemicals, particularly various types of phenolics. However, the types and amounts vary greatly between and within species. The food-processing operations applied to these grains, i.e. dehulling and decortication, malting, fermentation and thermal processing, dramatically affect the quantity of phenolics present, most generally reducing them. Thus the levels of phytochemicals in sorghum and millet foods and beverages are usually considerably lower than in the grains. Notwithstanding this, there is considerable evidence that sorghum and millet foods and beverages have important functional and health-promoting effects, specifically antidiabetic, cardiovascular disease and cancer prevention, due to the actions of these phytochemicals. Also their lactic acid bacteria-

fermented products may have probiotic effects related to their unique microflora. However, direct proof of these health-enhancing effects is lacking as most studies have been carried out on the grains or grain extracts and not the food and beverage products themselves, and also most research work has been *in vitro* or *ex vivo* and not *in vivo*. To provide the required evidence, better designed studies are needed. The sorghum and millet products should be fully characterised, especially their phytochemical composition. Most importantly, well-controlled human clinical studies and intervention trials are required [John RN Taylor* and Kwaku G Duodu (, Institute for Food, Nutrition and Well-being and Department of Food Science, University of Pretoria, Hatfield, 0028, South Africa), *Journal of the Science of Food and Agriculture*, 2015, **95**(2), 225–237].

NPARR, 6(3 & 4), 2015-107 Green tea: A novel functional food for the oral health of older adults

Functional foods are foods with positive health effects that extend beyond their nutritional value. They affect the function of the body and help in the management of specific health conditions. Green tea, a time-honoured Chinese herb, might be regarded as a functional food because of its inherent anti-oxidant, anti-inflammatory, antimicrobial and antimutagenic properties. They are attributed to its reservoir of polyphenols, particularly the catechin, epigallocatechin-3-gallate. Owing to these beneficial actions, this traditional beverage was used in the management of chronic systemic diseases including cancer. Recently, it has been emphasized that the host immuno-inflammatory reactions destroy the oral tissues to a greater extent than the microbial activity alone. Green tea with its wide spectrum of activities could be a healthy alternative for controlling these damaging reactions seen in oral diseases, specifically, chronic periodontitis, dental caries and oral cancer, which are a common occurrence in the

elderly population. [Sumit Gaur and Rupali Agnihotri* (Department of Periodontology, Manipal College of Dental Sciences, Manipal University, Manipal, Karnataka, India – 576104), *Geriatrics & Gerontology International*, 2014, **14** (2), 238–250]

NPARR, 6(3 & 4), 2015-108 Phenolic compounds, organic acids and antioxidant activity of grape juices produced from new Brazilian varieties planted in the Northeast Region of Brazil

The phenolic compounds, organic acids and the antioxidant activity were determined for grape juice samples from new Brazilian varieties grown in the Sub-middle São Francisco Valley in the Northeast Region of Brazil. The results showed that the Brazilian grape juices have high antioxidant activity, which was significantly correlated with the phenolic compounds catechin, epicatechin gallate, procyanidin B1, rutin, gallic acid, caffeic acid, *p*-coumaric acid, pelargonidin-3-glucoside, cyanidin-3-glucoside, cyaniding-3,5-diglucoside and delphinidin-3-glucoside. The produced juice samples showed higher concentrations of *trans*-resveratrol than those observed in juices made from different varieties of grapes from traditional growing regions. Organic acids concentrations were similar to those of juices produced from other classical varieties. It was demonstrated that it is possible to prepare juices from grapes of new varieties grown in the Northeast of Brazil containing a high content of bioactive compounds and typical characteristics of the tropical viticulture practised in the Sub-middle São Francisco Valley [Marcos dos Santos Lima, Igor de Souza Veras Silani, Isabela Maia Toaldo, Luiz Claudio Corrêa, Aline Camarão Telles Biasoto, Giuliano Elias Pereira, Marilde T. Bordignon-Luiz , Jorge Luiz Ninow* (Universidade Federal de Santa Catarina, Departamento de Engenharia de Alimentos, Campus Universitário, Trindade – 88040-900, Florianópolis, SC, Brazil), *Food Chemistry*, 2014, **161**, 94–103].

NPARR, 6(3 & 4), 2015-109 Coffee with cinnamon–Impact of phytochemicals interactions on antioxidant and anti-inflammatory *in vitro* activity

This paper evaluates the potential bioaccessibility and interactions between antiradical and anti-inflammatory compounds from coffee and cinnamon. Results obtained for whole plant material extracts were compared with those for chlorogenic and cinnamic acids (the main bioactive constituents of the study material). All samples, coffee, cinnamon and a mixture of the two showed abilities to scavenge free radicals and to inhibit lipoxygenase (LOX) activity. Both activities increased after simulated gastrointestinal digestion. In the mixture antiradical phytochemicals acted antagonistically – isoboles adopted the convex form. The same interactions were determined for chemical standards. The water-extractable LOX inhibitors acted synergistically – the isobole curve was “concave”. The same type of interaction was determined for standard compounds. Interestingly, after digestion *in vitro* a slight antagonism in the action of LOX inhibitors was observed. The results show that the food matrix and/or its changes during digestion may play an important role in creating the biological properties [Agata Durak*, Urszula Gawlik-Dziki and Łukasz Pecio (Department of Biochemistry and Food Chemistry, University of Life Sciences, Skromna Str. 8, 20-704 Lublin, Poland), *Food Chemistry*, 2014, **162**, 81–88].

NPARR, 6(3 & 4), 2015-110 Chemical guide parameters for Spanish lemon [*Citrus limon* (L.) Burm.] juices

To contribute for setting reference guideline for commercial juice extracted from the Spanish lemon varieties, chemical composition of 92 direct and 92 reconstituted samples were investigated. In direct lemon juice, titratable acidity was 52.4 g/L, being the citric acid the

main component. Glucose, fructose and sucrose concentrations were 7.9, 7.3 and 4.5 g/L, respectively. Predominant mineral was potassium (1264.2 mg/L), followed by phosphorous (306 mg/L), calcium (112 mg/L) and magnesium (92.6 mg/L). Hesperidin ranged from 257 to 484.8 mg/L, while water soluble pectins varied between 164.8 and 550 mg/L. Similar values were obtained in reconstituted lemon juice. There are different parameters that did not reach or exceeded the limits proposed by the European Association of the Industry of Juices and Nectars. These levels should be taken into account to modify the present reference guideline and that Spanish lemon juices are not discarded for to have lower or bigger values [José Lorente^a, Salud Vegara^a, Nuria Martí^a, Albert Ibarz^b, Luís Coll^c, Julio Hernández^c, Manuel Valero* and Domingo Saura^a (IBM-C-JBT Corp., FoodTech R&D Alliance, Instituto de Biología Molecular y Celular, Universidad Miguel Hernández (UMH) – Campus de Orihuela, Carretera de Beniel km 3.2, 03312 Orihuela, Alicante, Spain), *Food Chemistry*, 2014, **162**, 186–191].

NPARR, 6(3 & 4), 2015-111 Colour and carotenoid changes of pasteurised orange juice during storage

The correlation of carotenoid changes with colour degradation of pasteurised single strength orange juice was investigated at 20, 28, 35 and 42 °C for a total of 32 weeks of storage. Changes in colour were assessed using the CIELAB system and were kinetically described by a zero-order model. L^* , a^* , b^* , ΔE^* , C_{ab}^* and h_{ab} were significantly changed during storage ($p < 0.05$). Activation energies for all colour parameters were 64–73 kJ mol⁻¹. Several carotenoids showed important changes and appeared to have different susceptibilities to storage. A decrease of β -cryptoxanthin was observed at higher temperatures, whereas antheraxanthin started to decrease at lower temperatures. Depending on the time and

temperature, changes in carotenoids could be due to isomerisation reactions, which may lead to a perceptible colour change. Although the contribution of carotenoids was recognised to some extent, other reactions seem of major importance for colour degradation of orange juice during storage [Scheling Wibowo, Liesbeth Vervoort, Jovana Tomic, Jihan Santanina Santiago, Lien Lemmens, Agnese Panozzo, Tara Grauwet, Marc Hendrickx and Ann Van Loey* (Scopus - Author details - Van Loey, Ann M L KU Leuven, Laboratory of Food Technology - LFoRCe, 3000 Leuven, Belgium), *Food Chemistry*, 2015, **171**, 330–340]

***NPARR*, 6(3 & 4), 2015-112 Effect of stevia and citric acid on the stability of phenolic compounds and *in vitro* antioxidant and antidiabetic capacity of a roselle (*Hibiscus sabdariffa* L.) beverage**

Plant infusions are consumed due to their beneficial effects on health, which is attributed to their bioactive compounds content. However, these compounds are susceptible to degradation during processing and storage. The objective of

this research was to evaluate the effect of stevia and citric acid on the stability of phenolic compounds, antioxidant capacity and carbohydrate-hydrolysing enzyme inhibitory activity of roselle beverages during storage. The optimum extraction conditions of roselle polyphenolic compounds was of 95 °C/60 min, which was obtained by a second order experimental design. The incorporation of stevia increased the stability of colour and some polyphenols, such as quercetin, gallic acid and rosmarinic acid, during storage. In addition, stevia decreased the loss of ABTS, DPPH scavenging activity and α -amylase inhibitory capacity, whereas the incorporation of citric acid showed no effect. These results may contribute to the improvement of technological processes for the elaboration of hypocaloric and functional beverages [Iza F. Pérez-Ramírez^a, Eduardo Castaño-Tostado^a, José A. Ramírez-de León^b, Nuria E. Rocha-Guzmán^c, Rosalía Reynoso-Camacho*(Research and Graduate Studies in Food Science, Facultad de Química, Universidad Autónoma de Querétaro, Cerro de las campanas s/n, 76010 Querétaro, Qro., Mexico), *Food Chemistry*, 2015, **172**, 885-892].

COSMETICS/COSMECEUTICALS

NPARR, 6(3 & 4), 2015-113 Olive by-products: Challenge application in cosmetic industry

Olive tree is a traditional plant which fruits (*Olea europaea* L.) are used for olive oil production, especially in Mediterranean countries. Olive oil extraction produces by-products, which can become a major environmental issue. Recently, some studies have been carried out on these residues regarding phytochemical identification and biological and toxicological evaluation. The bioactive compounds contained by these by-products have a high antioxidant activity (especially oleuropein), a characteristic fatty acids profile and an interesting mineral composition. Indeed, taking into account its composition and sustainability issues, the reuse of these disposal residues is advisable. These agro-industrial by-products have the potential to be used with different purposes, providing economical advantage. In particular, the field of skin care products and cosmetics may benefit from these remaining materials, as those bioactive compounds can fulfill a real cosmetic function and activity. This review presents the composition of the different olive by-products and their bioactive compounds. The possible application of these wastes as cosmetic ingredients was critically reviewed [Francisca Rodrigues* , Filipa B. Pimentel and M. Beatriz P.P. Oliveira (Requimte, Department of Chemical Sciences, Faculty of Pharmacy, University of Porto, Portugal), *Industrial Crops and Products*, 2015, **70**, 116–124].

NPARR, 6(3 & 4), 2015-114 Formulation and evaluation of herbal antioxidant face cream of *Nardostachys jatamansi* collected from Indian Himalayan region

To prepare and evaluate a herbal antioxidant face cream which is made by the

ethanol extract of *Nardostachys jatamansi* (Valerianaceae). Antioxidant activity of ethanol extract was assessed by previously reported 2, 2-Diphenyl-1-picrylhydrazyl method. By discovering different types of formulations, such as oil in water, we were able to create several face creams respectively classified from F1 to F6, by incorporating different concentrations of stearic acid and acetyl alcohol. The evaluation of all formulations (F1 to F6) has been done by the analysis of different parameters like pH, viscosity, spread ability and stability. An ethanol fraction analyzed from a sample of *Nardostachys jatamansi* showed a significant antioxidant activity with an IC₅₀ value of 58.39 µg/mL while for ascorbic acid the IC₅₀ value was 46.68 µg/mL. Among the six formulations (F1-F6) F5 and F6 showed good spread ability, good consistency, homogeneity, appearance, pH; there is no proof of a separation phase and ease of removal. Also the formulations F5 and F6 showed no redness or edema or erythema and irritation during irritancy studies. These formulations can be safely used on the skin. Hence, the study suggests that the composition of extract and the base of the cream F5 and F6 are more stable and safe, but it may produce synergistic action [Abhay Prakash Mishra* , Sarla Saklani, Luigi Milella and Priyanka Tiwari (Department of Pharmaceutical Chemistry, H.N.B. Garhwal (A Central) University, Srinagar Garhwal, Uttarakhand, India), *Asian Pacific Journal of Tropical Biomedicine*, 2014, **4**, Suppl. 2, S679–S682].

NPARR, 6(3 & 4), 2015-115 Exploring the antioxidant potential of *Helichrysum stoechas* (L.) Moench phenolic compounds for cosmetic applications: Chemical characterization, microencapsulation and incorporation into a moisturizer

The present work explores the antioxidant potential of *Helichrysum stoechas* (L.) Moench phenolic compounds for cosmetic applications involving the following steps: chemical

characterization, microencapsulation and incorporation into a moisturizer. Eighteen different phenolic compounds were identified in flowering aerial parts (decoction and hydroalcoholic extract), being 3,5-*O*-dicaffeoylquinic acid and myricetin *O*-acetylhexoside the most abundant phenolic acid and flavonoid, respectively. Comparatively to the decoction form, the hydroalcoholic extract presented both higher antioxidant activity and higher phenolic content, being its lyophilized form chosen to proceed with microencapsulation studies. Double emulsion/evaporation microencapsulation technique was applied to produce polycaprolactone based microspheres containing *H. stoechas* hydroalcoholic extract, which were then successfully incorporated into a moisturizer. The results obtained demonstrated the antioxidant potential of *H. stoechas* hydroalcoholic extract and the viability of its microencapsulation, thus opening new perspectives for the exploitation of these natural phenolic extracts in applications such as the cosmetic industry [Marisa R. Barroso, Lillian Barros, Montserrat Dueñas, Ana Maria Carvalho, Celestino Santos-Buelga, Isabel P. Fernandes, Maria F. Barreiro and Isabel C.F.R. Ferreira* (Mountain Research Center (CIMO), ESA, Polytechnic Institute of Bragança, Campus de Santa Apolónia, 1172, 5301-855 Bragança, Portugal), *Industrial Crops and Products*, 2014, **53**, 330–336].

NPARR, 6(3 & 4), 2015-116 Therapeutic and cosmetic applications of Evodiamine and its derivatives—A patent review

Evodiamine, ((+)-(S)-8,13,13b,14-tetrahydro-14-methylindolo[2',3':3,4]pyrido[2,1-b]quinazolin-5(7H)-one) indoloquinazoline alkaloid, is the major component isolated from the fruits of *Evodia rutaecarpa*, family Rutaceae. Broad spectrum of pharmacological activities of Evodiamine suggests its imperative role in treating a variety of diseases influencing the function of diverse targets.

A comprehensive search was carried out to collect patent information regarding Evodiamine and its derivatives using different patent databases covering priority years to till date. The patents claiming therapeutic as well as cosmetic applications of Evodiamine and its derivatives were analyzed in detail and were classified technically based on the its application such as treatment of metabolic disorders, cancer, neurological disorders, and cardiovascular disorders, etc.

The analysis revealed that the use and the mode of actions of Evodiamine and its derivatives in weight management treatments are currently well established. For example the fat reducing property of this alkaloid is primarily due to its mode of actions such as prevention of muscle protein catabolism, enhancement of thermogenesis and lipid oxidation. Apart from its use for treating obesity, Evodiamine and its derivatives are also experimentally explored for their anti-cancer, anti-diabetic and anti-inflammatory properties. The possible mechanisms related to its anti-cancer activity as illustrated by different experimental studies include its potential action as modulator of specific receptors such as topoisomerase I, NF-kappa B and B-cell lymphoma 2 (Bcl2). The analysis hence highlights that, clinical studies pertaining to the anti-cancer, anti-diabetes as well as anti-inflammatory activities of the Evodiamine and its derivatives would possess important market potential for the development of Evodiamine based therapeutics [Kirti Gavaraskar* , Sivakami Dhulap and R.R. Hirwani (CSIR Unit for Research and Development of Information Products. “Tapovan”, NCL Campus, S. No. 113, 114, Pashan, Pune 411 008, India), *Fitoterapia*, 2015, **106**, 22–35].

NPARR, 6(3 & 4), 2015-117 The use of botanically derived agents for hyperpigmentation: A systematic review

Hyperpigmentation disorders are common among those seeking care from dermatologists and primary care physicians. The cosmeceutical

and natural product industries are rapidly growing and many botanical agents are purported to improve hyperpigmentation disorders. Clinical evidence for the use of botanical agents in the treatment of hyperpigmentation has been reviewed. The MEDLINE and Embase databases were searched and a total of 26 articles met inclusion criteria. Study methodology was analyzed and the reproducibility of the studies was graded. Several botanical agents appear promising as treatment options but few studies were methodologically rigorous. Several plant extract and phytochemicals effectively lighten signs of epidermal melasma and hyperpigmentation induced by ultraviolet radiation exposure. Results were mixed for treatment of solar lentigines or dermal hyperpigmentation. There were few rigorously designed studies; future research will be critical to further ascertain the discussed results. The subtype of hyperpigmentation is important for treatment prognosis, with dermal hyperpigmentation less responsive to treatment. Botanical extracts may play an integrative role in the treatment of hyperpigmentation and further studies that integrate them with standard therapies are needed. Side effects, including worsened hyperpigmentation, need to be discussed when considering these therapies [Whitney A. Fisk, MS, Oma Agbai, MD, Hadar A. Lev-Tov, MD, Raja K. Sivamani*(Department of Dermatology, University of California–Davis, Sacramento, California), *Journal of the American Academy of Dermatology*, 2014, **70** (2), 352–365].

NPARR, 6(3 & 4), 2015-118 Exploring the potential of using algae in cosmetics

The applications of microalgae in cosmetic products have recently received more attention in the treatment of skin problems, such as aging, tanning and pigment disorders. There are also potential uses in the areas of anti-aging, skin-whitening, and pigmentation reduction products. While algae species have already been used in some cosmetic formulations, such as

moisturizing and thickening agents, algae remain largely untapped as an asset in this industry due to an apparent lack of utility as a primary active ingredient. This review article focuses on integrating studies on algae pertinent to skin health and beauty, with the purpose of identifying serviceable algae functions in practical cosmetic uses Hui-Min David Wang, Ching-Chun Chen^a, Pauline Huynh, Jo-Shu Chang*(Department of Chemical Engineering, National Cheng Kung University, Tainan 701, Taiwan), *Bioresource Technology*, 2015, **184**, 355–362]

NPARR, 6(3 & 4), 2015-119 Potential of antioxidant extracts produced by aqueous processing of renewable resources for the formulation of cosmetics

The performance of natural extracts obtained from underutilized and residual vegetal and macroalgal biomass processed with food-grade green solvents was compared with that of commercial antioxidants. Selected extracts were obtained from two terrestrial sources: winery byproducts concentrate (WBC) and chestnut burs hydrothermally fractionated extract (CBAE), and from two underutilized seaweeds: *Sargassum muticum* extracts, either extracted with ethanol (SmEE) or after alginate extraction and hydrothermal fractionation (SmAE) and from *Ulva lactuca* processed by mild acid extraction and membrane concentration (UIAE). These extracts showed *in vitro* antioxidant properties comparable to commercial antioxidants and were safe for topical use based on the absence of skin-irritant effects at 0.1% on reconstructed human tissues. The stability of several cosmetic model emulsions was assessed during accelerated oxidation assays. The incorporation of natural extracts produced from renewable underutilized resources at 0.4–0.5% in an oil-in-water emulsions reduced lipid oxidation during storage [Elena M. Balboa, Maria Luisa Soto, Daniele R. Nogueira, Noelia González-López, Enma Conde, Andrés Moure,

María Pilar Vinardell, Montserrat Mitjans and
Herminia Domínguez*(Dep. Enxeñería
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Products*, 2014, **58**, 104–110].

DYES (incl. Food colorants)

NPARR, 6(3 & 4), 2015-120 Extraction of natural dyes from *Curcuma longa*, *Trigonella foenum graecum* and *Nerium oleander*, plants and their application in antimicrobial fabric

The present study has been focused on the extraction of natural dyes from *Curcuma longa*, *Trigonella foenum graecum* and *Nerium oleander* and investigation of their phytochemical and pharmacological characteristics. Dyes were prepared using aqueous, acidic, alcoholic and alkaline extraction techniques. UV spectral studies of the dyes showed a variation in absorption maxima and their color varied with respect to the pH and the solvent used during extraction. The dyes prepared from turmeric using aqueous extraction technique and from fenugreek using alkaline extraction showed good antibacterial activity. The aqueous and alcoholic extraction of *Nerium oleander* was able to inhibit the growth of many fungal strains including *Tricoderma* spp., *Tricophyton rubrum*, *Candida albicans*, *Aspergillus niger*, *Cladosporium* spp. etc. The antimicrobial property of the dyes was used in developing antimicrobial fabric [R. Mari Selvam*, G. Athinarayanan, A. Usha Raja Nanthini, A.J.A. Ranjit Singh, K. Kalirajan and P. Mosae Selvakumar (PG & Research Department of Chemistry, Sri Paramakalyani College, Alwarkurichi, Tamilnadu, India), *Industrial Crops and Products*, 2015, **70**, 84–90].

NPARR, 6(3 & 4), 2015-121 Development and optimisation of a non conventional extraction process of natural dye from olive solid waste using response surface methodology (RSM)

Dyes obtained from different natural sources have emerged as an important alternative to synthetic dyes. In this study, optimisation of natural colorant non-conventional extraction technique from olive waste was investigated using response surface methodology. The

combined effects of extraction conditions on total phenolic content (TPC) and relative color strength (*K/S*) were studied using a three-level three-factor Box–Behnken design. The optimum conditions for dye extraction were found to be 0.14 mol/L, 62.11 min, 71.23 °C and 4.5 g for sodium hydroxide concentration, extraction time, temperature, and mass of the waste, respectively. The efficiency of extraction under these optimum conditions was found to be 1133.86 mg/L of phenolics and relative colour strength (*K/S*) equal to 23.22. Further, Fourier Transform Infrared Spectroscopy was used to identify the major chemical groups in the extracted dye [Imen Elksibi*, Wafa Haddar, Manel Ben Ticha, Rafik gharbi and Mohamed F. Mhenni (Research Unit of Applied Chemistry and Environment, Faculty of Sciences of Monastir, 5000 Monastir, Tunisia), *Food Chemistry*, 2014, **161**, 345–352].

NPARR, 6(3 & 4), 2015-122 *Carthamus tinctorius* L.: A photophysical study of the main coloured species for artwork diagnostic purposes

In this work a spectrophotometric and fluorimetric study of yellow and red extracts from *Carthamus tinctorius* L. in solution and on dyed textiles is reported. The red dye, precipitated as an insoluble organic pigment, was also characterized as powder substrate and on painting mock-ups using different pictorial techniques based on the use of diverse binders. The dyestuffs were directly extracted from dried petals of *Carthamus* flowers following ancient recipes adapted for laboratory use. The main quinochalcone dyes (hydroxysafflor yellow A, safflor yellow A, anhydrosafflor yellow B and carthamin) were separated and isolated through both analytical and preparative High Performance Liquid Chromatography–Photo Diode Array and subsequently identified through Liquid Chromatography–Mass Spectrometry Quadrupole Time-Of-Flight analysis. The compounds were then studied in solution so as to supply

information concerning the scarcely studied fluorescence of these materials. Based on the photophysical behaviour determined in solution, spectral properties of dyed textiles and pictorial mock-ups were discussed. The results obtained on red reference samples are of peculiar relevance for the non-invasive identification of carthamin whose specific absorption and emission features have been clearly detected on a 16th century tapestry fragment [Catia Clementi, Gloria Basconi, Roberto Pellegrino and Aldo Romani (Dipartimento di Chimica, Università di Perugia, Via Elce di Sotto 8, 06123 Perugia, Italy), *Dyes and Pigments*, 2014, **103**, 127–137].

NPARR, 6(3 & 4), 2015-123 UV protective properties of cotton and flax fabrics dyed with multifunctional plant extracts

Ultraviolet radiation (UVR) blocking properties of textiles depend on fibre type, fabric construction and nature of finishing chemicals. Natural dyes can provide vegetable fibres with strong colours if mordants are used.

In this study UV protection properties of dyeing extracts from Mediterranean flora (*Helichrysum italicum* Roth, *Rubia peregrina* L., *Daphne gnidium* L., *Lavandula stoechas* L., *Cynara scolymus* L.) were tested in combination with fabrics made of vegetable fibres (cotton and flax) and different types of mordants (potassium alum and chestnuts tannins). Pre- and post-dyeing solutions were analyzed quali-quantitatively by HPLC/DAD/ESI-MS in order to calculate the dye uptake on fabrics during the dyeing process.

UVR transmittance of fabrics was measured using a spectrophotometer equipped with an integrating sphere. After the dyeing process only flax fabrics mordanted with alum and dyed with *Lavandula* and *Rubia*, and flax fabrics mordanted with tannin and dyed with *Rubia* and *Helichrysum* reached the minimum protection level. A very good protection level was reached by flax mordanted with alum and

dyed with *Helichrysum*. Chestnut tannins provided a slight support in phenols uptake for *Lavandula* and *Helichrysum* plant dyes with respect to potassium alum, but without an improvement of the fabrics UV protection properties; flax samples dyed with *Helichrysum* extract showed an improvement in UV protection properties when mordanted with potassium alum instead of tannins. Colour fastness and the persistence of UV protection characteristics were also tested after light/sun exposure and after several washes [Daniele Grifoni*, Laura Bacci, Sara Di Lonardo, Patrizia Pinelli, Arianna Scardigli, Francesca Camilli, Francesco Sabatini, Gaetano Zipoli and Annalisa Romani (Institute of Biometeorology (IBIMET), National Research Council (CNR), Via Giovanni Caproni, 8, 50145 Florence, Italy), *Dyes and Pigments*, 2014, **105**, 89–96].

NPARR, 6(3 & 4), 2015-124 Optimization of ultrasound-assisted extraction of natural pigments from *Bougainvillea glabra* flowers

In this study, ultrasound-assisted extraction (UAE) technique was used to examine and optimize the natural pigment extraction from *Bougainvillea glabra* flowers using four factors three level (extraction temperature, ultrasonic power, extraction time and solid–liquid ratio) Box-Behnken response surface design. From the results, second-order polynomial models were derived for the responses which were well correlated with experimental data ($R^2 > 0.98$). From response surface plots, extraction temperature, ultrasonic power and extraction time exhibited individual and interactive effects on the pigments yield. An extraction temperature of 55 °C, ultrasonic power of 88 W, extraction time of 37 min and a SL ratio of 1:17 g/ml were identified as optimal condition. Under this condition, the actual yield of (betacyanin of 1.72 ± 0.001 and betaxanthin of 5.78 ± 0.23 mg/g) pigments was acquired and well correlated with predicted values (betacyanin

was 1.76 mg/g and betaxanthin was 5.81 mg/g) J. Prakash Maran*, B. Priya and C. Vigna Nivetha (Department of Food Technology, Kongu Engineering College, Perundurai, Erode 638052, Tamil Nadu, India), *Industrial Crops and Products*, 2015, **63**, 182–189].

ESSENTIAL OILS (incl. Flavour and Fragrance)

NPARR, 6(3 & 4), 2015-125 **Bio-based composite edible films containing *Origanum vulgare* L. essential oil**

Biocomposite films based on fish gelatin and chitosan containing *Origanum vulgare* L. essential oil (OEO) at 0.4, 0.8, and 1.2% (w/v) were prepared by a solvent casting method and their physicochemical and antimicrobial properties were examined. The results showed that the incorporation of OEO caused a significant decrease ($p < 0.05$) in tensile strength (TS) and elastic modulus (EM), although no significant change was observed in elongation-at-break (EAB). Water vapor permeability (WVP) and solubility of films containing OEO increased as the amount of oil increased ($p < 0.05$). Oregano essential oil-loaded films displayed superior barrier capability to ultraviolet light. Fourier transforms infrared (FTIR) spectra indicated that the interaction between polymer matrix and essential oil was occurred. The properties of the films were related with their microstructure, which was observed by scanning electron microscopy (SEM). Atomic force microscopy (AFM) images showed that the surface roughness of the films was influenced by the inclusion of oil. OEO-incorporated films also exhibited higher antimicrobial activity against the gram-positive bacteria (*Staphylococcus aureus* and *Listeria monocytogenes*), and lower for gram-negative bacteria (*Salmonella enteritidis* and *Escherichia coli*). This study showed that OEO has the potential to prepare active edible films [Seyed Fakhreddin Hosseini, Masoud Rezaei, Mojgan Zandi, Farhid Farahmandghavi (Department of Seafood Processing, Faculty of Marine Sciences, Tarbiat Modares University, P.O. Box 46414-356, Noor, Iran), *Industrial Crops and Products*, 2015, **67**, 403–413].

NPARR, 6(3 & 4), 2015-126 **Antifungal effect of five essential oils against important pathogenic fungi of cereals**

Essential oils from five species of medicinal and food plants were tested as mycelial growth inhibitors against five important pathogenic fungal species that cause stem, leaf and ear diseases of cereals. An agar dilution method was used to determine the inhibitory effect and effective dose of essential oils extracted from *Pimpinella anisum*, *Thymus vulgaris*, *Pelargonium odoratissimum*, *Rosmarinus officinalis* and *Foeniculum vulgare* on the fungi *Oculimacula yallundae*, *Microdochium nivale*, *Zymoseptoria tritici*, *Pyrenophora teres* and *Fusarium culmorum*. All essential oils used in our experiment affected the growth of these fungi. Ultimately, the best antifungal activity (on the basis of inhibitory effect) was demonstrated by *Thymus vulgaris*. The chemical compositions of the essential oils were determined by gas chromatography/mass spectrometry analysis [Pavel Matusinsky, Miloslav Zouhar, Roman Pavela and Pavel Novy (Agrotest fyto, Ltd., Havlickova 2787, 767 01 Kromeriz, Czech Republic), *Industrial Crops and Products*, 2015, **67**, 208–215].

NPARR, 6(3 & 4), 2015-127 **Supercritical fluid extraction as an alternative process to obtain essential oils with anti-inflammatory properties from marjoram and sweet basil**

The anti-inflammatory potential of marjoram and sweet basil essential oils obtained by supercritical fluid extraction (SFE) was tested *in vitro* using THP-1 human macrophage cells. THP-1 cells were activated by lipopolysaccharide or human ox-LDL and the cytokine secretion and gene expression of, respectively, TNF- α , IL-1 β , IL-6 and IL-10 along with COX-2 and NF κ B gene expression was evaluated. Results indicated that both marjoram and sweet basil essential oils at a concentration of 10 μ g/mL markedly suppressed

the production of pro-inflammatory cytokines and gene expression in LPS and ox-LDL THP-1 activation. The chemical composition of marjoram and basil extracts was evaluated and the activity of the main compounds was also tested for cytokine production and gene expression. It is concluded that the anti-inflammatory activity of both oils is dedicated to their main compounds, respectively, sabinene hydrate and terpineol for marjoram and linalool and eugenol for sweet basil extracts. Furthermore, these results confirmed their application as anti-atherosclerotic agents.

Main compounds presented in supercritical basil (linalool and eugenol) and marjoram (sabinene hydrate and terpineol) essential oils also presented an important anti-inflammatory activity, which allowed us to propose these compounds as responsible for the anti-inflammatory activity found in essential oils. SFE allowed to obtain sage and marjoram essential oils with significant anti-inflammatory properties. Furthermore, these supercritical essential oils have also shown an important anti-inflammatory effect in an atherosclerotic environment and presented a highly potential application in the prevention of atherosclerosis [E. Arranz, L. Jaime, M.C. López de las Hazas, G. Reglero and S. Santoyo (Instituto de Investigación en Ciencias de la Alimentación (CIAL), Universidad Autónoma de Madrid, 28049 Madrid, Spain), *Industrial Crops and Products*, 2015, **67**, 121–129].

NPARR, 6(3 & 4), 2015-128 Variation in essential oil composition and antioxidant activity of cumin (*Cuminum cyminum* L.) fruits during stages of maturity

Chemical composition and antioxidant activity of essential oils of cumin fruits (*Cuminum cyminum* L.) at four stages of maturity (immature, intermediate, premature and full mature) were investigated. Maximum and minimum essential oil (EO) yields (4.3% and 2.7%) were observed at the mature and immature, respectively. The essential

oils were analyzed by GC and GC/MS. Results indicated that the amounts of α -pinene, β -pinene, α -phellandrene, α -terpinene, and γ -terpinene decreased, whereas the levels of *p*-cymene, α -terpineol, cumin aldehyde, and safranal increased during maturation process. The total phenol content of the essential oils of cumin fruits harvested at immature, intermediate, premature and full mature were 25.52, 40, 36.86, and 30 mg GAE/g EO, respectively. The essential oils showed lower antioxidant activity than BHT (butylated hydroxytoluene) (synthetic antioxidant). Antioxidant activities of the essential oils had positive correlation with their phenolic contents that increased at stages of intermediate and premature. In conclusion, the antioxidant activity of cumin essential oil was considered a useful antioxidative compound in the food industries [Mohammad Moghaddam*, Seyed Naser Khaleghi Miran, Abdollah Ghasemi Pirbalouti, Leila Mehdizadeh and Yadollah Ghaderi (Department of Horticulture, Faculty of Agriculture, Ferdowsi University of Mashhad, P.O. Box 91775-1163, Mashhad, Iran), *Industrial Crops and Products*, 2015, **70**, 163–169].

NPARR, 6(3 & 4), 2015-129 Influence of technical processing units on chemical composition and antimicrobial activity of carrot (*Daucus carrot* L.) juice essential oil

The effect of three processing units (blanching, enzyme liquefaction, pasteurisation) on chemical composition and antimicrobial activity of carrot juice essential oil was investigated in this paper. A total of 36 compounds were identified by GC–MS from fresh carrot juice essential oil. The main constituents were carotol (20.20%), sabinene (12.80%), β -caryophyllene (8.04%) and α -pinene (6.05%). Compared with the oil of fresh juice, blanching and pasteurisation could significantly decrease the components of the juice essential oil, whereas enzyme liquefaction had no considerable effect on the composition of juice essential oil. With regard to the antimicrobial activity, carrot juice essential oil could cause physical damage and

morphological alteration on microorganisms, while the three different processing units showed noticeable differences on the species of microorganisms, the minimum inhibitory concentration and minimum bactericidal concentration. Results revealed that the carrot juice essential oil has great potential for application as a natural antimicrobial applied in pharmaceutical and food industries [Tingting Ma, Jiyang Luo, Chengrui Tian, Xiangyu Sun, Meiping Quan, Cuiping Zheng, Lina Kang and Jicheng Zhan* (College of Food Science and Nutritional Engineering, China Agricultural University, Beijing 100083, China), *Food Chemistry*, 2015, **170**, 394–400].

NPARR, 6(3 & 4), 2015-130 **Performance of an active paper based on cinnamon essential oil in mushrooms quality**

The antioxidant capacity of two active papers (based on solid and emulsion paraffin) with cinnamon essential oil was studied.

Mushroom samples were introduced in macroperforated PET trays covered with the active papers, and weight loss and browning monitored for 9 days. The antioxidant capacity of the different papers was evaluated based on scavenging 1,1-diphenyl-2-picryl-hydrazyl (DPPH) and tyrosinase inhibition kinetics, and the release of aromatic volatile oils was determined by HSPME–GC–MS. Differences in performance were observed: the active papers were more efficient at avoiding weight loss and mushroom browning when compared to the non-active paraffin-based papers. The efficiency increased when the bottom and walls of the trays were covered rather than the bottom alone. Better results were observed when cinnamon was incorporated as emulsion paraffin instead of a solid [Y. Echevoyen and C. Nerín* (I3A, Department of Analytical Chemistry, University of Zaragoza, C/María de Luna 3, 50018 Zaragoza, Spain), *Food Chemistry*, 2015, **170**, 30–36].

FEED/FODDER

NPARR, 6(3 & 4), 2015-131 *Mucuna pruriens* detoxification: Effects of ensiling duration and particle size

Mucuna pruriens is grown for food and feed despite its L-3, 4-dihydroxyphenylalanine (L-dopa) concentration (30–70 g/kg), which is toxic to non-ruminants. This study determined if ensiling could reduce the L-dopa concentration of *Mucuna*. Experiment 1 examined the effect of ensiling duration on the fermentation characteristics and L-dopa concentration of *Mucuna*. Crushed (6 mm) *Mucuna* beans (912 g DM/kg) were ensiled in triplicate for 0, 3, 7, 14, 21, and 28 days in vacuum-sealed plastic bags. During the fermentation, pH decreased, whereas concentrations of ammonia-nitrogen, lactate, isobutyrate, and isovalerate increased ($P < 0.05$) non-linearly. The ammonia-nitrogen concentration remained below 100 g/kg of total N throughout the ensiling period but lactate concentration was 25.7 g/kg DM by d 28. A pH of 4.5 and an L-dopa concentration of 13 g/kg (54% reduction) were achieved after 28 days of ensiling. Experiment 2 examined effects of particle size of *Mucuna* on the L-dopa concentration and nutritional value after ensiling. Crushed *Mucuna* beans (6 mm, Coarse) were used intact or ground in a Wiley mill to pass through a 4-mm (Medium) or 2-mm (Fine) screen. Samples (1500 g) of each particle size were weighed into vacuum plastic bags in quadruplicate. Double-distilled water (900 ml) was added to each bag and the bags were sealed and ensiled for 28 days. Ensiling *Mucuna* with particle sizes of 2, 4 and 6 mm for 28 days decreased the L-dopa concentration from 28 to 12, 16, and 11 g/kg, representing decreases of 57, 42 and 64%, respectively. Ensiling also reduced ($P < 0.05$) the water-soluble carbohydrate, lysine and arginine concentrations and increased ($P < 0.05$) concentrations of ammonia-nitrogen and most amino acids. Coarse particles had

greater gross energy values than Medium or Fine particles and the greatest or among the greatest ($P < 0.05$) concentrations of all amino acids. Concentrations of amylase-neutral detergent fiber, starch, crude protein and fat were unaffected by treatment ($P > 0.05$). Therefore, ensiling coarse *Mucuna* particles for 28 days is recommended to reduce the L-dopa concentration and preserve the nutritional value [C.M. Huisden, N.J. Szabo, I.M. Ogunade and A.T. Adesogan* (Department of Animal Sciences, Institute of Food and Agricultural Life Sciences, University of Florida, Gainesville, FL 32608, USA), *Animal Feed Science and Technology*, 2014, **198**, 20–27].

NPARR, 6(3 & 4), 2015-132 The effect of steam pelleting of a dry dog food on the Maillard reaction

During processing of pet foods, the Maillard reaction (MR) can occur, which reduces the bioavailability of essential amino acids like lysine and results in the formation of advanced Maillard reaction products (MRPs). This study examined the effect of conditioning temperature (65 and 90 °C) and die hole length (ϕ 5 × 45, 65, and 80 mm) during pelleting processing of a standard dry dog food on selected indicators of the MR (total lysine, reactive lysine, fructoselysine, ϵ -N-carboxymethyllysine, (5-hydroxymethyl)-2-furfural, lysinoalanine), browning development and CIE-Lab color. Steam pelleting variables did not cause a significant loss of lysine or change in color and absorbance values. Analyzing the unprocessed ingredient mix suggests that the choice of the ingredients used in the ingredient mix, rather than the pelleting process applied, is responsible for the RL/TL ratio observed in the dry standard dog food used in this study. MRP content increased during steam pelleting (fructoselysine: 366.2 to 538.8 mg/kg DM; ϵ -N-carboxymethyllysine: 12.6 to 14.8 mg/kg DM; lysinoalanine: 5.7 to 7.7 mg/kg DM; $P < 0.05$). Increasing conditioning

temperature from 65 to 90 °C increased fructoselysine (475.9 to 601.6 mg/kg DM; $P<0.01$) and ϵ -*N*-carboxymethyllysine (14.3 to 15.1 mg/kg DM; $P=0.003$). An increased die hole length of 80 mm decreased fructoselysine content compared to 45 and 65 mm (461.3 vs. 573.3 and 581.6 mg/kg DM; $P<0.01$) but increased lysinoalanine content (8.8 vs. 7.4 and 6.8 mg/kg DM; $P=0.002$). Analyzing total and reactive lysine and absorbance values are not accurate enough to predict the MR and formation of MRPs during processing [C. van Rooijen, G. Bosch, P.A. Wierenga, W.H. Hendriks and A. F.B. van der Poel* (Animal Nutrition Group, Department of Animal Sciences, Wageningen University, PO Box 338, 6700 AH Wageningen, The Netherlands), *Animal Feed Science and Technology*, 2014, **198**, 238–247].

NPARR, 6(3 & 4), 2015-133 Effects of dietary pomegranate byproduct silage supplementation on performance, carcass characteristics and meat quality of growing lambs

In an experiment with 24 male growing Florina (Pelagonia) lambs, effects of dietary pomegranate byproduct silage (PS) on performance, carcass characteristics and meat chemical and fatty acid composition were determined. In the 9 week experiment, lambs were allocated to one of three dietary treatments (PS0, PS120, and PS240) of 8 lambs each. Lambs had an initial body weight (BW) of 18.8 ± 2.28 kg, and were fed one of three isonitrogenous (crude protein 171 g/kg, dry matter – DM basis) and isoenergetic (net energy for gain 5.62 MJ/kg, DM basis) total mixed rations (TMRs) *ad libitum*. The PS was added to the TMR at inclusion levels (as mixed basis) of 0, 120, and 240 g/kg DM for treatments PS0, PS120, and PS240, respectively. No differences ($P>0.05$) occurred among PS treatments in final BW (34.3 kg), BW gain (0.24 kg/day), DM intake (0.94 kg/day), and FCR (3.95 kg DM intake/kg BW gain). Moreover, carcass characteristics were not affected ($P>0.05$) with

increased PS feeding, except for the fat color, fat firmness, wetness and overall acceptability of carcasses, which improved ($P<0.05$). Fat content of meat was linearly increased ($P<0.001$) with increasing PS in lambs TMRs. PS supplementation caused linear ($P<0.05$) and quadratic ($P<0.01$) effect on 11-Hexadecenoic concentration and a linear decrease ($P<0.05$) in 6-9-Hexadecenoic and *cis*-11, 14-eicosadienoic acids concentrations, in intramuscular fat. A linear increase ($P<0.05$) was observed in linoleic acid and *trans*-10, *cis*-12 conjugated linoleic acid (CLA) ($P<0.05$) concentration, with increasing PS inclusion levels and a quadratic ($P<0.05$) and linear ($P<0.01$) effect on α -linolenic acid concentration. Meat total phenolic content increased linearly ($P<0.05$) and antioxidant activity was linearly ($P<0.05$) and quadratic affected ($P<0.05$), with maximum levels observed in intermediated group (PS120). Pomegranate byproduct silage supplementation, at levels up to 240 g/kg DM of TMR, in isonitrogenous and iso (net energy) energetic diets for growing lambs did not affect their performance and carcass quantitative characteristics, but improved qualitative carcass characteristics. More significantly, dietary PS supplementation improved the nutritional and functional qualities, as well as the antioxidant potential of meat, as indicated by the increase in essential fatty acids, linoleic, α -linolenic acid and *trans*-10, *cis*-12 CLA, in intramuscular fat and the increase in total phenolic content and antioxidant activity [B. Kotsampasi*, V. Christodoulou, A. Zotos, M. Liakopoulou-Kyriakides, P. Goulas, K. Petrotos, P. Natas and V.A. Bampidis (Animal Research Institute, Hellenic Agricultural Organization (HAO)–emeter, 58100 Giannitsa, Greece), *Animal Feed Science and Technology*, 2014, **197**, 92–102].

NPARR, 6(3 & 4), 2015-134 Effects of fermented and extruded wheat bran on total tract apparent digestibility of nutrients, minerals and energy in growing pigs

A pig digestibility trial was conducted to investigate the effects of fermentation or

extrusion of wheat bran included in a basal diet on coefficients of total tract apparent digestibility (CTTAD) regarding dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), starch, energy (GE), phosphorus (P) and calcium (Ca). In the experiment, 9 growing pigs were allocated to a 3 × 3 Latin square design to measure the CTTAD of the basal diet containing different modified wheat bran variants, and therefore to demonstrate relative differences in the CTTAD among the diets as a result of wheat bran modification. The wheat bran was used in native form (NWB), as fermented bran ensiled with *Lactobacillus paracasei* and *Lactobacillus plantarum* (FWB) and as extruded wheat bran (EWB). Wheat bran variants were included at 200 g kg⁻¹ in a phosphorus deficient basal diet. The obtained results show that the CTTAD of DM was increased when feeding the diet with FWB (+2%, $P < 0.05$) instead of NWB (0.87). Likewise the CTTAD of OM was also increased with FWB (+2%, $P < 0.05$), compared to NWB (0.88). Also the CTTAD of CF was improved with FWB and EWB (+9%, $P < 0.05$), related to NWB (0.58). The CTTAD of ash was improved with FWB (+14%, $P < 0.05$) compared to NWB (0.60). Correspondingly, the CTTAD values of P and Ca were also elevated when feeding the FWB diet. P-digestibility was increased in the FWB feeding group compared to those groups fed with NWB (+35%, $P < 0.05$) and EWB (+53%, $P < 0.05$). Regarding the Ca digestibility, similar results were obtained ($P < 0.05$). While the CTTAD of energy was increased in the FWB (+3%, $P < 0.05$) and EWB (+2%, $P < 0.05$) feeding groups compared to that of NWB (0.85), the N-balance and the CTTAD of starch were not affected by the treatments. Nevertheless, the CTTAD of EE was enhanced in the FWB treatment group (+40%, $P < 0.05$), and was also improved by extrusion (+30%, $P < 0.05$) compared to the NWB (0.50) treatment. In conclusion, fermented and extruded wheat bran exert some significant influence on the apparent total tract digestibility of several essential nutrients, minerals and energy when included in a basal diet, whereby fermentation seems to be the more potent strategy, as positive effects on the CTTAD of P and Ca could only be observed in the feeding

group with FWB [M. Kraler, K. Schedle*, K.J. Domig, D. Heine, H. Michlmayr and W. Kneifel (Institute of Animal Nutrition, Products, and Nutrition Physiology, University of Natural Resources and Life Sciences, Muthgasse 11, 1190 Vienna, Austria), *Animal Feed Science and Technology*, 2014, **197**, 121–129].

NPARR, 6(3 & 4), 2015-135 Amino acid digestibility in copra expellers and palm kernel expellers by growing pigs

An experiment was conducted to determine the coefficient of ileal apparent digestibility (CIAD) and the coefficient of ileal standardized digestibility (CISD) of crude protein (CP) and amino acids (AA) in copra expellers (CE) and palm kernel expellers (PKE) by pigs. Six boars fitted with a T-cannula in the distal ileum with an initial body weight of 65.2 ± 5.4 kg were individually housed in pens equipped with a feeder and a nipple drinker. A replicated 3 × 3 Latin square design was employed with 3 dietary treatments, 3 periods, and 6 animals. Two experimental diets were prepared to contain 400 g/kg of CE or PKE as the sole source of nitrogen. A nitrogen-free diet was also prepared to estimate the basal ileal endogenous loss of CP and AA. All diets contained 5 g/kg chromic oxide as an indigestible index. The CIAD of CP in CE was greater ($P = 0.002$) than in PKE (0.294 vs. 0.051). The values for the CIAD of all indispensable AA except histidine and lysine in CE were also greater ($P < 0.05$) than in PKE. The CISD of CP in CE was greater ($P = 0.014$) than in PKE (0.676 vs. 0.528). The values for the CISD of all indispensable AA except histidine, isoleucine, and lysine in CE were greater ($P < 0.05$) than in PKE. In conclusion, the digestibility of CP and most AA in CE was greater than in PKE [A.R. Son, Y. Hyun, J.K. Htoo, B.G. Kim* (Department of Animal Science and Technology, Konkuk University, Seoul 143-701, Republic of Korea), *Animal Feed Science and Technology*, 2014, **187**, 91–97].

NPARR, 6(3 & 4), 2015-136 The effect of adding stinging nettle (*Urtica dioica*) haylage to a total mixed ration on performance and rumen function of lactating dairy cows

In vitro studies found that inclusion of dried stinging nettle (*Urtica dioica*) at 100 mg/g dry matter (DM) increased the pH of a rumen fluid inoculated fermentation buffer by 30% and the effect was persistent for 7 days. Our objective was to evaluate the effects of adding stinging nettle haylage to a total mixed ration on feed intake, eating and rumination activity, rumen pH, milk yield, and milk composition of lactating dairy cows. Six lactating Holstein-Friesian cows were used in a replicated 3 × 3 Latin Square design experiment with 3 treatments and 3 week periods. Treatments were a control (C) high-starch (311 g/kg DM) total mixed ration diet and two treatment diets containing 50 (N5) and 100 (N10) g nettle haylage (DM/kg) as a replacement for ryegrass silage (*Lolium perenne*). There was an increase (linear, $P < 0.010$) in the proportion of large particles and a reduction in medium (linear, $P = 0.045$) and fine particles (linear, $P = 0.026$) in the diet offered with increasing nettle inclusion. A numerical decrease (linear, $P = 0.106$) in DM intake (DMI) was observed as nettle inclusion in the diet increased. Milk yield averaged 20.3 kg/day and was not affected by diet. There was a decrease (quadratic, $P = 0.01$) in the time animals spent ruminating as nettle inclusion in the diet increased, in spite of an increase in the number of boli produced daily for the N5 diet (quadratic, $P = 0.031$). Animals fed the N10 diet spent less time with a rumen pH below 5.5 ($P < 0.05$) than cows fed the N5 diet. Averaged over an 8.5 h sampling period, there were no changes in the concentration or proportions of acetate or propionate in the rumen, but feeding nettle haylage reduced the concentrations of n-butyrate (quadratic, $P < 0.001$), i-butyrate (linear, $P < 0.009$) and n-caproate (linear, $P < 0.003$). Milk and fat and protein corrected milk yield were not affected when nettles replaced ryegrass silage in the diet

of lactating dairy cows, despite a numerical reduction in feed intake. Rumination activity was reduced by the addition of nettle haylage to the diet, which may reflect differences in fibre structure between the nettle haylage and ryegrass silage fed. Changes observed in rumen pH suggest potential benefits of feeding nettle haylage for reducing rumen acidosis. However, the extent to which these effects were due to the fermentability and structure of the nettle haylage compared to the ryegrass silage fed, or a bioactive component of the nettles, is not certain [D.J. Humphries and C.K. Reynolds * (School of Agriculture, Policy and Development, University of Reading, Earley Gate, Reading RG6 6AR, United Kingdom), *Animal Feed Science and Technology*, 2014, **189**, 72–81].

NPARR, 6(3 & 4), 2015-137 Rehydration of corn grain with acid whey improves the silage quality

The objective of the study was to investigate the effects of rehydration with acid whey or water at three moisture levels, as well as the effects of bacterial inoculation, on the fermentation, chemical composition and aerobic stability of corn grain silages. The trial was conducted in a completely randomized design with four replicates in a factorial arrangement as follows: 3 (rehydration with three different moisture levels: 300, 350 and 400 mL/kg of corn grain) × 2 (silage inoculated with bacteria or not inoculated (control)) × 2 (liquid used in the rehydration: acid whey or water). Overall, corn grain silages rehydrated with acid whey produced more lactic acid than the silages rehydrated with water (13.8 vs. 12.6 g/kg of dry matter (DM), respectively). In addition, increases in the rehydration of corn grain silages promoted decreases (linear) in lactic acid concentration as well as in production of total acids. Although inoculated silages had higher pH as consequence of the rehydration using water at the three levels, these treatments presented high DM recovery. In general, neutral detergent fiber (aNDFom) decreased if inoculant was applied in corn grain

silages rehydrated with acid whey. After silos opening, silages rehydrated with 350 or 400 mL/kg (independent of the liquid) had lower aerobic stability than silages rehydrated with 300 mL/kg. Overall, we found that the inoculant did not promote significant changes in the composition of the corn grain silage. In contrast, the potential of the use of acid whey in ensiling corn grain is high, as its addition leads to improvements in the fermentation process and aerobic stability of the silages [Audaon V. Rezende, Carlos H.S. Rabelo*, Rosane M. Veiga, Luiz P. Andrade, Carla J. Härter, Flávio H.S. Rabelo, Fernanda C. Basso, Denismar A. Nogueira and Ricardo A. Reis (Departamento de Zootecnia, Universidade Estadual Paulista, 14884-900 Jaboticabal, São Paulo, Brazil), *Animal Feed Science and Technology*, 2014, **197**, 213–221].

NPARR, 6(3 & 4), 2015-138 Effects of grape seed supplementation, alone or associated with linseed, on ruminal metabolism in Sarda dairy sheep

Grape seed is a by-product of the winery and distillery industry which could be used in animal nutrition. To test the hypothesis that dietary supplementation with this by-product can decrease the biohydrogenation (BH) of healthy fatty acids (FA), the present study evaluated the effects of grape seed supplementation, alone or combined with linseed, on ruminal BH processes in dairy sheep. In this 60-d trial, 24 lactating Sarda dairy ewes were assigned to four homogeneous groups and fed as follows: (1) control diet (CON), (2) a diet supplemented with 300 g/d per head of grape seed (GS), (3) a diet supplemented with 220 g/d per head of extruded linseed (LIN), (4) and a diet supplemented with a mix of both grape seed and linseed (300 and 220 g/d per head, respectively) (MIX). Ammonia, pH, volatile fatty acids (VFA) and FA composition were determined in rumen liquor at three sampling dates (20, 40 and 60 d). Rumen pH was not influenced by diet ($P>0.05$). The ammonia content was increased ($P<0.05$) in GS

and MIX compared with LIN and CON. The molar proportions of acetate and propionate and their ratio were not affected by the diet ($P>0.05$), whereas the molar proportion of butyrate was the lowest in MIX. Rumenic acid (RA; CLA *cis*-9, *trans*-11) concentration increased in GS compared with CON (0.78 vs. 0.45 mg/100 mg FA; $P<0.05$), whereas the percentage of vaccenic acid (VA; C18:1 *trans*-11) tended to increase ($P<0.10$) in GS compared with CON. The concentration of VA was higher in MIX than in CON (8.18 vs. 3.77 mg/100 mg FA; $P<0.05$), whereas RA did not differ between the same groups. The concentration of linoleic acid (LA; C18:2 *n*-6) decreased and stearic acid (SA; C18:0) increased in all supplemented groups, whereas linolenic acid (LNA; C18:3 *n*-3) decreased in the two groups receiving grape seed compared with CON and LIN. The concentration of total odd- and branched-chain fatty acids (OBCFA) decreased in all supplemented groups compared with CON ($P<0.05$), evidencing that grape seed and linseed supplementation influenced the ruminal BH processes. Grape seed was able to increase the accumulation of RA when supplemented alone, and of VA when combined with linseed; however, the rumen accumulation of SA in both groups supplemented with grape seed evidenced that this by-product was not effective in decreasing the BH of dietary polyunsaturated fatty acids (PUFA) [F. Correddu, A. Nudda*, G. Battacone, R. Boe, A.H.D. Francesconi and G. Pulina (Dipartimento di Agraria, Sezione di Scienze Zootecniche, University of Sassari, Viale Italia 39, 07100, Sassari, Italy), *Animal Feed Science and Technology*, 2015, **199**, 61–72].

NPARR, 6(3 & 4), 2015-139 Effects of wet soya waste supplementation on the intake, growth and reproduction of goats fed Napier grass

This study evaluated the effects of different levels of soya waste on the intake, growth rates, reproduction and feed conversion efficiency of adult goats, as well as the daily

body weight (BW) gain of pre-weaning kids. Two experiments were conducted with Boer crossbred (Boer × local) and Jermasia goats. In experiment (Exp.) 1, 20 goats were divided into four groups (A, B, C and D), with five goats in each group. Groups A, B and C were given soya waste at a rate of 0.5, 1.0 and 2.0% of BW/day on a dry matter (DM) basis. Group D received soya waste *ad libitum*. In Exp. 2, 14 Jermasia does were split into a control group and a treatment group, with seven does in each group. The control group was fed pelleted compound feed at a rate of 2.0% of BW/day, and the treatment group was fed soya waste at a rate of 2.0% of BW/day. In both experiments, the animals were offered Napier grass *ad libitum*. In Exp. 1, with the increased dietary level of soya waste, the animals' grass intake declined, but their intake of total DM and nutrients tended to increase. The intakes of DM, crude protein (CP) and metabolisable energy (ME) were higher ($P < 0.05$) in Group C compared to Group A. The digestibility of DM and nutrients also tended to increase with the increased level of soya waste, and the digestibility of DM, organic matter, CP and neutral detergent fibre were higher ($P < 0.05$) in Group C compared to Group A. The average daily BW gain increased ($P < 0.05$) with the increased dietary level of soya waste. In Exp. 2, the DM and ME intakes of the does were the same in the control and treatment groups. However, the CP intake was higher ($P < 0.05$) in the treatment group compared to the animals in the control group. The BW and reproductive performance of the does fed the treatment feed were similar ($P > 0.05$) to those fed the control feed. The birth weight of the kids did not differ ($P > 0.05$) between the control and treatment groups. However, the BW gain of the pre-weaning kids fed the treatment feed was higher ($P < 0.05$) than that of the pre-weaning kids fed the control feed. Based on this 14-month long feeding study, high levels of soya waste (up to 2.0% DM of BW) did not have detrimental effects on the feed intake, weight gain and reproductive performance of goats, suggesting that soya

waste supplementation is a viable replacement for scarce feedstuffs, such as grass, and expensive commercially produced compound feed [M.M. Rahman, M.R. Rahman, T. Nakagawa, R.B. Abdullah*, W.E. Wan Khadijah and R. Akashi (Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia), *Animal Feed Science and Technology*, 2015, **199**, 104–112].

NPARR, 6(3 & 4), 2015-140 Ramie and kenaf as feed crops

Meeting the food needs, both as quantity and quality, and conserving natural resources and biodiversity simultaneously, represents a continuously increasing challenge. Food of animal origin, as an important part of these needs, creates also increasing feed demands, the most expensive part of its production, and drives to the necessity of a more complete evaluation of some feed sources, deriving from crops traditionally used in various other uses. Some fiber crops appear very promising in this direction and especially two of them, Ramie (*Boehmeria nivea*) and kenaf (*Hibiscus cannabinus*), show a serious potential for use, besides all other uses, in animal feeding. Their contents in main nutrients, as protein, carbohydrates, fats and minerals appears very satisfactory, combined to good palatability and digestibility, all prices being compatible to those of the most widely used animal fodders, soya bean meal, and alfalfa hay. Taking in consideration the potential of these plants for various other uses and their adaptability to a wide variety of environments, we are directed to the necessity of a more efficient use of them, using effectively all their potential for feed production, besides all other uses [E. Kipriotis, X. Heping, T. Vafeiadakis, M. Kiprioti and E. Alexopoulou (CRES—Center for Renewable Energy Sources and Saving, 19th km Marathonos Avenue, 19009 Pikermi Attikis, Greece), *Industrial Crops and Products*, 2015, **68**, 126–130].

NPARR, 6(3 & 4), 2015-141 Effects of plant vegetative stage and field drying time on chemical composition and *in vitro* ruminal degradation of forage soybean silage

The chemical composition and rumen degradability of ensiled soybean forage harvested at three plant vegetative stages (*i.e.*, R4, R5, R6) and wilted for 20 or 28 h was assessed in this study. The wilted forages were chopped from 1 to 2 cm and then manually pressed into 6 kg bags of fresh material (two bags for each combination of maturity stage and wilting duration) prior to storage under anaerobic condition for 90 days. The soybean silages were analysed for fermentative parameters and manually separated into leaves, stalks and pods. Whole forage and separated plant components were chemically analysed and the *in vitro* neutral detergent fibre (NDF) ruminal degradation (NDFD) was determined. Only whole plant silages were assessed for *in vitro* gas production (GP) and *in vitro* crude protein degradability (CPD). The dry matter (DM) content of the ensiled whole plants increased ($P=0.005$) from 454 to 485 and 518 g/kg from the R4 to R5 and R6 vegetative stages and was higher for forages wilted at 28 h than those at 20 h (528 *vs* 444 g/kg, $P<0.001$). Advancing plant maturity increased ($P<0.001$)

the crude protein (CP) and ether extract (EE) content from 164 to 199 and from 18 to 53 g/kg DM, respectively, but reduced ash ($P=0.011$) from 71 to 63 g/kg DM. The NDFD increased with plant maturity from 0.319 to 0.465 ($P<0.001$). The GP did not differ among maturity stages of forages or wilting lengths, while CPD increased from 0.391 to 0.548 ($P<0.001$) with advancing maturity and slightly decreased with the longer wilting duration ($P<0.008$). The DM content of the pods and stalks increased ($P<0.01$) with the vegetative stage and CP content increased in pods and decreased in leaves. Results indicate that harvesting soybean forage at an advanced maturity stage (*e.g.*, from R4 to R6) greatly increases the protein, the fat and the degradable NDF contents. Moreover, the wilting soybean forage has to be targeted to achieve a DM content of ensiled forage of about 440 g/kg (between about 410 and 480 g/kg, according to the maturity stage), and a further wilting determines no fermentative improvements at ensiling or relevant modification of silage nutritional contents [M. Spanghero*, C. Zanfi, M. Signor, D. Davanzo, V. Volpe and S. Venerus (Department of Agricultural and Environmental Sciences, University of Udine, Udine, Italy), *Animal Feed Science and Technology*, 2015, **200**, 102–106].

FIBRES (incl. Textile and other utility fibres)

NPARR, 6(3 & 4), 2015-142 Sustainable use of cassava (*Manihot esculenta*) roots as raw material for biocomposites development

This work is focused on the use of cassava roots peel and bagasse as natural fillers of TPS materials based on cassava starch. A deep insight into biocomposites microstructure was performed in order to support mechanical and barrier properties of the final materials. Cassava byproducts chemical composition and particle size distribution helped to explain TPS SEM morphology, mechanical and barrier properties modifications. Processing conditions favored starch-filler interactions leading to lower mixing energy requirements. The matrix-filler compatibility was demonstrated by FTIR and thermal analysis of TPS composites. Filler addition increased UV-barrier capacity and opacity of TPS materials, though water vapor permeability was maintained. Both byproducts reinforce TPS matrices even though low filler concentrations were used. Bagasse addition (1.5%) increased 260% elastic modulus and 128% maximum tensile stress of TPS composites, being the most efficient reinforcing agent due to its high residual starch content and lower proportion of smaller particles [Florencia Versino, Olivia V. López, M. Alejandra García* (Centro de Investigación y Desarrollo en Criotecnología de Alimentos, CIDCA (UNLP-CONICET), Facultad de Ciencias Exactas, UNLP, 47 y 116, 1900 La Plata, Argentina), *Industrial Crops and Products*, 2015, **65**, 79–89].

NPARR, 6(3 & 4), 2015-143 New flax producing bioplastic fibers for medical purposes

Flax (*Linum usitatissimum*) is an annual plant with a long history of cultivation and a great significance in medicine and industry. To increase the valuable qualities of flax products, the flax

genome has been genetically modified, with the specific aims to improve flax properties and usefulness for various industries. Through introduction of polyhydroxybutyrate (PHB) synthesis genes from *Ralstonia eutropha* into flax genome, biomechanical properties of fiber have been improved. In this paper, we report that those fibers contain higher quantities of phenolics in addition to PHB thus making the modified fibers a very suitable material for biomedical application, provided that the fabric is not treated chemically. The linen PHB-fabric promotes human fibroblast proliferation and has been shown to have antimicrobial activity in the *in vitro* studies. Based on this quality of the fabric, the new dressing for chronic wounds was developed and proven to be successful in a pre-clinical trial. Therefore, it was demonstrated that modified flax fibers are suitable material for biomedical industry [A. Kulma*, K. Skórkowska-Telichowska, K. Kostyn, M. Szatkowski, J. Skała, Z. Drulis-Kawa, M. Preisner, M. Żuk, J. Szperlik, Y.F. Wang and J. Szopa (Faculty of Biotechnology, University of Wrocław, Przybyszewskiego 63, 51-147 Wrocław, Poland), *Industrial Crops and Products*, 2015, **68**, 80–89].

NPARR, 6(3 & 4), 2015-144 The potential of stinging nettle (*Urtica dioica* L.) as a crop with multiple uses

Stinging nettle (*Urtica dioica* L.) is a well-known plant species that is considered a weed in intensive agriculture. This crop has gained the interest both scientifically and commercially because it is the source of many added-value natural products by exploiting all the plant parts (stem, leaves, roots and seeds). The main objective of this article is to describe-along with unpublished data-information that is spread in different sources, giving an updated and comprehensive overview of the potential end-products, covering aspects related to the whole plant production chain, and at the same time, providing unpublished data collected under different projects.

The effects of nettle cultivation on the environment are potentially favourable, it being a perennial low-requirement crop (it can reach about 3–12 Mg ha⁻¹ dry stalk yield with low inputs). Stinging nettle has a long history as a textile fibre; its fibre quality has been demonstrated (*e.g.* cellulose content around 86%) and is highly depending on the extraction method. Furthermore, several studies confirmed the presence of numerous active compounds, especially in nettle leaves (*e.g.* caffeic acid derivative compounds, ceramides, nine forms of carotenoids, essential fatty acids, vitamins, minerals, phytosterols, glycosides and proteins), with most promising application in the food/feed, medicinal and cosmetic sectors. Although with high market potentials, the products made from nettle are currently more a result of curiosity rather than large-scale industrial production, mostly due to lack in crop and post-harvest management. The definition of a production chain able to exploit the plant biomass as much as possible is a prerequisite to increase income and boost farmers' adoption, and to attract investors [Nicola Di Virgilio, Eleni G. Papazoglou, Zofija Jankauskiene, Sara Di Lonardo, Marcin Praczyk and Katarzyna Wielgusz* (National Research Council of Italy, Institute of Biometeorology, Via Piero Gobetti 101, 40129 Bologna, Italy), *Industrial Crops and Products*, 2015, **68**, 42–49].

NPARR, 6(3 & 4), 2015-145 New developments in fiber hemp (*Cannabis sativa* L.) breeding

Fiber hemp (*Cannabis sativa* L.) is a sustainable and high yielding industrial crop that can help to meet the high global demand for fibers. Hemp can be grown for fiber, seeds, and/or for dual purpose in a wide range of geographic zones and climates. Currently the main hemp producing regions in the world are China, Europe, and Canada. The number of new cultivars developed for each of these regions has gradually increased, with each region producing its own typical hemp cultivars for different

purposes. In this article, the state of the art of fiber hemp breeding programs in Europe, China, and Canada are reviewed. The breeding strategies and tools used in the breeding of hemp cultivars are discussed. We also provide an overview of genetic diversity in hemp for different traits. In addition, the current knowledge of the main breeding goals for fiber hemp, which are an improvement of fiber quality and fiber yield, breeding for specific cannabinoid profiles, control of flowering behavior, male flowering control, and breeding of cultivars for specific environments are evaluated. Lastly, we discuss the inestimable value of next generation technologies to breed new hemp cultivars that are suitable for a biobased economy [Elma M.J. Salentijn, Qingying Zhang, Stefano Amaducci, Ming Yang and Luisa M. Trindade* (Wageningen UR Plant Breeding, Wageningen University and Research Centre, P.O. Box 386, 6700 AJ Wageningen, The Netherlands), *Industrial Crops and Products*, 2015, **68**, 32–41].

NPARR, 6(3 & 4), 2015-146 Effect of herbicides on yield and quality of straw and homomorphic fibre in flax (*Linum usitatissimum* L.)

Fibre flax (*Linum usitatissimum* L.) is a very poor competitor with weeds, and to obtain acceptable yields, weeds should be effectively controlled. Very little information is available on the tolerance of flax to herbicide applications. Types of applied herbicides determine not only the yield of flax but can also affect yield of fibre, its quality and may affect processes (physical, chemical and enzymatic) used in the refining of homomorphic fibres to increase their thinness and divisibility. Presented basic field research was carried out in the years 2011–2012. In the studies the impact of three herbicides (with a.i. linuron, bentazon and chlorsulfuron) was examined on the control of weeds, course of vegetation and yield and quality of flax homomorphic fibre. The applied herbicides had a significant impact on the weed control, the length of the vegetation, straw

yield, the percentage of fibre in the straw, weight and length of the fibre and its thinness and divisibility. The lowest number and mass of weeds and the highest flax straw yield and fibre quality was obtained after chlorsulfuron application. Bentazon, despite its high herbicidal effectiveness, reduced both the amount and quality of fibre yield when compared to chlorsulfuron, due to its phytotoxic effect on flax. Pre-emergence linuron application resulted in the longest fibres and highest fibre content in flax straw [Jerzy Mańkowski, Krzysztof Pudelko*, Jacek Kołodziej and Tomasz Karaś (Poznań University of Life Sciences, Department of Biochemistry and Biotechnology, ul. Dojazd 11, 60-632 Poznań, Poland), *Industrial Crops and Products*, 2015, **70**, 185–189].

NPARR, 6(3 & 4), 2015-147 **Investigation of microstructure and tensile properties of porous natural coir fibre for use in composite materials**

Natural coir fibres are studied for use as reinforcement in composite materials. In order to efficiently use the fibres and understand the composite properties, the microstructure and the mechanical properties of coir fibres are investigated in this study. X-ray microtomography in SEM (SEM-CT) and SEM image analysis are used to examine the fibre internal structure including the organisation of elementary fibres, microfibril angles and fibre porosity. Mechanical properties of coir fibres are determined by performing fibre tensile tests, in which an integrated optical strain mapping system is used to define fibre strain for producing more reliable values of *E*-modulus and strain at failure. The results show that technical coir fibres comprise plenty of elementary fibres and a lacuna at the centre. The elementary fibre is built up by two main cell walls which consist of bundles of microfibrils with a large misorientation with respect to the elementary fibre axis. Coir fibres appear to have a high porosity of 22 to 30%. The high microfibrillar angle in the coir fibres leads to the low stiffness in fibre direction and to high

elongation to failure thanks to reorientation of the microfibrils under tensile loading [L.Q.N. Tran*, T. Nguyen Minh, C.A. Fuentes, T. Truong Chi, A.W. Van Vuure and I. Verpoest (Singapore Institute of Manufacturing Technology, Agency for Science, Technology and Research (A*STAR), Singapore), *Industrial Crops and Products*, 2015, **65**, 437–445].

NPARR, 6(3 & 4), 2015-148 **In-situ evaluation of flax fibre degradation during waterageing**

The lifetime of a plant fibre biocomposite in an aggressive environment is highly influenced by the evolution of the properties of its components (fibre, matrix and interface) during ageing. This article aims to estimate the evolution of flax fibre stiffness during two months immersion of a flax/PLLA biocomposite in water, using in-situ measurements involving nanoindentation. The evolution of the nanoindentation modulus is found to be correlated with water uptake. In addition, the degradation mechanism is assessed using biochemical analyses such as total sugar and uronic acid and also by SEM observations.

Fibre stiffness reduction can be primarily explained by fibre cracking induced by differential swelling between internal cell-wall layers (S1-S2-S3) and between components within each cell-wall layer. A supplementary mechanism is the dissolution of fibre polysaccharides such as pectins that could ensure load transfer between cellulose microfibrils within the S2 Layer (A. Le Duigou*, A. Bourmaud and C. Baley, *Industrial Crops and Products*, 2015, **70**, 204-210)

NPARR, 6(3 & 4), 2015-149 **A comparative study of mechanical and comfort properties of bamboo viscose as an eco-friendly alternative to conventional cotton fibre in polyester blended knitted fabrics**

In this comparative study, bamboo viscose fibre was studied as an eco-friendly

alternative to cotton fibre in polyester-cellulosic blends. Conventional cotton is not considered eco-friendly because it requires large quantities of water and pesticides during its production. The eco-friendly nature of bamboo viscose is subject to the employed production method. Polyester-bamboo (PB) and polyester-cotton (PC) blended yarns were prepared by employing open-end spinning technique and the said yarns were single jersey weft knitted. The yarn tensile strength, fabric bursting strength, bending length, thermal resistance and moisture management properties were studied. The PB blend outperformed the PC blend in terms of mechanical properties and exhibited lower thermal resistance than the PC blend, which is favourable for summer clothing. However, the moisture management properties of PB blended fabrics were found to be similar to those of PC blended fabrics at higher proportions of bamboo viscose fibre in the PB blend [Muhammad Tausif*, Faheem Ahmad, Uzair Hussain, Abdul Basit, Tanveer Hussain (Department of Textile Engineering, University of Engineering and Technology Lahore (Faisalabad Campus), Faisalabad, Pakistan), *Journal of Cleaner Production*, 2015, **89**, 110–115].

NPARR, 6(3 & 4), 2015-150 Understanding the lodging stability of green flax stems; The importance of morphology and fibre stiffness

Flax fibres (*Linum usitatissimum*) with good mechanical properties are required to reinforce polymers. Usually, their characterisation is made on retted and scutched fibres. This work provides a new and original method to both determine the stiffness of green fibres contained inside the plant and to estimate the crop lodging stability.

Two recent flax varieties (Eden and Terre de Lin (TDL) 25) with a distinct lodging resistance (respectively high and low) were studied. Both varieties, grown under the same conditions, exhibit a similar fibre yield. The

analysis conducted is based on the correlation between the bending stiffness of the stems, the distribution of fibres in a cross section and the properties of elementary flax fibres. The results of the mechanical characterisation indicate that the Eden variety has a superiority concerning fibre stiffness (68 GPa versus 55 GPa). The analysis of the bending stiffness of a dried plant at different localisations along the stem and of its fibre distribution in the corresponding cross section allowed us to estimate the fibres average modulus. Results obtained by this method were very close to the tensile tests values. The same procedure was used on green stems to approach the living state of the plant and to determine the Young's modulus of green fibres. The results highlighted a variation of fibre stiffness between the green state and the dried state (around +25%). The results enabled the use of a simplified buckling model, which confirmed the superiority of the Eden variety in lodging resistance. Thus, the analysis of the mechanical properties of flax stems and their structure could be a selection criterion [Marianne Gibaud, Alain Bourmaud* and Christophe Baley (Université de Bretagne-Sud, EA 4250, LIMATB, BP 92116, 56321, Lorient Cedex, France), *Biosystems Engineering*, 2015, **137**, 9–21].

NPARR, 6(3 & 4), 2015-151 Accelerated retting cum softening of coconut fibre

Accelerated chemical retting of raw coconut fibre was attempted. The treatment of raw coconut fibre with a combination of sodium sulphide, sodium hydroxide, sodium carbonate, reduce retting time from 6 to 12 months to 2 h. Chemical treatment decreases the linear density (about 36%), diameter (about 35%), and flexural rigidity (about 72%), ultimately resulting in much softer fibre. The treatment showed positive result towards mechanical proprieties. Fine structure analysis of the treated fibres through FTIR, XRD, TGA, SEM and component analysis validates the beneficial modification with improved properties. The chemical constituent, FTIR and TG analyses

revealed enhancement of cellulose content and reduction in lignin, hemicelluloses etc. Resultant crystallinity index of the treated coconut fibre is enhanced by 36% compared to the raw fibres. SEM showed that chemical retting is most efficient in removal of impurities. The effluent obtained from chemical

retting was suitably treated to make it safe for discharge [Gautam Basu, Leena Mishra* , Seiko Jose and Ashis Kumar Samanta (ICAR—National Institute of Research on Jute and Allied Fibre Technology, Kolkata 700040, India), *Industrial Crops and Products*, 2015, **77**, 66–73].

FOOD (incl. Dairy, Fishery, Poultry and other Plant and Animal products)

NPARR, 6(3 & 4), 2015-152 By-product from decoction process of *Hibiscus sabdariffa* L. calyces as a source of polyphenols and dietary fiber

Dietary fiber (DF) and antioxidant compounds are widely used as functional ingredients. The market in this field is competitive and the search for new types of quality ingredients for the food industry is intensifying. The aim of this study was to evaluate the composition and antioxidant activity of by-products generated during the decoction of calyces of four Mexican *Hibiscus sabdariffa* L. cultivars ('Criolla', 'China', 'Rosalis' and 'Tecoanapa') in order to assess them as a source of functional ingredients. Some calyx components were partially transferred to the beverage during the decoction process, while most were retained in the decoction residues. These by-products proved to be a good source of DF (407.4–457.0 g kg⁻¹ dry matter) and natural antioxidants (50.7–121.8 μmol Trolox equivalent g⁻¹ dry matter). The decoction process extracted some soluble carbohydrates, ash and some extractable polyphenols. The DF content changed in the dried residues, which could be considered as high-DF materials with a high proportion of soluble DF (~20% of total DF) and considerable antioxidant capacity. These by-products could be used as an antioxidant DF source [Sonia G Sáyago-Ayerdi*, Carolina Velázquez-López, Efigenia Montalvo-González and Isabel Goñi (Sonia G Sáyago-Ayerdi, Laboratorio Integral de Investigación en Alimentos, División de Estudios de Posgrado, Instituto Tecnológico de Tepic, Av. Tecnológico 2595, CP 63175, Tepic, Nayarit, Mexico), *Journal of the Science of Food and Agriculture*, 2014, **94**(5), 898–904].

NPARR, 6(3 & 4), 2015-153 Bread enriched with quinoa leaves – The influence of protein–

phenolics interactions on the nutritional and antioxidant quality

This paper investigates the functional and potential biological properties of bread fortified with quinoa leaves (QL) in the light of protein–phenolic interactions. The addition of QL changed the textural properties of bread crumb. With the replacement of wheat flour by QL (1–5%), a linear increase in crumb hardness, cohesiveness and gumminess was observed. Fortification positively affected antioxidant properties and phenolic contents; however, in some cases experimental values were significantly lower than those predicted. The QL addition affected nutrient content and digestibility. The starch digestibility of the bread investigated in this study was inversely proportional to the percentage content of QL (the changes in protein digestibility were not so pronounced). Increasing peak areas of extracts obtained after digestion of fortified bread and the significant reduction of free amino groups confirm the presence of interactions between phenolics and proteins. The quality of fortified bread is strongly affected by phenolic compounds and food matrix interactions [Michał Świeca*, Łukasz Sęczyk, Urszula Gawlik-Dziki and Dariusz Dziki (Department of Biochemistry and Food Chemistry, University of Life Sciences, Skromna Str. 8, 20-704 Lublin, Poland), *Food Chemistry*, 2014, **162**, 54–62].

NPARR, 6(3 & 4), 2015-154 Nutritional quality of rice bran protein in comparison to animal and vegetable protein

Rice bran protein (RBP) was prepared by alkali extraction and isoelectric precipitation from defatted rice bran. The protein quality of RPB was evaluated and compared to two vegetable proteins [soy protein (ISP) and rice endosperm protein (REP)] and two animal proteins [whey protein (WPI) and casein]. RPB contained 74.93% of protein and its pepsin

digestibility and KOH solubility were 89.8% and 91.5%, respectively.

In Sprague-Dawley rats, RBP showed protein efficiency ratio, net protein ratio, net protein utilisation, and biological value of 2.39, 3.77, 70.7, and 72.6, which were comparable to the qualities of animal proteins. The true digestibility of RBP (94.8%) was significantly higher than that of REP (90.8%), ISP (91.7%)

and WPI (92.8%) and the same as that of casein. Protein digestibility corrected amino acid score (PDCAAS) of RBP was 0.90. These results suggest that rice bran protein appears to be a promising protein source with good biological values and digestibility [Sung-Wook Han, Kyu-Man Chee and Seong-Jun Cho* (Ingredients R&D Center, CJ Cheiljedang, 636 Guro-dong, Guro-gu, Seoul 152051, Republic of Korea), *Food Chemistry*, 2015, **172**, 766–769].

FRUITS

NPARR, 6(3 & 4), 2015-155 Spray drying of orange peel extracts: Yield, total phenolic content, and economic evaluation

Orange peel extract powders were produced using two steps: microwave-assisted extraction and spray drying. The extraction solvent-to-solid ratio has been found to significantly affect the level of total phenolic compounds in the extract and powder. Under the outlet air temperatures between 43 and 79 °C, spray drying of orange peel extracts resulted in a peak yield trend (between 75% and 92%) and high TPC (total phenolic content) recoveries. An evaluation of economics has also been conducted, suggesting that this process is economically feasible, with profits of 6.1 USD/kg and 8.8 USD/kg for solvent to solid ratios of 2 and 14, respectively. The uncertainty analysis of the economics showed that the selling price, the labor cost and the orange peel cost are the three most important parameters compared with the costs of electricity, natural gas, and water [Dian Shofinita* and T.A.G. Langrish (Drying and Process Technology Group, School of Chemical and Biomolecular Engineering, The University of Sydney, Chemical Engineering Building J01, NSW 2006, Australia), *Journal of Food Engineering*, 2014, **139**, 31–42].

NPARR, 6(3 & 4), 2015-156 Watermelon consumption improves inflammation and antioxidant capacity in rats fed an atherogenic diet

Cardiovascular disease (CVD) is the leading cause of death in the United States. Watermelon, rich in antioxidants and other bioactive components, may be a viable method to improve CVD risk factors through reduced oxidative stress. The purpose of the study was to determine the effects of watermelon powder consumption on lipid profiles, antioxidant capacity, and inflammation in dextran sodium sulfate (DSS)-treated rats fed an atherogenic diet.

We hypothesized that watermelon would increase antioxidant capacity and reduce blood lipids and inflammation through modulation of related gene expression. Forty male-weanling (21 days old) Sprague-Dawley rats were divided into 4 groups (10 per group, total N = 40) in a 2 diets (control or 0.33% watermelon) × 2 treatments (with or without DSS) factorial design using an atherogenic diet. Watermelon-fed groups exhibited significantly lower serum triglycerides, total cholesterol, and low-density lipoprotein cholesterol ($P < .05$). C-reactive protein levels were significantly lower in watermelon-fed rats than the control ($P = .001$). In addition, oxidative stress as measured by thiobarbituric acid reactive substances was significantly lower in watermelon groups ($P = .001$). Total antioxidant capacity, superoxide dismutase, and catalase activities were greater in watermelon groups ($P < .05$). Aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, and lactate dehydrogenase were significantly lower in DSS-treated rats when watermelon was consumed ($P < .05$). Fatty acid synthase, 3-hydroxy-3methyl-glutaryl-CoA reductase, sterol regulatory element-binding protein 1, sterol regulatory element-binding protein 2, and cyclooxygenase-2 gene expression was significantly downregulated in the watermelon group without DSS ($P < .05$). These findings indicate that watermelon improves risk factors for CVD in rats through better lipid profiles, lower inflammation, and greater antioxidant capacity by altering gene expression for lipid metabolism [Mee Young Hong, Nicole Hartig, Katy Kaufman, Shirin Hooshmand, Arturo Figueroa, and Mark Kern* (School of Exercise and Nutritional Sciences, San Diego State University, San Diego CA USA 92182), *Nutrition Research*, 2015, **35** (3), 251–258].

NPARR, 6(3 & 4), 2015-157 Lipophilic phytochemicals from banana fruits of several *Musa* species

The chemical composition of the lipophilic extract of ripe pulp of banana fruit from several

banana cultivars belonging to the *Musa acuminata* and *Musa balbisiana* species (namely 'Chinese Cavendish', 'Giant Cavendish', 'Dwarf Red', 'Grand Nain', 'Eilon', 'Gruesa', 'Silver', 'Ricasa', 'Williams' and 'Zelig') was studied by gas chromatography–mass spectrometry for the first time. The banana cultivars showed similar amounts of lipophilic extractives (ca. 0.4% of dry material weight) as well as qualitative chemical compositions. The major groups of compounds identified in these fractions were fatty acids and sterols making up 68.6–84.3% and 11.1–28.0%, respectively, of the total amount of lipophilic

components. Smaller amounts of long chain aliphatic alcohols and α -tocopherol were also identified. These results are a relevant contribution for the valorisation of these banana cultivars as sources of valuable phytochemicals (ω -3 and ω -6 fatty acids, and sterols) with well-established beneficial nutritional and health effects [Carla Vilela, Sónia A.O. Santos, Juan J. Villaverde, Lúcia Oliveira, Alberto Nunes, Nereida Cordeiro, Carmen S.R. Freire and Armando J.D. Silvestre*(CICECO and Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal), *Food Chemistry*, 2014, **162**, 247–252].

FUEL

NPARR, 6(3 & 4), 2015-158 **An evaluation of *Moringa peregrina* seeds as a source for bio-fuel**

Moringa peregrina leaves and pods are known for their medicinal and nutritional values. In this paper, *M. peregrina* seeds had been investigated for the first time as a potential source for bio-fuel. Physical characterization revealed that *M. peregrina* seed is composed of about 59% kernel and 41% husk. The kernel was found to contain about 38% of oil. Higher heating values of 18.21, 20.65 and 39.99 MJ/kg were obtained for *M. peregrina* seed husk, *M. peregrina* seed oil cake and *M. peregrina* seed oil respectively. Thermochemical characteristics and thermal behavior of *M. peregrina* seed husk and *M. peregrina* seed oil cake in an inert atmosphere of N₂ were studied. The initial results showed that *M. peregrina* seed husk and *M. peregrina* seed oil cake could potentially produce energy through thermochemical conversion processes. Low iodine value (67.73 g I₂/100 g oil) and high saponification value (187.53 mg KOH/g oil) were reported for *M. peregrina* seed oil. Thus, a high cetane number (60.16) was reported for *M. peregrina* seed-oil-based biodiesel. *M. peregrina* seed oil was found to contain very low free fatty acids (0.35%), rendering its conversion into biodiesel possible in one step by alkaline catalyst. A high fraction of unsaturated fatty acids was observed in *M. peregrina* seed oil (81.24%) while 76.92% of *M. peregrina* seed oil was contributed by monounsaturated fatty acids with oleic acid as the major component (72.19%). Therefore, high thermo-oxidative stability was observed in *M. peregrina* seed oil. However, its significant fraction of long-chain fatty acids (C20:0 + C20:1 + C22:0) (6.76%) may affect the cold flow properties of the derived biodiesel. We concluded from this study that *M. peregrina* is a potential source for both bio-fuel and food [Mohammed Salaheldeen*, M.K. Aroua, A.A. Mariod, Sit Foon Cheng, Malik A. Abdelrahman

(Chemical Engineering Department, Faculty of Engineering, University Malaya, 50603 Kuala Lumpur, Malaysia), *Industrial Crops and Products*, 2014, **61**, 49–61].

NPARR, 6(3 & 4), 2015-159 **Simultaneous saccharification and fermentation of industrial sweetpotatoes for ethanol production and anthocyanins extraction**

A simultaneous saccharification fermentation (SSF) system was studied for ethanol production in flour industrial sweetpotato (ISP) feedstocks (lines: white DM02-180 and purple NC-413) as an integrated cost saving process, and to examine the feasibility of extracting anthocyanins from flour purple ISPs under a simultaneous extraction and fermentation (SEF) system. Furthermore, a separate hydrolysis fermentation (SHF) configuration was carried out to establish a baseline in sugar consumption and ethanol production from the ISP lines. The thermotolerant ethanol producing yeast strain *Kluyveromyces marxianus* NCYC 851 and the mesophilic *Saccharomyces cerevisiae* Ethanol Red were evaluated, using commercial alpha amylases for hydrolysis of available ISP starch to sugars. Fermentation by *S. cerevisiae* during SHF had an ethanol yield of 0.32 g/g dry ISP, a 1.1-fold increase above that produced by *K. marxianus*. Subsequent studies showed that ethanol yield could be increased in a SSF system with a maximum ethanol yield of 0.39 g/g dry ISP achieved, a 15% increase compared with using a SHF system when *S. cerevisiae* was used. Simultaneous extraction and fermentation of flour purple-fleshed NC-413 ISPs was studied to evaluate the effect of pH on extraction of total monomeric anthocyanins (TMA) and ethanol production. On average, maximum ethanol yield ranged from 0.31 to 0.34 g/g dry ISP and TMA concentration ranged from 45 to 64 mg cyanidin-3-glu/100 g dry powder (10–22 mg/100 g fresh weight) with the greatest ethanol production coming from non-adjusted pH fermentations. The

highest anthocyanin recovery, 64 mg cyanidin-3-glu/100 g dry powder was obtained at 35 °C and pH 4.5 using *S. cerevisiae* Ethanol Red. This study showed the feasibility of extracting anthocyanins and producing ethanol simultaneously in one unit operation without the need of purified solvents [Joscelin T. Diaz, Mari S. Chinn* and Van-Den Truong (Department of Biological and Agricultural Engineering, North Carolina State University, Campus Box 7625, Raleigh, NC 27695, United States), *Industrial Crops and Products*, 2014, **62**, 53-60].

NPARR, 6(3 & 4), 2015-160 **Fresh oil palm frond juice as a renewable, non-food, non-cellulosic and complete medium for direct bioethanol production**

Oil palm frond (OPF) is the largest biomass source in the palm oil industry. Fresh OPF juice can be readily obtained by just pressing the fresh OPF, similar to sugarcane juice. OPF juice contains sugars and other nutrients such as nitrogen, magnesium, calcium, zinc, phosphorus and sulphur, making it a potential medium for bioethanol fermentation. In this study, the potential of fresh OPF juice as a complete non-food medium for direct bioethanol production was evaluated. A promising yield of 0.38 g bioethanol per g sugars consumed was obtained after 24 h of fermentation of fresh OPF juice without nutrient supplementation and without pH correction, which is comparable to synthetic medium at 0.40 g/g. This value is also comparable to the 0.4 g/g yield obtained from sugarcane juice in the Brazilian bioethanol industry. Therefore, this study provides an opportunity for the use of fresh OPF juice as a new renewable, non-food and non-cellulosic feedstock for the bioethanol industry [Sharifah Sopliah Syed Abdullah, Yoshihito Shirai, Ezyana Kamal Bahrin and Mohd Ali Hassan* (Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 UPM Serdang,

Selangor, Malaysia), *Industrial Crops and Products*, 2015, **63**, 357–361].

NPARR, 6(3 & 4), 2015-161 **Canola meal moisture-resistant fuel pellets: Study on the effects of process variables and additives on the pellet quality and compression characteristics**

This study focuses on pelletization of waste canola meal biomass to increase the bulk density, thereby reducing the transportation and storage costs, thus provide better material feeding in gasification reactors with less dust formation. The effects of feed constituents of canola meal such as protein, fiber, fat, lignin and feed moisture content as well as added binder, lubricant and densification process parameters on the strength and durability of the densified product are investigated. The increased durability (99%) of canola meal pellets was a result of added binder (5 wt%) and the inherent protein (40 wt%) and lignin (12 wt%) content in the feed. From the compression data at different temperature and pressure, Kawakita and Lüdde model (1971) was developed to classify the feed material into groups. The R^2 value ≥ 0.999 showed good model fit. It was found that at temperature >70 °C, the particle undergoes rearrangement followed by fragmentation and particle plastic deformation during the compression process. The effects of coating agent on pellet durability, hardness and moisture uptake were studied to produce moisture-resistant pellets. Finally, the pellets were gasified in a fixed bed reactor using different gasifying agents such as steam, oxygen (O₂) and carbon dioxide (CO₂) and their effects were assessed. Carbon dioxide was found to give maximum carbon efficiency (CE) up to 82.7% and 50.7 MJ/m³ LHV of gas at a temperature of 750 °C and equivalence ratio (ER) of 0.4., whereas O₂ gave 66.5% of CE with 44.7 MJ/m³ LHV of gas at 650 °C and 0.4 ER and steam produced gas with LHV 40.8 MJ/m³ with CE 27.4% at 650 °C and

0.2 ER. Thus, by producing moisture-resistant canola meal pellets with reasonable fuel characteristics, pelletization of canola meal provides a promising alternative for the utilization of canola meal waste as an alternative source of renewable energy [Ashwini Tilay, Ramin Azargohar, Mark Drisdelle and Ajay Dalai*(Janusz Kozinski^c (Department of Chemical and Biological Engineering, College of Engineering, University of Saskatchewan, Saskatoon, SK S7N 5A9, Canada), *Industrial Crops and Products*, 2015, **63**, 337–348].

NPARR, 6(3 & 4), 2015-162 Production of biofuels from sweet sorghum juice via ethanol–methane two-stage fermentation

Sweet sorghum juice is rich in fermentable sugar. Combining ethanol fermentation with methane fermentation to convert sweet sorghum juice to biofuels not only maximizes the energy recovery, but also reduces the environmental load. A two-stage fermentation, consisting of continuous ethanol fermentation and thermophilic methane fermentation, was developed to convert sweet sorghum juice to productions of ethanol and methane. The results of batch ethanol fermentation indicated that it was essential to supplement the feedstock with nutrients in order to improve the ethanol yield. Continuous ethanol fermentation could be performed at 35 °C without decreasing the ethanol yield at a dilution rate of 0.3 h⁻¹, and ethanol yield and productivity of 88.5% and 20.3 g/L/h were obtained, respectively. In contrast, the productivity was improved to 27.4 g/L/h by increasing the dilution rate to 0.4 h⁻¹ at a fermentation temperature of 33 °C. The stillage eluted from the ethanol production process was subjected to thermophilic methane fermentation. After adjusting the C/N ratio of the stillage to 40, a total organic carbon (TOC) removal efficiency of 87.0% and gas evolution rate of 1200 mL/g-TOC were achieved, even at a high TOC loading rate of 10 g/L/d by

adding (NH₄)₂SO₄ of 0.1 g/L-stillage [Masatoshi Takaki, Li Tan^{*}, Toru Murakami, Yue-Qin Tang, Zhao-Yong Sun, Shigeru Morimura and Kenji Kida (Graduate School of Science and Technology, Kumamoto University, 2-39-1 Kurokami, Kumamoto 860-8555, Japan) , *Industrial Crops and Products*, 2015, **63**, 329–336].

NPARR, 6(3 & 4), 2015-163 Ceiba pentandra, Nigella sativa and their blend as prospective feedstocks for biodiesel

There are more than 350 oil-bearing crops identified as potential sources for biodiesel production around the globe. The wide range of available feedstocks for biodiesel production represents one of the most significant factors for producing biodiesel. The current research work is carried out on fuel properties of biodiesel prepared from the non-edible oils of *Ceiba pentandra*, *Nigella sativa* and their mixture. *N. sativa* is believed to be investigated for the first time as a biodiesel feedstock while *C. pentandra* has been reported recently in few studies. Owing to higher acid value, acid-esterification and alkali-transesterification processes have been carried out for biodiesel production. The fuel properties of *C. pentandra* methyl ester (CPME), *N. sativa* methyl ester (NSME) and their feedstock mixture (NSME/CPME) are determined. It has been found that the produced biodiesel from respective feedstocks matches the properties set by ASTM 6751 standards. However, the fuel properties of the *C. pentandra* biodiesel exhibited better calorific value, viscosity and flash point while *N. sativa* exhibited excellent cold flow properties and oxidation stability [T.M. Yunus Khan^{*}, A.E. Atabani , Irfan Anjum Badruddin , R.F. Ankalgi, T.K. Mainuddin Khan and Ahmad Badarudin^a (Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia), *Industrial Crops and Products*, 2015, **65**, 367–373].

NPARR, 6(3 & 4), 2015-164 Evaluation of whole Jerusalem artichoke (*Helianthus tuberosus* L.) for consolidated bioprocessing ethanol production

For consolidated bioprocessing (CBP), components of Jerusalem artichoke (*Helianthus tuberosus* L.) tubers and stalks as a potential bioenergy crop were analyzed as carbon and nutrient sources, respectively. The effectiveness of chemical pretreatment with dilute acid or alkali was evaluated to develop a CBP method. Cellulose content, delignification, and enzymatic hydrolysis efficiency of the pretreated stalks were increased more effectively by NaOH treatment than dilute H₂SO₄ treatment. However, weight loss was greater during alkali pretreatment. Additionally, large volumes of water were required to wash the alkali-treated biomass. Therefore, CBP using the dilute acid-pretreated stalk and the ground tuber of *Kluyveromyces marxianus* were investigated. Fermentation of both pretreated stalks and tubers by *K. marxianus* with no nutrient supplementation proceeded acceptably. At 10% (w/v) stalk and 8% (w/v) tuber loading, *K. marxianus* produced 45.3 g/L ethanol after 30 h. The ethanol yield was 0.252 g ethanol per g dry biomass, or 0.32 g ethanol per g fermentable sugars, with a fermentable sugar conversion rate of 60%. These results suggest a cost-effective CBP strategy for bioethanol production from the whole Jerusalem artichoke plant (Seonghun Kim and Chul Ho Kim* (Jeonbuk Branch Institute, Korea Research Institute of Bioscience and Biotechnology, 181 Ipsin-gil, Jeongeup 580-185, Republic of Korea), *Renewable Energy*, 2014, **65**, 83–91].

NPARR, 6(3 & 4), 2015-165 Biodiesel production from swine manure via housefly larvae (*Musca domestica* L.)

Although biodiesel is a sustainable and renewable diesel fuel, the current feedstock predominantly from edible oils limits the

economic feasibility of biodiesel production and thus the development of a cost-effective non-food feedstock is really essential. In this study, approximately 21.6% of crude grease was extracted from housefly (*Musca domestica* L.) larvae reared on swine manure, and the extracted grease was evaluated for biodiesel production concerning the variables affecting the yield of acid-catalyzed production of methyl esters and the properties of the housefly larvae-based biodiesel. The optimized process of 8:1 methanol/grease (mol/mol) with 2 vol% H₂SO₄ reacted at 70 °C for 2 h resulted in a 95.7% conversion rate from free fatty acid (FFA) into methyl esters. A 90.3% conversion rate of triglycerides (crude grease) to its esters was obtained from alkaline trans-esterification using sodium hydroxide as catalyst. The major fatty acid components of this larvae grease were palmitic (29.1%), oleic (23.3%), palmitoleic (17.4%) and linoleic (17.2%). The housefly larvae-based biodiesel has reached the ASTM D6751-10 standard in density (881 kg/m³), viscosity (5.64 mm²/s), ester content (96.8%), flash point (145 °C), and cetane number (52). These findings suggest that the grease derived from swine manure-grown housefly larvae can be a feasible non-food feedstock for biodiesel [Sen Yang, Qing Li, Yang Gao, Longyu Zheng and Ziduo Liu* (State Key Laboratory of Agricultural Microbiology, College of Life Science and Technology, Huazhong Agricultural University, Wuhan 430070, Hubei, PR China), *Renewable Energy*, 2014, **66**, 222–227].

NPARR, 6(3 & 4), 2015-166 Electrical energy production from the integrated aerobic-anaerobic treatment of organic waste by ORC

The energetic performance of an ORC system fueled by the heat generated from the integrated aerobic/anaerobic treatment of organic waste was analyzed. The temperature and heat content of the exhaust air arising from the aerobic treatment were increased by the combustion of

the biogas produced by the anaerobic digestion of a fraction of the same waste. On the basis of the amount of excess air exploited in the process, for each tonne of organic waste treated, it was possible to produce from 30 to 90 kg of exhaust air per day with a mean temperature ranging from 330 to 340 K. By processing from 0.5% to 16% of the whole organic waste in an anaerobic digestion section instead of the aerobic one, it was possible to increase the exhaust air temperature from 340 to 510 K, leading to an increase in the ORC size from about 0.05 to about 1 W/tonne/year. The best energetic utilization of the biogas was achieved for ORC compression ratios from 1.5 to 2 and for maximum air temperatures from 335 to 340 K. In these conditions, by using a micro-ORC system (*i.e.* <15 kW), it was possible to convert about 20% of the energy content of the biogas into electrical energy [Francesco Di Maria*, Caterina Micale and Alessio Sordi (Dipartimento di Ingegneria, Università di Perugia, Via G Duranti 67, 06125 Perugia, Italy), *Renewable Energy*, 2014, **66**, 461–467].

NPARR, 6(3 & 4), 2015-167 Investigating the energy use of vegetable market waste by briquetting

The present paper reports a study conducted at Sardar Patel Renewable Energy Research Institute, aiming at transforming vegetable market waste (VMW) into an energy-briquette. The raw green vegetable market waste gave about 15–20% dry matter after open sun drying. The dried mass of the VMW was converted into a pulverized form and subsequently into briquettes without using any external binding agent. Although the lignin contents of the VMW were low (3.23–5.51%) as compared to other lingo-cellulosic biomass, good quality briquettes were produced without using any binding agent. The bulk densities of briquettes were almost 10–15 times higher than the material in dry loose form. The calorific value

of four different types of VMW used in this study ranged 10.26–13.70 MJ kg⁻¹ of dry matter [N.S.L. Srivastava, S.L. Narnaware*, J.P. Makwana, S.N. Singh and S. Vahora (Thermo-Chemical Conversion Division, Sardar Patel Renewable Energy Research Institute, Vallabh Vidyanagar, 388 120 Gujarat, India), *Renewable Energy*, 2014, **68**, 270–275].

NPARR, 6(3 & 4), 2015-168 Optimization of biodiesel production from waste fish oil

The present study deals with the production of biodiesel using waste fish oil. The research assesses the effect of the transesterification parameters on the biodiesel yield and its properties, including temperature (40–60 °C), molar ratio methanol to oil (3:1–9:1) and reaction time (30–90 min). The experimental results were fitted to complete quadratic models and optimized by response surface methodology. All the biodiesel samples presented a FAME content higher than 93 wt.% with a maximum, 95.39 wt.%, at 60 °C, 9:1 of methanol to oil ratio and 90 min. On the other hand, a maximum biodiesel yield was found at the same methanol to oil ratio and reaction time conditions but at lower temperature, 40 °C, which reduced the saponification of triglycerides by the alkaline catalyst employed. Adequate values of kinematic viscosity (measured at 30 °C) were obtained, with a minimum of 6.30 mm²/s obtained at 60 °C, 5.15:1 of methanol to oil ratio and 55.52 min. However, the oxidative stability of the biodiesels produced must be further improved by adding antioxidants because low values of IP, below 2.22 h, were obtained. Finally, satisfactory values of completion of melt onset temperature, ranging from 3.31 °C to 3.83 °C, were measured [Pedro J. García-Moreno*, Mohriam Khanum^b, Antonio Guadix and Emilia M. Guadix (Department of Chemical Engineering, University of Granada, 18071 Granada, Spain), *Renewable Energy*, 2014, **68**, 618–624].

NPARR, 6(3 & 4), 2015-169 Biodiesel production from *Calophyllum inophyllum* oil using lipase producing *Rhizopus oryzae* cells immobilized within reticulated foams

Biodiesel production from non-edible *Calophyllum inophyllum* linn oil with high levels of Free Fatty Acid (FFA) (acid value –6.732 mg KOH/g of oil) was investigated using whole-cell biocatalysts. *Rhizopus oryzae* cells immobilized within reticulated polyurethane foams were used as biocatalysts for biodiesel production. The effects of reaction parameters such as methanol-to-oil molar ratio, water content, and temperature for the production of biodiesel through methanolysis in a packed-bed reactor (PBR) were studied. Molar ratio of methanol-to-oil – 12:1, water content – 15%v/v, cell concentration – 20% and temperature 35 °C were found to be the optimum. The yield of biodiesel obtained in batch methanolysis from *C. inophyllum* oil under optimized condition was 92%. Long-term stability of immobilized cells for methanolysis was verified using re-usability studies [A. Arumugam and V. Ponnusami (School of Chemical & Biotechnology, SASTRA University, Thirumalaisamudram, Thanjavur 613 401, India), *Renewable Energy*, 2014, **64**, 276–282].

NPARR, 6(3 & 4), 2015-170 Wood characterization for energy application proceeding from pruning *Morus alba* L., *Platanus hispanica* Münchh. and *Sophora japonica* L. in urban areas

Pruning urban forests generates significant amounts of lignocellulosic biomass every year. The energy potential of this biomass is unclear. The aim of this research was direct analysis of the gross calorific value (GCV), elemental composition and moisture content of *Morus alba* L., *Platanus hispanica* Münchh. and *Sophora japonica* L. by means of laboratory equipment. This analysis allowed for further development of indirect GCV prediction models

which are economically attractive and less time consuming to direct analysis. These models presented high coefficients of determination (R^2 0.66–0.96). It has been determined that the species with highest mean GCV is *S. japonica* L. (19615.68 kJ/kg-dry sample) whereas the one with the lowest is the *M. alba* L. (18192.87 kJ/kg-dry sample). Elemental analysis showed highest carbon (48.22%), hydrogen (6.17%) and nitrogen (1.16%) content in *S. japonica* L. in dry samples. Sulfur was constant at the level 0.05% for all analyzed species. Also percentage of bark and wood density were determined. Mean percentage of bark was highest for *P. hispanica* Münchh. (13.05%) while wood density was highest for *S. japonica* L. (0.86 g cm^{-3}). This way the research has proven that the biomass produced by pruning urban forests appears to be an interesting source of renewable energy [B. Velázquez-Martí, M. Sajdak, I. López-Cortés and A.J. Callejón-Ferre* (Departamento de Ingeniería, Universidad de Almería, Ctra. Sacramento s/n, La Cañada de San Urbano, 04120 Almería, Spain), *Renewable Energy*, 2014, **62**, 478–483].

NPARR, 6(3 & 4), 2015-171 Studies on co-cracking of jatropha oil with bagasse to obtain liquid, gaseous product and char

Co-cracking of jatropha oil (JO) and bagasse was investigated under TGA conditions. The different heating rates of 5 K min^{-1} , 15 K min^{-1} , 25 K min^{-1} and 35 K min^{-1} under the nitrogen (N_2) atmosphere were used. The Flynn–Wall–Ozawa, Kissinger–Akahira–Sunose (KAS) and Friedman models were employed to study the kinetic analysis of the samples. The main components of degradation for cracking of bagasse and co-cracking of JO + Bagasse take place in three steps/phases as observed from DTG curve and even from the Flynn–Wall–Ozawa, KAS and Friedman curves. The co-cracking reactions were carried out in a fixed bed tubular batch reactor and the results indicate the

presence of interactions among the reactive intermediates of JO and Bagasse. The synergism of the co-cracking process was observed from the yield of gaseous products and char. The liquid product obtained from the co-cracking of JO + Bagasse was aliphatic in nature. The deoxygenation, decarboxylation, decarbonylation reactions taking place during co-cracking process resulted in the removal of oxygenates from the co-cracked liquids. GC-MS of the co-cracked liquid indicated the presence of alkanes (47%).

The gaseous products consisted of methane, n-pentane, n-butane, 2-methyl butane and certain uncondensed components. The chars obtained contained metals such as Mg, Al, Fe, K etc. The feasibility of utilization of the liquid, solid and gaseous products obtained from co-cracking as a fuel source was observed [Shelly Biswas* , Pravakar Mohanty and D.K. Sharma (Centre for Energy Studies, Indian Institute of Technology Delhi, New Delhi 110016, India), *Renewable Energy*, 2014, **63**, 308–316].

INSECTICIDES (incl. Fungicides, Herbicides, Nematicides, Larvicides, etc.)

NPARR, 6(3 & 4), 2015-172 *In vivo* evaluation of two essential oil based botanical formulations (EOBBFs) for the use against stored product pathogens and pests, *Aspergillus* species and *Callosobruchus* species (Coleoptera: Bruchidae)

Laboratory bioassays were conducted to evaluate the comparative efficacy of two essential oil based botanical formulations (EOBBFs) made from 1, 5 and 10% concentrations of *Chenopodium ambrosioides* and *Clausena pentaphylla* essential oils for the storage of pigeon pea seeds. *C. ambrosioides* and *C. pentaphylla* oils were formulated as bioproduct A and B respectively. During *in vivo* evaluation of both bioproducts against the fungi (*Aspergillus flavus*, *A. niger*, *A. ochraceus* and *A. terreus*) of pigeon pea seeds for six months; bioproduct A was more potent than bioproduct B, with 85.2–96.4% percent protection of seeds from fungal contamination. When *Callosobruchus chinensis* and *C. maculatus* adults were exposed to bioproducts A and B for 72 h (28 ± 2 °C and $75 \pm 5\%$ r.h.), significant mortality ($P < 0.05$) of the test insects was observed. 100% mortality of both insects was achieved by 5 and 10% of bioproduct A and 10% of bioproduct B. Both the bioproducts at different dosages (1, 5 and 10%) significantly reduced oviposition and adult emergence of *C. chinensis* and *C. maculatus* in treated pigeon pea seeds. Furthermore, *in vivo* fumigant efficacy tests against these insects on pigeon pea seeds revealed that both bioproducts significantly protected 1 kg of seeds for up to six months. Both EOBBF enhanced feeding deterrence and so reduced the seed damage as well as weight loss in fumigated seed samples. Both EOBBFs were non-phytotoxic regarding the germination of pigeon pea seeds. Sensory evaluation revealed that appearance, tenderness, flavour, taste, colour and overall acceptability were significantly

higher in fumigated seeds than non-fumigated ones after 6 months of storage. It was concluded that after multilocation field trials, the bioproducts may be formulated and commercialized as substitutes for synthetic fumigants for safe storage of pigeon pea seeds and other food commodities [Abhay K. Pandey, Pooja Singh, Uma T. Palni and Nijendra N. Tripathi* (Bacteriology and Natural Pesticide Laboratory, Department of Botany, DDU Gorakhpur University, Gorakhpur, 273009, Uttar Pradesh, India), *Journal of Stored Products Research*, 2014, **59**, 285–291].

NPARR, 6(3 & 4), 2015-173 *Pistacia lentiscus* essential oil has repellent effect against three major insect pests of pasta

Rhyzopertha dominica, *Sitophilus zeamais*, and *Tribolium confusum* are three of the major food-stuff pests who cause important economic losses of shelved products with special reference to pasta. Due to its long shelf life, pasta is highly exposed to insects that can penetrate into the packaging with consequences economically severe. Eco-friendly strategies to prevent such insect attacks to the final packaged product are therefore highly foreseen by pasta companies. Due to their repellent properties, essential oils, extracted from aromatic plants, could represent a valid, eco-friendly alternative to chemical repellents. In this study, we evaluated the repellent activity of *Pistacia lentiscus* essential oil (PEO) and its main chemical components by two different bioassay with and without the presence of pasta. Results showed that the whole PEO exerts a broad-range aspecific repellency among the target pests with RD_{50} values ranging from 0.010 to $0.037 \mu\text{L cm}^{-2}$. On the contrary, the repellence of PEO components resulted to vary depending on the compound and on the pest species. Among the PEO chemical components, relative median potency analyses indicated that β -caryophyllene was able to exert the highest repellency rates against *S. zeamais* (RD_{50}

0.046 $\mu\text{M cm}^{-2}$). The comparison between the two bioassays, with and without pasta, indicated that the two methodologies gave consistent results. Overall, our research firstly showed that, because of their effectiveness as repellents, PEO and its major constituents could represent valid and safe tools against pasta pests [Hind Houria Bougherra, Stefano Bedini, Guido Flamini, Francesca Cosci, Kamel Belhamef, Barbara Conti*(Department of Agriculture, Food and Environment, University of Pisa, Italy), *Industrial Crops and Products*, 2015, **63**, 249–255].

NPARR, 6(3 & 4), 2015-174 Extracts of *Ageratum conyzoides*, *Coriandrum sativum* and *Mentha piperita* inhibit the growth of the symbiotic fungus of leaf-cutting ants

Leaf-cutting ants live in symbiosis with the fungus *Leucoagaricus gongylophorus* (Singer) Möller that grows in their nests. This fungus is the main nutritional source for these ants that provide conditions for its development. Although plant extracts of *Ageratum conyzoides* L., *Coriandrum sativum* L. and *Mentha piperita* L. are known to cause mortality in ants in the laboratory, their effects on *L. gongylophorus* are still unknown. The aim of the present study was to determine the effects of the *A. conyzoides*, *C. sativum* and *M. piperita* extracts on *L. gongylophorus*. The biomass of the fungus grown by the leaf-cutting ants was assessed in culture medium with three concentrations (25, 50, and 100 mg/mL) of *A. conyzoides*, *C. sativum* and *M. piperita* extracts. The results showed that all the three extracts inhibited the growth of *L. gongylophorus*. At concentrations of 25, 50, and 100 mg/mL, the *A. conyzoides* extract exhibited 81, 93, and 100% reduction in the fungal biomass; the *C. sativum* extract showed 23, 27, and 100% reduction in the fungal biomass; and the *M. piperita* extract demonstrated 96, 99, and 100% reduction in the fungal biomass, respectively. Furthermore, the secondary metabolic compounds of these plants were found to have fungistatic and fungicidal

properties, similar to that observed in other fungal species. In conclusion, the extracts of *A. conyzoides*, *C. sativum* and *M. piperita* inhibited the growth of *L. gongylophorus* in the laboratory, and should be further studied for their potential use in baits to control leaf-cutting ants [W.C.C. Morais, M.A.P. Lima, J.C. Zanuncio*, M.A. Oliveira, M.A.L. Bragança, J.E. Serrão and M.C. Della Lucia (Departamento de Biologia Animal, Universidade Federal de Viçosa, Av. P. H. Rolfs s/n, Centro, Viçosa 36570000, Minas Gerais, Brazil), *Industrial Crops and Products*, 2015, **65**, 463–466]

NPARR, 6(3 & 4), 2015-175 Essential oils of green and red *Perilla frutescens* as potential sources of compounds for mosquito management

Dengue fever is a mosquito-borne disease transmitted by *Aedes aegypti* producing high rates of human morbidity and mortality. In order to find new and effective compounds against *A. aegypti* with low mammalian and less environmental toxic products, green and red *Perilla frutescens* (L.) Britt. (perilla) essential oils were investigated for their deterrent and larvicidal activity. Green perilla oil showed more promising deterrent and larvicidal activity than red perilla oil. Therefore, we focused on the principle compounds in green perilla oil and, in addition, perilla alcohol and perillic acid were included for the activity relationship on the allylic methyl groups on carbon 7. Chemical composition of green and red perilla essential oils was compared using gas-chromatography–flame ionization detection (GC–FID) and gas chromatography–mass spectrometry (GC–MS). In biting deterrent bioassays, biting deterrence index (BDI) values for compounds methyl perillate (0.73), perillic acid (0.71), perilla alcohol (0.69), perilla aldehyde (0.62), caryophyllene oxide (0.60), and limonene (0.52) indicated good biting deterrent activity but the activity was significantly lower (proportion not

biting (PNB) value 0.84) than the positive control *N,N*-diethyl-3-methylbenzamide (DEET) at 25 nmol/cm². In larval bioassays, methyl perillate was the most toxic compound with LC₅₀ of 16.0 ppm. Methyl perillate was the most active compound against *A. aegypti* larvae and this compound may offer a new biodegradable mosquito control agent [Nurhayat Tabanca*, Betul Demirci, Abbas Ali, Zulfiqar Ali, Eugene K. Blythe and Ikhlas A. Khan (National Center for Natural Products Research, The University of Mississippi, University, 38677 MS, USA), *Industrial Crops and Products*, 2015, **65**, 36-44].

NPARR, 6(3 & 4), 2015-176 Extraction of botanical pesticides from *Pelargonium graveolens* using supercritical carbon dioxide

Pelargonium graveolens is a valuable source of biologically active compounds and a promising botanical pesticide. In this study, supercritical fluid extraction (SFE) of *Pelargonium* leaves was optimized to improve the extraction yields, selectivity and pesticidal activity under different operational conditions (pressure 9–30 MPa, temperature 40 and 50 °C). The composition and pesticidal activity of the CO₂ extracts were compared with the isolates obtained by maceration and hydrodistillation. GC–MS and GC–FID were used to determine the chemical composition of the isolates. The insecticidal activity (acute and chronic toxicity, antifeedancy) of the isolates was measured on larvae of *Spodoptera littoralis*. The antifungal activity was evaluated as the inhibition effect on the growth of model pathogenic and toxinogenic fungi (*Fusarium oxysporum*, *Penicillium expansum*, *Aspergillus fumigatus*). The highest yield of CO₂ extract was 44.5 mg gplant⁻¹ at 30 MPa, 40 °C and the maximum concentration of the volatiles in extract was 56% w/w at 9 MPa, 50 °C. The insecticidal activity of isolates differed according to the type of test: CO₂ extracts obtained at 9 MPa, 50 °C and at 12 MPa, 40 °C exhibited the highest chronic toxicity (LD₅₀ = 6 µg) and antifeedancy

(ED₅₀ = 95 µg cm⁻²), respectively. The essential oil obtained by hydrodistillation, with the yield of 8.5 mg gplant⁻¹ showed the strongest acute toxicity (LD₅₀ = 28 µg). The antifungal activity of isolates increased as the volatile concentration in isolates increased. Results suggest that CO₂ extracts of *P. graveolens* can be suitable substitutes to the essential oil in the use as botanical pesticides [Zdenka Machalova*, Marie Sajfirtova, Roman Pavela and Martin Topiar (Institute of Chemical Process Fundamentals of the ASCR, v.v.i., Rozvojova 135, 165 02, Prague 6, Czech Republic), *Industrial Crops and Products*, 2015, **67**, 310–317].

NPARR, 6(3 & 4), 2015-177 Efficacy of *Brassica juncea* granulated seed meal against *Melolontha* grubs

The grubs of *Melolontha melolontha* and *Melolontha hippocastani* damage the roots of many plants and are therefore considered serious pests in agriculture, horticulture and forestry in central and eastern Europe. Since the implementation of legislative regulations banning the use of synthetic insecticides against these pests in soil, alternative methods have gained high priority. The plants of the family Brassicaceae have recently received much attention due to the high content of glucosinolates (GSLs) in their tissues. The GSL breakdown products are highly biocidal in relation to many soil-borne pests. We tested *Brassica juncea* granulated seed meal against *Melolontha* grubs under semi-natural (the concentration-response experiments) and field conditions. The efficacy and the indirect lethal concentrations of GSLs that were necessary to obtain 50% and 95% grub mortality (ILC50 and ILC95, respectively) were estimated.

The concentration-response experiments revealed that the ILC50 of GSLs dominated by sinigrin (97%) for the L1, L2 and L3 grubs was 118.4, 167.1 and 173.5 µmol/L, respectively, and

the ILC95 was 293.3, 312.7 and 401.7 $\mu\text{mol/L}$, respectively. Under field conditions, the mortality of the L3 grubs in the plots that were treated with granulated *B. juncea* seed meal at ILC99.8 was almost twice as high (82.2%) as that of the grubs in the untreated plots (45.4%), and the changes in the grub density with time in these plots were significantly different. The results of our experiments demonstrate the high potential of soil biofumigation using *B. juncea* granulated seed meal to control *Melolontha* grubs [Lidia Sukovata* , Tomasz Jaworski and Andrzej Kolk (Forest Research Institute, Forest Protection Department, 3, Braci Leśnej St., Sękocin Stary, 05-090 Raszyn, Poland), *Industrial Crops and Products*, 2015, **70**, 260–265].

NPARR, 6(3 & 4), 2015-178 Castor bean cake contains a trypsin inhibitor that displays antifungal activity against *Colletotrichum gloeosporioides* and inhibits the midgut proteases of the dengue mosquito larvae

A novel trypsin inhibitor, named RcTI, was purified from castor bean cake (*Ricinus communis* L.) by heat treatment followed by chromatography on anhydrotrypsin-Sepharose 4B and Resource Q. RcTI is a 14 kDa competitive inhibitor with pI 5.2 and a dissociation constant (K_i) of 1.9×10^{-5} mM. The amino-terminal sequence showed similarity with a 2S sulfur-rich seed storage protein (83%) and napin-like protein (48%). RcTI was stable over a broad pH range and is exceptionally resistant to heating as it retained high inhibitory activity toward trypsin after incubation at 100 °C for 2 h. RcTI (13 μg) inhibited the spore germination of the phytopathogenic fungus *Colletotrichum gloeosporioides* and promoted 91% inhibition of the proteases from the midgut of *Aedes aegypti* larvae. The results of the present study indicate that RcTI has biotechnological potential as an alternative agent to combat the important phytopathogen *C. gloeosporioides* and the larvae of *A. aegypti* [Rodolpho G.G. Silva, Ilka M. Vasconcelos, Acrísio J.U.B. Filho, Ana F.U. Carvalho, Terezinha M. Souza^b, Darcy M.F.

Gondim^a, Anna L.N. Varela^a and José T.A. Oliveira* (Biochemistry and Molecular Biology Department, Federal University of Ceara, CE, Brazil), *Industrial Crops and Products*, 2015, **70**, 48–55].

NPARR, 6(3 & 4), 2015-179 Effect of herbicides on yield and quality of straw and homomorphic fibre in flax (*Linum usitatissimum* L.)

Fibre flax (*Linum usitatissimum* L.) is a very poor competitor with weeds, and to obtain acceptable yields, weeds should be effectively controlled. Very little information is available on the tolerance of flax to herbicide applications. Types of applied herbicides determine not only the yield of flax but can also affect yield of fibre, its quality and may affect processes (physical, chemical and enzymatic) used in the refining of homomorphic fibres to increase their thinness and divisibility. Presented basic field research was carried out in the years 2011–2012. In the studies the impact of three herbicides (with a.i. linuron, bentazon and chlorsulfuron) was examined on the control of weeds, course of vegetation and yield and quality of flax homomorphic fibre. The applied herbicides had a significant impact on the weed control, the length of the vegetation, straw yield, the percentage of fibre in the straw, weight and length of the fibre and its thinness and divisibility. The lowest number and mass of weeds and the highest flax straw yield and fibre quality was obtained after chlorsulfuron application. Bentazon, despite its high herbicidal effectiveness, reduced both the amount and quality of fibre yield when compared to chlorsulfuron, due to its phytotoxic effect on flax. Pre-emergence linuron application resulted in the longest fibres and highest fibre content in flax straw (Jerzy Mańkowski, Krzysztof Pudełko*, Jacek Kołodziej, Tomasz Karaś and Krzysztof Pudełko (Poznań University of Life Sciences, Department of Biochemistry and Biotechnology, ul. Dojazd 11, 60-632 Poznań, Poland), *Industrial Crops and Products*, 2015, **70**, 185–189].

MANURE/FERTILIZERS

NPARR, 6(3 & 4), 2015-180 Vermicomposting eliminates the toxicity of *Lantana* (*Lantana camara*) and turns it into a plant friendly organic fertilizer

In evidently the first study of its kind, vermicompost derived solely from a weed known to possess plant and animal toxicity was used to assess its impact on the germination and early growth of several plant species. No pre-composting or supplementation of animal manure was done to generate the vermicompost in order to ensure that the impact is clearly attributable to the weed. Whereas the weed used in this study, *Lantana* (*Lantana camara*), is known to possess strong negative allelopathy, besides plant/animal toxicity in other forms, its vermicompost was seen to be a good organic fertilizer as it increased germination success and encouraged growth of all the three botanical species explored by the authors—green gram (*Vigna radiata*), ladies finger (*Abelmoschus esculentus*) and cucumber (*Cucumis sativus*). In terms of several physical, chemical and biochemical attributes that were studied, the vermicompost appeared plant-friendly, giving best results in general when employed at concentrations of 1.5% in soil (w/w). Fourier transform infrared spectrometry revealed that the phenols and the sesquiterpene lactones that are responsible for the allelopathic impact of *Lantana* were largely destroyed in the course of vermicomposting. There is also an indication that lignin content of *Lantana* was reduced during its vermicomposting. The findings open up the possibility that the billions of tons of phytomass that is generated annually by *Lantana* and other invasives can be gainfully utilized in generating organic fertilizer via vermicomposting [N. Hussain, Tasneem Abbasi^{1*} and S.A. Abbasi (Centre for Pollution Control & Environmental Engineering, Pondicherry University, Chinakalpet,

Puducherry 605 014, India), *Journal of Hazardous Materials*, 2015, **298**, 46–57].

NPARR, 6(3 & 4), 2015-181 Assessment of biofertilizer quality and health implications of anaerobic digestion effluent of cow dung and chicken droppings

Anaerobic digestate have been identified as a rich source of essential plant nutrients. Nevertheless, its safety measured by the concentration of pathogen present is of great concern to end users. This research explored the efficiency of the mesophilic biodigestion process in the stabilization and sanitization of cow dung and chicken droppings. Six (6) kg each of cow dung and chicken droppings were collected fresh and free from impurities, pre-fermented, mixed with water in the ratio 1:1 w/v to form slurry, fed into the respective reactors and digested for 30 days at an average ambient temperature of 30 ± 2 °C. The pH of the medium fluctuated between 6.5 and 8.0. The analysis of the feedstock and effluent of the digesters showed that a total solids reduction of 75.3% and 60.1% were recorded for cow dung and chicken droppings while the reduction in total coliforms was 95% and 70% respectively for the dung and droppings. Microbial analysis of the biofertilizer produced reveals both aerobic and anaerobic organisms which include species of *Pseudomonas*, *Klebsiella*, *Clostridium*, *Bacillus*, *Bacteroides*, *Salmonella*, *Penicillium* and *Aspergillus*. *Escherichia coli* and *Shigella* spp. were removed while species of *Salmonella* and *Klebsiella* were still present in the digestate. Notwithstanding these results, the digestate still requires further treatment for it to be suitable for application on unrestricted crops either as fertilizer; otherwise a health problem would be created as attempt is made to improve soil fertility [M.I. Alfa*, D.B. Adie, S.B. Igboro, U.S. Oranusi, S.O. Dahunsi and D.M. Akali (Department of Water Resources & Environmental Engineering, Ahmadu Bello University, Zaria, Nigeria), *Renewable Energy*, 2014, **63**, 681–686].

OIL/FATS

NPARR, 6(3 & 4), 2015-182 **Extraction of oil from *Jatropha curcas* seeds by subcritical fluid extraction**

In this study, a method for the extraction of oil from *Jatropha curcas* seeds using subcritical fluid extraction was developed. Extraction conditions, optimized by response surface methodology, were as follows: ethanol/hexane, 7:1 mL/mL; solvent/solid ratio, 30 mL/g; time, 45 min. The yield of the oil extracted from the *J. curcas* seeds by this method was then compared to different extraction methods (reflux extraction, microwave extraction, ultrasonic extraction and subcritical fluid extraction). The oil samples were analyzed using gas chromatography–mass spectrometry (GC–MS) and Fourier transform infrared spectrometer (FTIR). Results showed the maximal yield of *Jatropha* seed oil under the conditions tested of subcritical fluid extraction reached 40.28 g oil/100 g dry seeds at a temperature of 90 °C, a pressure of 0.5 MPa. Based on the comparison between different extraction methods, the oil extracted by subcritical fluid extraction had a good appearance and a high yield. In addition to subcritical fluid extraction, the extraction processes of maceration extraction, reflux extraction, and ultrasonic extraction were modeled and discussed. The subcritical fluid extraction method was found to compare adequately to the other methods, and provided a good amount of correlating data [Jing Liu, Pan Chen, Jing He, Lihong Deng, Luying Wang, Jiandu Lei* and Long Rong (MOE Key Laboratory of Wooden Material Science and Application, Beijing Forestry University, Beijing 100083, PR China), *Industrial Crops and Products*, 2014, **62**, 235–241].

NPARR, 6(3 & 4), 2015-183 **Enrichment of erucic acid from pennycress (*Thlaspi arvense* L.) seed oil**

Pennycress (*Thlaspi arvense* L.) is a winter annual that has a wide geographic

distribution and a growth habit that makes it suitable for an off-season rotation between corn and soybeans in much of the Midwestern United States. Pennycress seed contains 36% oil with 36.6% erucic acid content. There are a number of markets that pennycress could supply from an enriched erucic fatty acid fraction. Erucic acid was enriched using two independent separation methods; vacuum distillation of fatty acids or methyl esters and fractional crystallization of potassium soaps directly from the triglyceride. Fractional crystallization provided the highest level of purity, yielding an 87% erucic enriched fraction but in low theoretical recovery of 23% when ethanol was used as the crystallization solvent. A higher theoretical erucic recovery (59%) was obtained when methanol was used as a solvent yielding a 71% enriched erucic acid fraction. This method utilized a mixed solvent (90:10 methanol/water) for crystallization with a 5:1 solvent to analyte ratio. In an independent study, molecular distillation of the fatty acid methyl esters at 90 °C, 7 Pa of pressure enriched the erucic acid content to 67.1% in a single pass and could be further enriched to 71.6% with a second pass with an overall mass balance for this double distilled fraction of 43.2%. Distillation of the fatty acids was similar to the methyl esters yielding a fraction that contained 69.0% erucic with an overall mass balance of this fraction of 38.4% after two distillations. All three enriched fractions (feed, distilled FAME and mother liquor) were suitable for biodiesel; 40 °C viscosity range 4.142–5.509, 100 °C viscosity range of 1.713–2.095. Pour points were improved from the feed of –18 °C to –27 °C in the mother liquor fraction and remained the same in the distillate at –18 °C. HFRR wear scars ranged from 120 to 177 µm across all fractions [Terry A. Isbell*, Roque Evangelista, Steve E. Glenn, Drew A. Devore, Bryan R. Moser, Steven C. Cermak, and Serin Rao (United State Department of Agriculture, Agriculture Research Service, National Center for Agricultural Utilization Research, 1815 N. University St. Peoria, IL 61604, USA), *Industrial Crops and Products*, 2015, **66**, 188–193].

NPARR, 6(3 & 4), 2015-184 **Extraction of tocopherol-enriched oils from *Quinoa* seeds by supercritical fluid extraction**

The efficiency of supercritical fluid extraction (SFE) in the production of oil with a high concentration of tocopherols (vitamin E), from seeds of Quinoa (*Chenopodium quinoa* Willd.), was investigated. The effect of the process parameters such as pressure, temperature and time of extraction on the total tocopherol yield was studied. For this purpose, the response surface methodology (RSM) was applied. The optimal SFE conditions for the tocopherol-enriched oil

extraction from Quinoa seeds were: extracting pressure 18.5 MPa, extracting temperature 130 °C and extracting time 180 min. These optimum conditions yielded in tocopherol concentration of 336.0 mg/100 g of oil and tocopherols were more than four times concentrated than in classical hexane extraction [Katarzyna Przygoda and Grażyna Wejnerowska* (Department of Food Analytics and Environmental Protection, Faculty of Chemical Technology and Engineering, University of Technology and Life Sciences in Bydgoszcz, Seminaryjna 3 St., 85-326 Bydgoszcz, Poland), *Industrial Crops and Products*, 2015, **63**, 41–47].

PHYTOCHEMICALS

NPARR, 6(3 & 4), 2015-185 Exploitation of *Cocos nucifera* a non-food toward the biological and nanobiotechnology field

Cocos nucifera is one of the most adaptable products which possess several protein fractions such as albumins, globulins, prolamines, glutelins 1 and 2 which were found and reported. Since *C. nucifera* was rich in nutritional value, it has wide medicinal applications. In this manuscript, we have reviewed on the anti-inflammatory, antioxidant, antimicrobial, antimalarial, leishmanicidal, and insecticidal activity. Also *C. nucifera* act as a low cost agricultural waste which was widely used in the preparation of nanoparticles: in this review, we have also focused on silver, gold, aluminum oxide, and doped nanoparticles like europium doped yttrium oxide nanoparticles [Selvaraj Mohana Roopan* and Ganesh Elango (Chemistry Research Laboratory, Organic Chemistry Division, School of Advanced Sciences, VIT University, Vellore, Tamilnadu 632014, India), *Industrial Crops and Products*, 2015, **67**, 130–136].

NPARR, 6(3 & 4), 2015-186 *Capparis* species: A potential source of bioactives and high-value components: A review

Capparis species, also known as Caper plants, are recognized as a potential source of valuable nutrients and biochemical compounds with physiological functions. The multiple biological activities including antibacterial, antifungal, hepatoprotective, anthelmintic, antidiabetic, anti-inflammatory, anti-cancer, and antihyperlipidemic as well as folk medicinal uses of Caper plants have been ascribed to the presence of functional bioactives, such as phenolic acids, flavonoids, alkaloids, phytosterols, natural sugars, vitamins, and organic acids. In view of the high nutritional value and traditional food and folk medicinal uses of *Capparis* species, it is important

to compile a comprehensive review on related aspects of these multipurposes plants. Hence, the present review manuscript focuses on the detailed profile of valuable nutrients and biochemical compounds as well as medicinal health functions and biological activities of selected species of *Capparis*, so as to explore their potential uses as ingredients of functional food and nutraceuticals and natural pharmaceuticals [Tehseen Gull, Farooq Anwar*, Bushra Sultana, Maria Angelica Cervantes Alcayde and Wasif Nouman (Department of Pharmaceutical Chemistry, College of Pharmacy, Salman bin Abdulaziz University, Al-Kharj 11942, Saudi Arabia), *Industrial Crops and Products*, 2015, **67**, 81–96].

NPARR, 6(3 & 4), 2015-187 Green and efficient extraction of bioactive flavonoids from *Equisetum palustre* L. by deep eutectic solvents-based negative pressure cavitation method combined with macroporous resin enrichment

In the present study, deep eutectic solvents (DESs) as new extraction solvents, are proposed for the green and efficient extraction and separation of bioactive flavonoids from *Equisetum palustre* L. with negative pressure cavitation-assisted extraction (NPCE) combined with macroporous resin enrichment. A series of different DES systems were investigated for the extraction of bioactive flavonoids in *E. palustre*. Compared with conventional extraction solvents, DES composed of choline chloride/betaine hydrochloride-ethylene glycol possessed a more effective extraction yields. In addition, the DES-NPCE extraction procedures were also optimized systematically. The optimal conditions were obtained as follows: choline chloride-betaine hydrochloride-ethylene glycol formed a DES with the mole ratio of 1:1:2, 20% water content, extraction pressure –0.07 MPa, extraction temperature 60°C, solvent to solid ratio 25:1 mL/g, and the extraction time 20 min. Furthermore, the direct enrichment of nine flavonoids in DES extraction solution were

efficiently achieved using macroporous resin HPD-826. The contents of the nine target flavonoids separated by HPD-826 resin were from 0.17% to 3.37%, and the recovery yields from 57.14% to 89.25%. In conclusion, the developed DES-NPCE combined with macroporous resin enrichment can be an alternative procedure for the green and efficient extraction and separation of bioactive flavonoids from plant sample matrices [Xiao-Lin Qi, Xiao Peng, Yu-Yan Huang, Lu Li, Zuo-Fu Wei, Yuan-Gang Zu, Yu-Jie Fu* (Key Laboratory of Forest Plant Ecology, Ministry of Education, Northeast Forestry University, Harbin 150040, China), *Industrial Crops and Products*, 2015, **70**, 142–148].

NPARR, 6(3 & 4), 2015-188 **Structural characterization and antioxidant activities of a novel fructan from *Achyranthes bidentata* Blume, a famous medicinal plant in China**

Achyranthes bidentata is one of the most important medicinal plants in Henan Province of China. Due to the excellent ethnopharmacological uses and scientifically proved biological properties, *A. bidentata* is worth investigating. In this manuscript, a novel water-soluble polysaccharide (ABP70-2) with a low molecular weight (M_w) of 3406 Da was isolated from the roots of *A. bidentata* by hot water extraction and further successively purified through DEAE-cellulose 52 and Sephacryl S-100HR columns. ABP70-2 was composed of glucose and fructose in a molar ratio of 1:18. Its exact structural features were first elucidated by a combination of monosaccharide analysis, infrared spectroscopy, methylation, gas chromatography–mass spectrometry (GC–MS) analysis, and NMR studies (^1H , ^{13}C , NOESY, HSQC, and HMBC). The data obtained indicate that ABP70-2 possessed a backbone of (2 → 6)-linked β -D-fructofuranosyl (FruF), with (2 → 1)-linked β -D-FruF branched chains, and terminated with Glc and Fru residues. Advanced structures and

conformation of ABP70-2 were preliminarily investigated by scanning electron microscope (SEM), circular dichroism spectroscopy (CD), and Congo-red assay (CR). The in vitro antioxidant activity showed that ABP70-2 possessed a concentration dependent 1, 1-diphenyl-2-picrylhydrazyl (DPPH \cdot) free radical scavenging activity, with an EC_{50} value of 1.05 $\text{M}\mu$ [Changsheng Wang, Dehong Hua and Chunyan Yan* (College of Pharmacy, Guangdong Pharmaceutical University, Guangzhou 510006, PR China), *Industrial Crops and Products*, 2015, **70**, 427–434].

NPARR, 6(3 & 4), 2015-189 **Extraction of xylan from wood pulp and brewer's spent grain**

Hemicelluloses are potential raw materials for different types of biobased materials. Alkaline extraction of bleached birch kraft pulp yields pure, high molecular weight hemicellulose (xylan) and hemicellulose-poor pulp. In this work, the concentration of alkali and the extraction temperature were studied as parameters for xylan yield and mass balance in the extraction. Extraction at room temperature using 1 molar aqueous sodium hydroxide (NaOH) showed the highest value for the mass balance with 98.5 wt % on dry matter of pulp – 16.1 wt.% xylan in the extract and 82.4 wt.% extracted pulp. Recycling of 90% of the NaOH used for the extraction was demonstrated by ultrafiltration. The ultrafiltration process is thus a highly potential tool offering an economical way to simultaneously recycle chemicals and separate products from process liquids in xylan extraction and other biorefinery processes. The concept of alkaline extraction was also demonstrated for brewer's spent grain (BSG). Arabinoxylan comprised 80% of the carbohydrates in the alkaline extract of BSG. However, the selectivity of the extraction was poor as proteins, lipids and some lignin were also efficiently extracted from BSG in alkaline conditions [Christiane Laine*, Katariina

Kemppainen, Lauri Kuutti, Antero Varhimo, Sari Asikainen , Antti Grönroos, Marjo Määttänen , Johanna Buchert, Ali Harlin (VTT Technical Research Centre of Finland, P.O. Box 1000, 02044 VTT, Finland), *Industrial Crops and Products*, 2015, **70**, 231–237].

RUBBER/GUM/RESIN

NPARR, 6(3 & 4), 2015-190 **Karanja [*Millettia pinnata* (L.) Panigrahi] seed oil as a renewable raw material for the synthesis of alkyd resin**

Non-edible vegetable oils are an important class of bio-resource for producing polymeric materials due to their large abundance, low cost and renewability. Karanja (*Millettia pinnata*) tree is an evergreen, drought resistant, nitrogen fixing tree belonging to Leguminaceae family. Karanja seed oil (~27 wt%) mainly consisting of triglycerides is a good source of non-edible vegetable oil for synthesizing alkyd resin. Triglyceride was first converted to monoglyceride by glycerolysis process. The monoglyceride was then reacted with phthalic and/or maleic anhydride to produce alkyd resins. The synthesized resins were characterized by FT-IR and ¹H NMR spectroscopy. The surface characteristic of the cured resins was studied by SE microscopy. The physico-chemical properties of the resins such as colour, acid value, free fatty acid content and iodine value were evaluated. The coating performance of the cured resins was tested by measuring chemical resistance, thermal stability, pencil hardness, gloss and adhesion [Montu Moni Bora, Riblu Deka, Nuruddin Ahmed and Dilip Kumar Kakati* (Department of Chemistry, Gauhati University, Guwahati, Assam 781014, India), *Industrial Crops and Products*, 2014, **61**, 106–114].

NPARR, 6(3 & 4), 2015-191 **Greener approach for synthesis of antibacterial silver nanoparticles using aqueous solution of neem gum (*Azadirachta indica* L.)**

A simple method for the green synthesis of silver nanoparticles (AgNPs) using autoclave assisted gum extract of neem (*Azadirachta indica*) has been investigated for the first time. Silver nanoparticles were formed due to reduction of

silver nitrate solution when mixed with the gum extract after autoclaving at 121 °C and 15 psi. The UV–vis absorption spectrum of the biologically reduced reaction mixture showed the surface plasmon peak at 418 nm which is characteristic peak of silver nanoparticles. The functional biomolecules present in the gum extract and the interaction between the nanoparticles were identified by the Fourier transform infrared spectroscopy (FTIR) analysis. Average diameter of the synthesized nanoparticles was found to be <30 nm, as revealed from transmission electron microscopy (TEM) and atomic force microscopy (AFM) analysis. X-ray diffraction (XRD) analysis confirmed the face-centered cubic crystalline structure of metallic silver. The synthesized silver nanoparticles exhibited antibacterial activity against clinical isolates of *Salmonella enteritidis* and *Bacillus cereus*. Moreover, the antibacterial activity of the silver nanoparticles was further confirmed by degradation of test bacterial DNA. The results suggest that the gum mediated synthesized silver nanoparticles could be used as a promising antibacterial agent against clinical pathogens [Palaniyandi Velusamy*, Jayabrata Das, Raman Pachaiappan, Baskaralingam Vaseeharan, and Kannaiyan Pandian (Department of Biotechnology, School of Bioengineering, SRM University, Chennai 603 203, Tamil Nadu, India), *Industrial Crops and Products*, 2015, **66**, 103–109].

NPARR, 6(3 & 4), 2015-192 **Physicochemical, shear flow behaviour and emulsifying properties of *Acacia cochliacantha* and *Acacia farnesiana* gums**

The physicochemical, shear flow behaviour and emulsifying properties of gum exudates from *Acacia cochliacantha* and *Acacia farnesiana* were analysed and compared to those for *Acacia senegal* gum. Evaluation of physicochemical properties showed that *A. farnesiana* and *A. senegal* gums displayed levorotatory activity, relatively high carbohydrate/protein ratio and high content of

dietary fibre. Similarly, *A. farnesiana* and *A. senegal* gums formed stable oil-in-water emulsions with smaller droplet sizes and coalescence rates in the order of 10^{-8} , meaning for very stable disperse systems. Otherwise, *A. cochliacantha* gum was the only with dextrorotatory activity, high content of protein and arabinogalactan-proteins (AGPs), but low carbohydrate fraction; nevertheless, despite the possible advantages of high protein content associated with emulsifying properties, this polysaccharide showed lesser stability on emulsions. These results indicate that there is correlation between emulsion stability and an adequate carbohydrate/protein balance in the gums; additionally of the AGPs presence. Thus, *A. farnesiana* gum may be considered for oil-in-water emulsion stabilization and sources of soluble dietary fibre due to their relatively high polysaccharide fraction [Roberto Sibaja-Hernández, Angélica Román-Guerrero, Gabriela Sepúlveda-Jiménez and Mario Rodríguez-Monroy* (Departamento de Biotecnología, Centro de Desarrollo de Productos Bióticos del Instituto Politécnico Nacional, Calle CEPROBI No. 8, Col. San Isidro, C.P. 62731 Yautepec, Morelos, Mexico), *Industrial Crops and Products*, 2015, **67**, 161–168].

NPARR, 6(3 & 4), 2015-193 A sustainability review of domestic rubber from the guayule plant

Guayule (*Parthenium argentatum* Gray) is an arid-adapted, low-input perennial shrub native to Mexico and southern Texas that has received considerable attention as an alternative source of natural rubber. It has potential to replace the most common types of rubbers, including synthetic rubber derived from petroleum and natural rubber, which is tapped

from Hevea (*Hevea brasiliensis*) trees grown in tropical regions, primarily Southeast Asia. The guayule plant produces natural rubber in its bark parenchyma cells and the shrub is processed to extract the latex. Guayule rubber is comparable in quality to Hevea natural rubber and the residual, non-latex guayule plant material can be transformed into valuable co-products, such as bioenergy. This review introduces the reader to guayule rubber production (agriculture, processing and products) and explores the sustainability implications of guayule rubber commercialization related to the three pillars of sustainability, including environmental impacts of rubber production, economic barriers and advantages, and social implications. The review highlights areas of focus that could be leveraged to help guayule become a more sustainable source of natural rubber. Guayule rubber provides an opportunity to lower the environmental impacts of a major commodity, to develop an industry to support the local U.S. economy, and to reduce U.S. dependence on non-renewable petroleum sources and rubber imports. Proposed recommendations to further support guayule sustainability include improving the efficiency of agricultural and processing activities, utilization of guayule co-products to improve economics of guayule cultivation, and the establishment of a secure guayule rubber supply at a production level that could consistently meet rubber demands. A better understanding of guayule rubber life-cycle impacts could be a way to reduce the environmental footprint of guayule rubber products and expedite its commercialization [Daina Rasutis, Kullapa Soratana, Colleen McMahan^c, Amy E. Landis* (School of Sustainable Engineering and the Built Environment, Arizona State University, 781 E. Terrace Rd., Tempe, AZ, USA), *Industrial Crops and Products*, 2015, **70**, 383–394].

SPICES/CONDIMENTS

NPARR, 6(3 & 4), 2015-194 Improved properties and microbiological safety of novel cottage cheese containing spices

The study focuses on developing novel cottage cheese containing spices with acceptable sensory properties, increased biological value and extended shelf life. Thirty types of cheese with added fresh or dried parsley, dill, pepper, garlic and rosemary were produced. Characterisation of phenolic compounds, antioxidant capacity and antibacterial activity of spices and cheese samples were evaluated. The cheese containing fresh pepper and fresh and dried herbs showed excellent sensory properties, with the best results obtained with fresh sweet red pepper. Dry rosemary had the highest antioxidant and antibacterial activity due to high mass fractions of caffeic and rosmarinic acids as well as high mass fractions of flavones and phenolic diterpenes. The plant extracts examined in vitro and in situ effectively reduce numbers of foodborne pathogens like *Salmonella typhimurium*, *Escherichia coli*, *Staphylococcus aureus* and *Listeria monocytogenes*, and therefore have potential as natural preservatives and antioxidants [Josipović, R, Knežević, Z.M, Frece, J, Markov, K, Kazazić, S. and Mrvčić, J. (Institute of Public Health of Brod-Posavina County, Vladimira Nazora 2A, Slavonski Brod, Croatia), *Food Technology and Biotechnology*, 2015, **53**(4), 454-462].

NPARR, 6(3 & 4), 2015-195 Hypoglycemic and hypolipidemic effects of cinnamon (Review)

Cinnamon, a well-known spice comprising the types Ceylon cinnamon and cassia cinnamon has attracted much attention regarding its anti-diabetic potentials. It has been demonstrated that cinnamons extract has enhanced GLUT4 contents in cytoplasmic membrane, where it facilitates glucose entrance into the cell, a process implicating AMPK pathway. We conclude that cinnamon possess anti-diabetic properties, the effects of which, differ by population. Studies

must be conducted to further determine how specific variables, such as diet, ethnicity, BMI, glucose levels, cinnamon dose, and concurrent medication, affect cinnamon responsiveness, regarding diabetes mellitus and its complications [Vallianou, N.G. *, Evangelopoulos, A., Kollas, A. and Kazazis, C. (Evangelismos General Hospital, 5 Pyramidon str, Municipality of Marachonas, Athens, Greece), *Current Topics in Nutraceutical Research*, 2014, **12** (4), 127-134].

NPARR, 6(3 & 4), 2015-196 Curcumin and diabetes: Mechanisms of action and its anti-diabetic properties (Review)

Curcumin, a yellow substance derived from the Rhizotna *Curcumea longae*, is the main constituent of the spice turmeric. It is a lipophylic polyphenol, a bis- α β -unsaturated β -diphenone with the chemical formula C₂₁H₂₀O₆ and chemical name of (E, E)-1, 7-bis(4-hydroxy-3-methoxyphenyl)-1-6-beptadiene-3,5 dione). There are numerous studies documenting curcumin's anti-inflammatory and anti-diabetic properties, among which the inhibition of inflammatory cytokines, such as MCP and TNF- α along with the induction of AMPK through inhibition of MAPK play a pivotal role in its mechanisms of action. In this review, the anti-diabetic properties of curcumin and its potential beneficial effects in the prevention and treatment of diabetes mellitus has been discussed [Kazazis, C., Vallianou, N.G., Kollas, A.*, Evangelopoulos, A. (Evangelismos General Hospital, 5 Pyramidon str, Municipality of Marathon, Athens, Greece), *Current Topics in Nutraceutical Research*, 2014, **12**(4), 135-142].

NPARR, 6(3 & 4), 2015-197 Evaluation of coriander spice as a functional food by using in vitro bioassays

Coriander leaves and seeds are widely used as a condiment and spice. The use of roasted coriander seeds in food and beverage is very common. In this study, we investigated raw and

roasted coriander seeds for their functional food quality using antioxidant, anti-inflammatory and human tumour cell proliferation inhibitory assays. The hexane and methanolic extracts of raw and roasted coriander seeds showed identical chromatographic and bioassay profiles. Chromatographic purification of the roasted seed extracts afforded triptrosetinin as the predominant component. Other isolates were petroselinic acid, 1,3-dipetroselinin, 2-*C*-methyl-d-erythritol, 2-*C*-methyl-d-erythritol 4-*O*- β -d-glucopyranoside and linalool. Hexane and methanolic extracts of both raw and roasted seeds and pure isolates from them showed comparable antioxidant and anti-inflammatory activities to the positive controls used in the assays, and inhibited the growth of human tumour cells AGS (gastric carcinoma), DU-145 and LNCaP (prostate carcinoma), HCT-116 (colon carcinoma), MCF-7 (breast carcinoma) and NCI-H460 (lung carcinoma) by 4–34%, respectively [Chuan-Rui Zhang, Amila A. Dissanayake, Kudret Kevseroğlu and Muraleedharan G. Nair* (Bioactive Natural Products and Phytochemicals Laboratory, Department of Horticulture, Michigan State University, East Lansing 48824, MI, USA), *Food Chemistry*, 2015, **167**, 24–29].

NPARR, 6(3 & 4), 2015-198 Enzyme-assisted extraction of bioactive compounds from bay leaves (*Laurus nobilis* L.)

Bay leaves (*Laurus nobilis* L.) are widely used as a condiment and their therapeutic benefits are well known. These biological properties were attributed to a plethora of highly bioactive secondary metabolites namely essential oils and phenolics. However, their recovery from plant matrix is generally limited by the presence of physical barrier (cell wall). Thus, the use of novel extraction procedures to enhance their release is particularly important. Therefore, the aim of this work is to assess the potential use of enzyme treatment (cellulase, hemicellulase, xylanase and the ternary mixture of them) as a tool to improve the extraction efficiency of bioactive compounds

from bay leaves. Results showed that enzyme pre-treatment resulted in 243, 227, 240.54 and 0.48% increase in the essential oil yields in samples treated with cellulase, hemicellulase, xylanase and the ternary mixture, respectively. Compositional analysis by GC and GC–MS revealed remarkable enrichment of the essential oils derived from enzyme-treated samples with oxygenated monoterpenes, leading hence to better antioxidant activity as revealed by the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and azino-bis-(3-ethylbenzothiazolone 6-sulphonic acid) (ABTS) assays. The 1, 8-cineole, α -terpinyl acetate, methyl eugenol, linalool, α -pinene, sabinene and β -pinene were found as the most prominent components in all essential oils. Most importantly, enzyme treatment did not induce transformation of the volatile components, but it contributes to the liberation of some glycosidically bound volatiles. Moreover, it significantly enhances the release of phenolic compounds from the hydrodistilled residual leaves and consequently their antioxidant activity. These results suggest that enzyme pre-treatment could be useful for extracting valuable components, and hold good potential for use in food, cosmetic and pharmaceutical industries [Abdennacer Boulila, Imed Hassen, Lamia Haouari, Feiza Mejr and Ines Ben Amor (Hervé Casabianca and Karim Hosni*(Laboratoire des Substances Naturelles, Institut National de Recherche et d'Analyse Physico-chimique (INRAP), Biotechpole de Sidi Thabet, 2020 Ariana, Tunisia), *Industrial Crops and Products*, 2015, **74**, 485–493].

NPARR, 6(3 & 4), 2015-199 Potential of black pepper as a functional food for treatment of airways disorders

The potential of black pepper (*Piper nigrum*) to cause bronchodilation was examined using *in vivo* and *in vitro* assays. HPLC fingerprint analysis of the crude extract of *Piper nigrum* (Pn.Cr) and its fractions showed piperine, piperidine, eugenol and catechin as plant

constituents. In anaesthetized rats, Pn.Cr and piperine relieved carbachol (CCh)-induced bronchospasm. In isolated guinea-pig trachea, Pn.Cr and piperine inhibited CCh and K^+ (80 mM)-induced contractions, potentiated isoprenaline concentration–response curves (CRCs) and suppressed Ca^{2+} CRCs. In guinea-pig atria, Pn.Cr and piperine showed stimulatory and inhibitory effects on rate and force of contraction. Its fractions showed similar activities with varied potency in the *in vivo* and *in vitro* assays. These results suggest that black pepper and piperine cause bronchodilation through dual inhibition of phosphodiesterase enzyme and Ca^{2+} influx, which substantiate its potential as a functional food ingredient for airway disorders [Abdul Rehman, Malik Hassan Mehmood*, Muhammad Haneef, Anwarul Hassan Gilani, Maimoona Ilyas, Bina Shaheen Siddiqui and Mansoor Ahmed (Natural Products Research Division, Department of Biological & Biomedical Sciences, Aga Khan University, Stadium Road, Karachi, Sindh 74800, Pakistan), *Journal of Functional Foods*, 2015, **19**, Part A, 126–140].

NPARR, 6(3 & 4), 2015-200 Analgesic principle from *Curcuma amada*

The rhizome of *Curcuma amada* has been used as a folk medicine for the treatment of rheumatic disorders in the northern part of Bangladesh and has also used for the treatment of inflammation and fever in the Ayurvedic and Unani systems of medicine. Aim of the study was to investigate the analgesic principle of the MeOH extract of the rhizome of *Curcuma amada* by an *in vivo* bioassay guided chromatographic separation and purification, and the structure elucidation of the purified compound by spectroscopic methods. Dried powder of *Curcuma amada* rhizomes was extracted with MeOH. The analgesic activity of the crude extract and its chromatographic fractions as well as the purified compound itself was evaluated by the acetic acid induced writhing method and the formalin induced licking test in Swiss albino

mice. The MeOH extract was separated by chromatographic methods and the pure active compound was purified by crystallization in hexanes. The structure of the pure compound was then elucidated by spectroscopic methods.

The MeOH extract of *Curcuma amada* exhibited 41.63% and 45.53% inhibitions in the acetic acid induced writhing method at doses of 200 mg/kg and 400 mg/kg, respectively. It also exerted 20.43% and 28.50% inhibitions in early phase at doses of 200 mg/kg and 400 mg/kg, respectively, and 30.41% and 42.95% inhibitions in late phase at doses of 200 mg/kg and 400 mg/kg, respectively in the formalin induced licking test. Vacuum Liquid Chromatography (VLC) of crude extract yielded five fractions and Fr. 1 was found to have the most potent analgesic activity with inhibitions of 36.96% in the acetic acid induced writhing method and 47.51% (early phase), 39.50% (late phase) in the formalin induced licking test at a dose of 200 mg/kg. Column chromatography of Fr. 1 on silica gel generated seven fractions (SF. 1–SF. 7). SF. 2 showed the most potent activity with inhibition of 49.81% in the acetic acid induced writhing method at a dose of 100 mg/kg. Crystallization of SF. 2 yielded (1) (zederone, 520 mg). It showed statistically significant inhibitions of 38.91% and 52.14% in the acetic acid induced writhing method at doses of 20 mg/kg and 40 mg/kg, respectively. Moreover, it also showed statistically significant inhibitions of 27.79% and 29.93% (early phase) and of 38.24% and 46.08% (late phase) in the formalin induced licking test at doses of 20 mg/kg and 40 mg/kg, respectively.

Isolation and characterization of zederone (1) as analgesic principle of *Curcuma amada* corroborate its use in Ayurvedic, Unani and folk medicines for the treatment of rheumatic disorders and also contributing to its pharmacological validation [Chowdhury Faiz Hossain* , Mohammad Al-Amin, Kazi Md Mahabubur Rahman, Aurin Sarker^a, Md Mahamudul Alam, Mahmudul Hasan

Chowdhury, Shamsun Nahar Khan and Gazi Nurun Nahar Sultana (Department of Pharmacy, East West University, A/2, Jahurul Islam Avenue, Aftabnagar, Dhaka 1212, Bangladesh), *Journal of Ethnopharmacology*, 2015, **163**, 273–277].

NPARR, 6(3 & 4), 2015-201 Oil and fatty acid accumulation during coriander (*Coriandrum sativum* L.) fruit ripening under organic cultivation

To evaluate the accumulation of oil and fatty acids in coriander during fruit ripening, a field experiment was conducted under organic cultivation conditions in Auch (near Toulouse, southwestern France) during the 2009 cropping season. The percentage and composition of the fatty acids of coriander were determined by gas chromatography. Our results showed that rapid oil accumulation started in early stages (two days after flowering, DAF). Twelve fatty acids were identified. Saturated and polyunsaturated acids were the dominant fatty acids at earlier stages (2–12 DAF), but decreased after this date. After this stage, petroselinic acid increased to its highest amount at 18 DAF. In contrast, palmitic acid followed the opposite trend. Saturated and polyunsaturated fatty acids decreased markedly and monounsaturated fatty acids increased during fruit maturation. It appears that the fruit of coriander may be harvested before full maturity [Quang-Hung Nguyen, Thierry Talou, Mureil Cerny, Philippe Evon and Othmane Merah* (Université Fédérale de Toulouse Midi-Pyrénées, INP-ENSIACET, Laboratoire de Chimie Agro-industrielle, F-31030 Toulouse, France), *The Crop Journal*, 2015, 3(4), 366–369].

NPARR, 6(3 & 4), 2015-202 Coriander (*Coriandrum sativum* L.) and its bioactive constituents

Coriander (*Coriandrum sativum* L.), a member of the Apiaceae family, is among most

widely used medicinal plant, possessing nutritional as well as medicinal properties. Thus, the aim of this updated review is to highlight the importance of coriander as a potential source of bioactive constituents and to summarize their biological activities as well as their different applications from data obtained in recent literature, with critical analysis on the gaps and potential for future investigations. A literature review was carried out by searching on the electronic databases including PubMed, Scopus, ScienceDirect, and Google Scholar for studies focusing on the biological and pharmacological activities of coriander seed and herb bioactive constituents. All recent English-language articles published between 2000 and 2014 were searched using the terms ‘*C. sativum*’, ‘medicinal plant’, ‘bioactive constituents’, and ‘biological activities’. Subsequently, coriander seed and herb essential oils have been actively investigated for their chemical composition and biological activities including antimicrobial, antioxidant, hypoglycemic, hypolipidemic, anxiolytic, analgesic, anti-inflammatory, anti-convulsant and anti-cancer activities, among others. Although coriander has been reported to possess a wide range of traditional medicinal uses, no report is available in its effectiveness use in reactive airway diseases such as asthma and bronchiolitis. In brief, the information presented herein will be helpful to create more interest towards this medicinal species by defining novel pharmacological and clinical applications and hence, may be useful in developing new drug formulations in the future or by employing coriander bioactive constituents in combination with conventional drugs to enhance the treatment of diseases such as Alzheimer and cancer [Bochra Laribi*, Karima Kouki, Mahmoud M'Hamdi and Taoufik Bettaieb (National Agronomic Institute of Tunisia, 43, Av. Charles Nicolle, 1082 Tunis, Tunisia), *Fitoterapia*, 2015, **103**, 9–26].

SUGAR

NPARR, 6(3 & 4), 2015-203 Production of fermentable sugars from sugarcane bagasse by enzymatic hydrolysis after autohydrolysis and mechanical refining

The autohydrolysis process has been considered a simple, low-cost and environmental friendly technology for generation of sugars from biomass. In order to improve accessibility of enzymes during enzymatic hydrolysis as well as to allow the recovery of hemicellulose in the filtrate, the sugarcane bagasse was pretreated using autohydrolysis followed by a mechanical refining process. The autohydrolysis was carried out in three different conditions. Autohydrolysis at 190 °C for 10 min provided the highest overall sugar (19.2/100 g raw bagasse) in prehydrolyzate. The enzymatic hydrolysis step was performed for all the post-treated solids with and without refining at enzyme loadings of 5 and 10 FPU/g for 96 h. A total of 84.4% of sugar can be recovered from sugarcane bagasse at 180 °C for 20 min with 5 FPU/g enzyme charge. The economic analysis for the proposed method showed that the bioethanol production can have a financial return larger than 12% [Larisse Aparecida Ribas Batalha*, Qiang Han, Hasan Jameel, Hou-min Chang, Jorge Luiz Colodette and Fernando José Borges Gomes (Department of Chemistry at Federal University of Viçosa, Viçosa, MG 36570-000, Brazil), *Bioresource Technology*, 2015, **180**, 97–105].

NPARR, 6(3 & 4), 2015-204 Bentonite, temperature and pH effects on purification indexes of raw sugar beet juice to production of inverted liquid sugar

The present study deals with modeling of the effects of processing temperature (30–95 °C), concentration of Bentonite (Bent) (1–5 g/L) and pH (3.5–6) on color, turbidity, purity, ash and invert sugar content of purified raw sugar-beet juice. The used methodology was the face central

composite design of response surface to optimize the key parameters (temperature of processing, concentration of Bent and pH) of the process. The main goal was to focus on the possibility to produce invert sugar directly from raw sugar-beet juice in conjunction with an alternative purification method and also comparison with the common conventional lime processing in the industry. In this way, second-order polynomial models were developed for dependent responses using least-square fit of regression analysis. The results of analysis of variance indicated that all three investigated independent parameters have significant influence on purity indexes of raw beet-juice. The optimum condition was a constant reaction time (30 min) at temperature of 75 °C, pH 4.47 and Bent concentration of 1.7 g/L which were determined on minimization of color, turbidity and ash content and maximization of invert sugar and purity. At this optimum point: color, turbidity, purity, ash and invert sugar content were found to be 1664 ICU₄₂₀, 6.3 NTU, 93.9%, 0.55% and 1.6%, respectively. Also the clarified juice quality obtained by Bent method was improved greatly when compared with conventional limed-carbonated as the color and turbidity in clarified juice were removed by the rate of 35.55% and 76.09%, respectively [Eisa Jahed, Mohammad Hossein Haddad Khodaparast and Amin Mousavi Khaneghah* (Department of Food Science and Technology, Islamic Azad University, Science and Research Branch, Tehran, Iran), *Applied Clay Science*, 2014, **102**, 155–163].

NPARR, 6(3 & 4), 2015-205 Rapid screening for anthocyanins in cane sugars using ESR spectroscopy

Anthocyanin, which is soluble in water and released into sugar steam during extraction, was investigated in this study. The anthocyanin content in refined sugar, plantation white sugar, soft brown sugar and raw sugar was determined using electron spin resonance (ESR) spectroscopy, which was operated at room

temperature, and compared with spectra from standard anthocyanin. The ESR spectra of red and violet anthocyanins was predominantly $g \approx 2.0055$, which corresponded to an unpaired electron located in the pyrylium ring. Signals for Fe (III) and Mn (II), which naturally occur in plants, were found in raw sugar, soft brown sugar and standard anthocyanin but were absent from refined sugar and plantation white sugar due to the refining process. In addition, the ESR results were correlated with the apparent colour of the sugar, which was determined using the method of the International Commission for Uniform Methods of Sugar Analysis and inductively coupled plasma optical emission spectroscopy [Kheamrutai Thamaphat*, Bernard A. Goodman^b, Pichet Limsuwan and Siwaporn Meejoo Smith-(Green Synthesis and Application Laboratory, Department of Physics, Faculty of Science, King Mongkut's University of Technology Thonburi, Bangkok 10140, Thailand), *Food Chemistry*, 2015, **171**, 123–127].

NPARR, 6(3 & 4), 2015-206 **Energy improvements in jaggery making process**

Jaggery (unrefined sugar) is produced by evaporating water from sugarcane juice in steel pans situated over pit furnaces. While it delivers a health friendly sweetening agent with medicinal value (and), its performance, both in terms of technical efficacy and financial sustenance, is being questioned. In India, jaggery is produced in

batch operations, of about 1 ton per day capacity. Bagasse is used as fuel for the process. Improving the efficiency of bagasse utilization is of interest because surplus bagasse could be used elsewhere as a fuel. If all energy in the bagasse were used to heat and evaporate water from the juice, calculations show the rate of bagasse consumption would be 0.65 kg bagasse per kg jaggery. Heat losses in flue gas at 1000 K with no excess oxygen are calculated to decrease the efficiency to 72% (0.90 kg bagasse per kg jaggery). In this study, two single-pan jaggery units were tested wherein, efficiencies varied from 53-76% and 50–57%. The higher efficiencies in each unit were obtained by blocking some of the air inlet holes to decrease the excess air flow. The second unit has a taller chimney than the first, which may contribute to greater air flow due to increased draft. Excess air contributes to lower combustion temperatures, causing a decreased rate of heat transfer to the juice. Minimizing excess air flow into the furnace is a possible strategy for increasing the efficiency of bagasse utilization and might be implemented quite easily by placing dampers at air inlets. This study also included tests of one four-pan jaggery unit. Measured efficiencies were about 50%. Radiative heat transfer to three of the four pans is calculated to be hindered substantially by a low view factor [Kiran Y. Shiralkar, Sravan K. Kancharla, Narendra G. Shah* and Sanjay M. Mahajani (CTARA IIT Bombay, India), *Energy for Sustainable Development*, 2014, **18**, 36–48].

THERAPEUTICS

NPARR, 6(3 & 4), 2015-207 Pharmacological basis for the medicinal use of *Carissa carandas* in constipation and diarrhea

Carissa carandas Linn. commonly known as “Karaunda” (Apocynaceae) is a popular medicinal herb widely distributed in different parts of Pakistan. In addition to other medicinal uses, *Carissa carandas* is popular in indigenous system of medicine for its medicinal use in gut motility disorders like, constipation and diarrhoea. This study was planned to provide pharmacological basis to the medicinal use of *Carissa carandas* in constipation and diarrhoea. The crude extract of the leaves of *Carissa carandas* (Cc.Cr) was prepared in methanol and its fractionation was carried out with ethylacetate, petroleum ether and *n*-butanol. *In-vivo* studies were conducted on mice, while isolated rabbit jejunum and guinea-pig ileum preparations were used for the *in-vitro* experiments. The spasmogenic and spasmolytic responses of gut tissues were recorded using isotonic transducers coupled with PowerLab data acquisition system. The HPLC fingerprints of Cc.Cr, its petroleum (Cc.Pef), ethylacetate (Cc.Eaf) and *n*-butanol (Cc.Baf) fractions showed the presence of oleanolic acid, ursolic acid, stigmasterol and β -sitosterol. Oral administration of Cc.Cr to mice increased fecal output at lower doses (30 and 50 mg/kg), while it showed protection against castor oil-induced diarrhea at higher doses (300 and 600 mg/kg). In isolated guinea-pig ileum and rabbit jejunum, Cc.Cr and Cc.Baf exhibited stimulatory effect at 0.003–3 mg/ml, which was partially sensitive to atropine or pyrillamine or partially/fully sensitive to atropine+pyrillamine, followed by relaxation at higher tested concentrations, being more potent in rabbit tissues. The ethylacetate fraction (0.1–5 mg/ml) exhibited fully atropine-sensitive contractions in both guinea-pig and rabbit tissues, being more potent in guinea-pig while more efficacious in rabbit tissues. However, the petroleum fraction (0.003–1.0 mg/ml) showed

only spasmolytic activity in spontaneously contracting rabbit tissues, similar to nifedipine. In guinea-tissue, Cc.Pef did not cause any stimulant effect. When studied against high K^+ (80 mM)-induced contraction, the crude extract and its fractions caused a dose-dependent inhibition, with the following order of potency: Cc.Pef>Cc.Eaf>Cc.Cr \geq Cc.Baf, similar to nifedipine indicating Ca^{++} channel antagonist like activity, which was further confirmed when the plant extract displaced Ca^{++} curves to the right with suppression of maximum effect similar to that of nifedipine.

This study demonstrates that the crude extract of *Carissa carandas* possesses a gut-stimulatory effect mediated primarily through the activation of muscarinic and histaminergic receptors while its spasmolytic effect was mediated possibly through Ca^{++} antagonist pathway. Thus, this study provides a clear evidence for the dual effectiveness of *Carissa carandas* in constipation and diarrhea, thus validating its medicinal use [Malik Hassan Mehmood, Nfn Anila, Sabira Begum, Saqib A. Syed, Bina S. Siddiqui and Anwarul-Hassan Gilani*(Natural Product Research Division, Department of Biological and Biomedical Sciences, The Aga Khan University Medical College, Karachi 74800, Pakistan), *Journal of Ethnopharmacology*, 2014, **153** (2), 359–367].

NPARR, 6(3 & 4), 2015-208 Pharmacological basis for the medicinal use of *Linum usitatissimum* (Flaxseed) in infectious and non-infectious diarrhea

Linum usitatissimum, commonly known as Flaxseed has traditionally been used for the management of diarrhea and gastrointestinal infections. This study was planned to assess pharmacological basis for the medicinal use of Flaxseed in infectious and non-infectious diarrhea. The crude aqueous-methanolic extract of Flaxseed was studied using the *in vivo* castor oil-induced diarrhea, gut motility and enteropooling assays. Mechanistic basis was further elucidated by testing

the inhibitory effect on spontaneously contracting isolated rabbit jejunum preparations, suspended in a 10 ml tissue bath containing Tyrode' solution, maintained at 37 °C and aerated with carbogen. Antibacterial efficacy of the Flaxseed extract was tested against different enteric and non-enteric pathogenic bacteria using *in vitro* antibacterial assays. Flaxseed extract reduced the diarrheal score in mice, by 39%, 63.90% and 68.34% at the respective doses of 100, 300 and 500 mg/kg. Intestinal secretions were reduced by 24.12%, 28.09% and 38.80%, whereas the intestinal motility was reduced by 31.66%, 46.98% and 56.20% at respective doses of 100, 300 and 500 mg/kg. When tested on isolated rabbit jejunum preparations, Flaxseed extract produced a dose-dependent inhibition of both spontaneous and high K⁺ (80 mM)-induced contractions, and shifted the concentration–response curves of Ca⁺⁺ to the right with suppression of the maximum response, similar to that caused by verapamil. Flaxseed extract was found to possess bactericidal activity at the tested concentrations of 12.5 mg/ml, against vancomycin-resistant *Enterococcus faecalis* (100%), *Escherichia coli* K1 (88.88%), methicillin-resistant *Staphylococcus aureus* (98.76%), *Bacillus cereus* (92.64%), *Pseudomonas aeruginosa* (76.83%) and *Salmonella typhi* (26.91±3.35%). The concentration of 10 mg/ml showed bactericidal effects against all the aforementioned pathogens except *Escherichia coli* K1, whereas for *Pseudomonas aeruginosa* and *Salmonella typhi*, it was bacteriostatic at this concentration. The results indicated that *Linum usitatissimum* (Flaxseed) extract exhibits antidiarrheal and antispasmodic activities by virtue of its antimotility and antisecretory effects which are mediated possibly through inhibition of Ca⁺⁺ channels, though additional mechanism(s) cannot be ruled out. Flaxseed extract proved effective against both enteric and non-enteric pathogens causing diarrhea, thus ensuring wide coverage and rationalizing its medicinal use in both the infectious and non-infectious diarrhoea [Amber Hanif Palla^a, Naveed Ahmed Khan^a, Samra Bashir^a, Najeeb ur-Rehman^{a, b}, Junaid Iqbal and Anwarul-Hassan Gilani *(Department of Biological and Biomedical Sciences, The Aga Khan University Medical

College, Karachi 74800, Pakistan), *Journal of Ethnopharmacology*, 2015, **160**, 61–68].

NPARR, 6(3 & 4), 2015-209 Antidiarrheal and antioxidant activities of chamomile (*Matricaria recutita* L.) decoction extract in rats

Matricaria recutita L. (Chamomile) has been widely used in the Tunisian traditional medicine for the treatment of digestive system disorders. The present work aims to investigate the protective effects of chamomile decoction extract (CDE) against castor oil-induced diarrhea and oxidative stress in rats. The antidiarrheal activity was evaluated using castor oil-induced diarrhea method. In this respect, rats were divided into six groups: Control, Castor oil, Castor oil+Loperamide (LOP) and Castor oil+various doses of CDE. Animals were per orally (*p.o.*) pre-treated with CDE during 1 h and intoxicated for 2 or 4 h by acute oral administration of castor oil.

The results showed that CDE produced a significant dose-dependent protection against castor oil-induced diarrhea and intestinal fluid accumulation. On the other hand, we showed that diarrhea was accompanied by an oxidative stress status assessed by an increase of malondialdehyde (MDA) level and depletion of antioxidant enzyme activities as superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx). Castor oil also increased gastric and intestinal mucosa hydrogen peroxide (H₂O₂) and free iron levels. Importantly, we showed that chamomile pre-treatment abrogated all these biochemical alterations.

These findings suggested that chamomile extract had a potent antidiarrheal and antioxidant properties in rats confirming their use in traditional medicine [Hichem Sebai*, Mohamed-Amine Jabri, Abdelaziz Souli, Kais Rtibi, Slimen Selmi, Olfa Tebourbi, Jamel El-Benna, Mohsen Sakly (Laboratoire de Physiologie Intégrée, Faculté des Sciences de Bizerte, 7021 Zarzouna, Tunisia), *Journal of Ethnopharmacology*, 2014, **152** (2), 327–332].

NPARR, 6(3 & 4), 2015-210 Consumption of Dried Apple Peel Powder Increases Joint Function and Range of Motion

The goal for this study was to evaluate the effects of consumption of dried apple peel powder (DAPP) on joint function and range of motion (ROM). Additional *in vitro* and clinical testing was performed to suggest specific mechanisms of action. An open-label clinical pilot study involved 12 healthy people with moderate loss of joint ROM and associated chronic pain. The subjects consumed 4.25 g DAPP daily for 12 weeks, with evaluations at baseline, 2, 4, 8, and 12 weeks. ROM was evaluated at each visit using dual digital inclinometry. Pain scores were collected using Visual Analogue Scales. Blood draws enabled testing of serum antioxidant protective capacity using the cellular antioxidant protection (CAP-e) bioassay. Additional *in vitro* testing involved testing of cyclooxygenase-2 (COX-2) and lipoxygenase inhibition, cellular antioxidant protection by the CAP-e bioassay, and formation of reactive oxygen species (ROS) by polymorphonuclear (PMN) cells by flow cytometry. Twelve weeks of consumption of DAPP was associated with improved ROM. DAPP provided antioxidants that were available to enter into and protect cells from oxidative damage *in vitro*, and consumption of DAPP for 12 weeks was associated with a statistically significant improvement in serum antioxidant protective status. DAPP inhibited both COX-2 and lipoxygenase enzymes, and pretreatment of inflammatory PMN cells with DAPP before inflammatory stimulus resulted in reduced ROS formation. This suggests multifaceted anti-inflammatory properties of DAPP. Consumption of DAPP was associated with improved joint function and improved serum antioxidant protection status. The observed pain reduction may be associated with the improved antioxidant status and linked to the apple polyphenols' anti-inflammatory effects [Jensen Gitte S*, Attridge Victoria L., Benson Kathleen F., Beaman Joni L., Carter Steve G., and Ager David (NIS Labs, 1437 Esplanade, Klamath Falls, OR

97601, USA), *Journal of Medicinal Food*, 2014, 17(11), 1204-1213].

NPARR, 6(3 & 4), 2015-211 Coriander Leaf Extract Exerts Antioxidant Activity and Protects Against UVB-Induced Photoaging of Skin by Regulation of Procollagen Type I and MMP-1 Expression

Ultraviolet (UV) radiation causes photodamage to the skin, which, in turn, leads to depletion of the dermal extracellular matrix and chronic alterations in skin structure. Skin wrinkles are associated with collagen synthesis and matrix metalloproteinase-1 (MMP-1) activity. *Coriandrum sativum* L. (coriander leaf, cilantro; CS) has been used as a herbal medicine for the treatment of diabetes, hyperlipidemia, liver disease, and cancer. In this study, we examined whether CS ethanol extract (CSE) has protective effects against UVB-induced skin photoaging in normal human dermal fibroblasts (NHDF) *in vitro* and in the skin of hairless mice *in vivo*. The main component of CSE, linolenic acid, was determined by gas chromatography-mass spectroscopy. We measured the cellular levels of procollagen type I and MMP-1 using ELISA in NHDF cells after UVB irradiation. NHDF cells that were treated with CSE after UVB irradiation exhibited higher procollagen type I production and lower levels of MMP-1 than untreated cells. We found that the activity of transcription factor activator protein-1 (AP-1) was also inhibited by CSE treatment. We measured the epidermal thickness, dermal collagen fiber density, and procollagen type I and MMP-1 levels in photoaged mouse skin *in vivo* using histological staining and western blot analysis. Our results showed that CSE-treated mice had thinner epidermal layers and denser dermal collagen fibers than untreated mice. On a molecular level, it was further confirmed that CSE-treated mice had lower MMP-1 levels and higher procollagen type I levels than untreated mice. Our results support the potential of *C. sativum* L. to prevent skin photoaging [Hwang Eunson, Lee Do-Gyeong, Park Sin Hee, Oh Myung Sook, and Kim Sun Yeou (College of Pharmacy,

Gachon University, 191 Hambakmoero, Yeonsu-Gu, Incheon 406-799, Republic of Korea), *Journal of Medicinal Food*, 2014, **17**(9), 985-995].

NPARR, 6(3 & 4), 2015-212 Composition and antiproliferative effect of essential oil of *Origanum vulgare* against tumor cell lines

Cancer is a leading cause of death and is responsible for one in eight deaths worldwide. The use of herbs as complementary medicine for cancer, especially advanced cancer, has recently increased. The aim of this study was to evaluate *in vitro*, the antiproliferative effect of *Origanum vulgare* against human breast adenocarcinoma (MCF-7), and human colon adenocarcinoma (HT-29). The essential oil (EO) was extracted from a bought amount of *O. vulgare* dried leaves and analyzed in a gas chromatograph interfaced with a mass selective detector. The cytotoxicity test was performed by sulforhodamine B assay. The results show that the EO is composed mostly of 4-terpineol and induces a high cytotoxicity effect in HT-29. In the MCF-7 cell line the EO was less effective. In conclusion, this study showed that *O. vulgare* main component is 4-terpineol and was effective in inducing cancer cell growth inhibition [Karine Rech Begnini, Fernanda Nedel, Rafael Guerra Lund*, Pedro Henrique de Azambuja Carvalho, Maria Regina Alves Rodrigues, Fátima Tereza Alves Beira, and Francisco Augusto Burkert Del-Pino (Dentistry, Pelotas Dental School, Federal University of Pelotas (UFPel), Gonçalves Chaves St., 457/503, Pelotas 96015-560, RS, Brazil), *Journal of Medicinal Food*, 2014, **17**(10), 1129-1133].

NPARR, 6(3 & 4), 2015-213 Sorghum [*Sorghum bicolor* (L.) Moench] leaf sheath dye protects against cisplatin-induced hepatotoxicity and oxidative stress in rats

This study sought to determine the protective effect of dietary inclusion of sorghum leaf sheath dye on cisplatin-induced hepatotoxicity and oxidative stress in rats. Adult male rats were

randomly divided into four groups with six animals in each group. Groups I and II were fed a basal diet, while groups III and IV were fed diets containing 0.5% and 1% sorghum leaf sheath dye, respectively, for 20 days before cisplatin administration. Hepatotoxicity was induced by a single dose of cisplatin (7 mg/kg body weight, i.p.), and the experiment was terminated at 3 days after cisplatin injection. The liver and plasma were studied for hepatotoxicity and antioxidant capacity. Cisplatin caused a significant ($P < .05$) alteration in plasma and liver enzymatic (catalase, glutathione-S-transferase [GST], and superoxide dismutase [SOD]) and nonenzymatic (glutathione [GSH] and vitamin C) antioxidant indices with a concomitant increase in the malondialdehyde (MDA) content; however, there was a significant ($P < .05$) restoration of the antioxidant status coupled with a significant ($P < .05$) decrease in the tissue MDA content, after consumption of diets containing sorghum leaf sheath dye. Furthermore, dietary inclusion of sorghum leaf sheath dye caused a marked reduction in the activities of alanine aminotransferase and aspartate aminotransferase after cisplatin administration. However, the ability of the dye to prevent significant cisplatin-induced alteration of both plasma and liver antioxidant indices suggests an antioxidant mechanism of action. Hence, this protective effect of *Sorghum bicolor* leaf sheath dye against cisplatin-induced hepatotoxicity in rats reflects its potential and beneficial role in the prevention of liver damage associated with cisplatin administration [Ademiluyi Adedayo O*, Oboh Ganiyu, Agbebi Oluwaseun J, Boligon Aline A, and Athayde Margareth L (Functional Foods, Nutraceuticals and Phytomedicine Unit, Department of Biochemistry, Federal University of Technology, Akure, PMB 704, Akure 340001, Nigeria), *Journal of Medicinal Food*, 2014, **17**(12), 1332-1338].

NPARR, 6(3 & 4), 2015-214 TRAMP Prostate tumor growth is slowed by walnut diets through altered igf-1 levels, energy pathways, and cholesterol metabolism

Dietary changes could potentially reduce prostate cancer morbidity and mortality. Transgenic

adenocarcinoma of the mouse prostate (TRAMP) prostate tumor responses to a 100 g of fat/kg diet (whole walnuts, walnut oil, and other oils; balanced for macronutrients, tocopherols [α - and γ]) for 18 weeks *ad libitum* were assessed. TRAMP mice ($n=17$ per group) were fed diets with 100 g fat from either whole walnuts (diet group WW), walnut-like fat (diet group WLF, oils blended to match walnut's fatty acid profile), or as walnut oil (diet group WO, pressed from the same walnuts as WW). Fasted plasma glucose was from tail vein blood, blood was obtained by cardiac puncture, and plasma stored frozen until analysis. Prostate (genitourinary intact [GUI]) was weighed and stored frozen at -80°C . Plasma triglyceride, lipoprotein cholesterol, plasma multianalyte levels (Myriad RBM Rat Metabolic MAP), prostate (GUI), tissue metabolites (Metabolon, Inc., Durham, NC, USA), and mRNA (by Illumina NGS) were determined. The prostate tumor size, plasma insulin-like growth factor-1 (IGF-1), high density lipoprotein, and total cholesterol all decreased significantly ($P<.05$) in both WW and WO compared to WLF. Both WW and WO versus WLF showed increased insulin sensitivity (Homeostasis Model Assessment [HOMA]), and tissue metabolomics found reduced glucose-6-phosphate, succinylcarnitine, and 4-hydroxybutyrate in these groups suggesting effects on cellular energy status. Tissue mRNA levels also showed changes suggestive of altered glucose metabolism with WW and WO diet groups having increased *PCK1* and *CIDEA* mRNA expression, known for their roles in gluconeogenesis and increased insulin sensitivity, respectively. WW and WO group tissues also had increased MSMB mRNA a tumor suppressor and decreased *COX-2* mRNA, both reported to inhibit prostate tumor growth. Walnuts reduced prostate tumor growth by affecting energy metabolism along with decreased plasma IGF-1 and cholesterol. These effects are not due to the walnut's N-3 fatty acids, but due to component(s) found in the walnut's fat component [Kim Hyunsook, Yokoyama Wallace and Davis Paul Andrew* (Paul Andrew Davis,

PhD, Department of Nutrition, University of California, Davis, Davis, CA 95616, USA), *Journal of Medicinal Food*, 2014, **17**(12), 1281-1286].

NPARR, 6(3 & 4), 2015-215 **Chemical composition and antibacterial activity of foliage and resin essential oils of *Araucaria cunninghamii* Aiton ex D. Don and *Araucaria heterophylla* (Salisb.) Franco from India**

The essential oils of foliage and resin of *Araucaria cunninghamii* Aiton ex D. Don and *Araucaria heterophylla* (Salisb.) Franco were isolated by hydrodistillation and subsequently analyzed using gas chromatography (GC/FID) and GC-mass spectrometry (GC/MS). Altogether 113 constituents, representing 84.0–97.6% of the total oil compositions were identified. Major constituents of the foliage oil of *A. cunninghamii* were beyerene (34.6–44.4%), caryophyllene oxide (0.5–17.9%), α -pinene (3.3–16.2%), germacrene D (0.1–9.8%), kaurene (1.7–5.1%), and 13-*epi*-dolabradiene (4.2–4.8%). However, the resin oil of *A. cunninghamii* was characterized by higher amounts of (*E*)-caryophyllene (60.8%), caryophyllene oxide (13.4%), and (*E*)- β -farnesene (4.9%). The foliage oil of *A. heterophylla* was dominated by 13-*epi*-dolabradiene (42.7%), beyerene (22.2%), rimuene (13.7%), and dolabradiene (3.9%), whereas the resin oil of *A. heterophylla* contained α -copaene (29.9%), germacrene D (21.4%), γ -gurjunene (9.7%), δ -cadinene (7.1%), and sandaracopimara-8(14),15-diene (6.5%) as main constituents. The foliage and resin essential oils of both species showed minimum inhibitory concentration (MIC) in the range of 250–500 $\mu\text{g/mL}$ and minimum bactericidal concentration (MBC) in the range of 1000 to >1000 $\mu\text{g/mL}$ against tested bacterial strains [Ram S. Verma*, Rajendra C. Padalia, Prakash Goswami, Sajendra K. Verma, Amit Chauhan, Mahendra P. Darokar (Department of Natural Product Chemistry, CSIR-Central Institute of Medicinal and Aromatic Plants, Research Centre-Pantnagar, P.O. Dairy Farm

Nagla, Udham Singh Nagar, Uttarakhand 263149, India), *Industrial Crops and Products*, 2014, **61**, 410–416].

NPARR, 6(3 & 4), 2015-216 **Phytochemical, antioxidant, antibacterial, and α -amylase inhibitory properties of different extracts from betel leaves**

Antimicrobial and antioxidant activities, phenol content, and α -amylase inhibitory effects of a local variety of betel leaves were evaluated. The effects of various solvents (methanol, ethanol, acetone, and ethyl acetate) on phenols and antioxidant activities were also studied. Methanol and ethanol (90%) extracts showed maximum phenolic contents (205.2 and 202.9 mg GAE/g, respectively). Maximum flavonoid contents were determined using 90% acetone (82.5 mg CE/g), and the highest inhibition percentage of 2,2-diphenyl-1-picrylhydrazyl radical was exhibited by 90% ethanol (percent inhibition, 94%). α -Amylase activity assay showed that α -amylase inhibitory activities were positively correlated with the total phenolic content of ethanol and methanol. Considering antimicrobial activities, we found that all of the Gram-positive bacteria and Gram-negative bacteria were inhibited by betel leaf extract except *Pseudomonas aeruginosa*. Our results could provide a basis of future studies on betel leaves used in food and pharmaceutical applications [Leila Nouri and Abdorreza Mohammadi Nafchi* (Food Biopolymer Research Group, Food Science and Technology Department, Damghan Branch, Islamic Azad University, Damghan, Semnan, Iran), *Industrial Crops and Products*, 2014, **62**, 47–52].

NPARR, 6(3 & 4), 2015-217 **In vitro antimutagenic activity of *Vitex agnus-castus* L. essential oils and ethanolic extracts**

This study investigated the antimutagenic activity of the essential oil of the leaves and the

ethanolic extract of the seeds of *Vitex agnus-castus*, a common plant with both medicinal and economic value. Ames *Salmonella*/microsome mutagenicity tests showed the essential oil of *V. agnus-castus* leaves at 0.125, 0.0125, and 0.00125 mg/plate concentrations and the ethanolic extract of *V. agnus-castus* seeds at 2.5, 0.25, and 0.025 mg/plate concentrations to have antimutagenic effects on *Salmonella typhimurium* TA98 and TA100. Moreover, neither the essential oils nor the ethanolic extracts exhibited any mutagenic activity themselves. To our knowledge, this is the first study to be conducted on the antimutagenic activities of *V. agnus-castus* essential oils and extracts and provides important data for the fields of medicine and pharmaceuticals [Nurdan Sarac* , Aysel Ugur and Burak Sen (Medical Laboratory Programme, Vocational School of Health Sciences, Mugla Sitki Kocman University, Mugla, Turkey), *Industrial Crops and Products*, 2015, **63**, 100–103].

NPARR, 6(3 & 4), 2015-218 **Biosynthesis, characterization and antibacterial effect of plant-mediated silver nanoparticles using *Ceropegia thwaitesii* – An endemic species**

Leaf extract of *in vitro* raised plants of *Ceropegia thwaitesii* was assessed for the green synthesis of silver nanoparticles (AgNPs). The biosynthesized AgNPs were authorized by UV–vis spectrophotometer with surface plasmon resonance at 430 nm. The scanning electron microscope (SEM), dynamic light scattering (DLS) analysis confirmed the particle size 100 nm, and X-ray diffraction (XRD) confirmed the crystalline character of AgNPs. Further, Fourier transform infrared (FTIR) authorized the presence of triterpenoids and methoxy groups played an important reduction role in the synthesis process. It shows the significant antibacterial efficacy against *Salmonella typhi*, *Shigella flexneri*, *Klbsiella pneumonia*, *Eschericia coli* and others species. From the results, it is suggested that green synthesized AgNPs could be used effectively in future

biomedical engineering [S. Muthukrishnan, S. Bhakya^b, T. Senthil Kumar* and M.V. Rao^a (Department of Industry University Collaboration, Bharathidasan University, Tiruchirappalli 620 024, Tamil Nadu, India), *Industrial Crops and Products*, 2015, **63**, 119-124].

NPARR, 6(3 & 4), 2015-219 **Antibacterial activity of spathe from *Phoenix dactylifera* L. against some food-borne pathogens**

The study aimed to evaluate the in vitro antibacterial activity of extracts from spathe (date palm) against *Listeria monocytogenes* ATCC 7644, *Staphylococcus aureus* (ATCC 25923 and 29213), *Staphylococcus saprophyticus* ATCC 15305, *Salmonella enterica* subsp. *enterica* ATCC 13076, *Escherichia coli* ATCC 25922, and *Pseudomonas aeruginosa* ATCC 27853. Results of the agar diffusion assay indicated that the 80% methanolic extract of spathe (ME) was the most active sample against test pathogens, compared to water or petroleum ether extracts. The inhibition zones produced by ME were 11–31 mm against the test bacteria. Minimum inhibitory concentration (MIC), determined by the agar dilution method of ME against gram positive bacteria was 1.5 mg/ml. MIC of ME for gram negative bacteria was 3 mg/ml. Preliminary phytochemical tests revealed that ME contained phenolics and flavonoids. The Folin–Ciocalteu method showed that total phenolics (265.7 mg Gallic acid equivalent/g) were significantly ($P < 0.05$) higher in ME than other extracts. Total antioxidant capacity (phosphomolybdenum method) of ME was 530 μ g ascorbic acid equivalent/g. It could be summarized that spathe contains active phytochemicals which may find applications in the food industry and pharmaceuticals [Najeeb S. Al-zoreky* and dulla Y. Al-Taher (Department of Food and Nutrition Science, College of Agricultural and Food Sciences, King Faisal University, P.O. Box 400, Al-Ahsa 31982, Saudi Arabia), *Industrial Crops and Products*, 2015, **65**, 241–246].

NPARR, 6(3 & 4), 2015-220 ***Lawsonia inermis* L. – A commercially important primaeval dying and medicinal plant with diverse pharmacological activity: A review**

Lawsonia inermis, popularly known as Henna or Mehndi in the Oriental world, is an evergreen medium sized shrub of the Family Lythraceae. The leaf paste of this plant has been traditionally used for dying hair, skin and nails since antiquity. Besides cosmaceutical usages, the plant also harbours a well-documented folklore history for treating convulsion, jaundice and malignant ulcers. Phytochemical studies in henna plant have indicated the presence of several bioactive molecules like isoplumpagin, lupeol, 30-norlupan-3-ol-20-one, betuhennan, betuhennanic acid and n-tridecanoate phenolic glycosides, lawsoniaside, β -sitosterol and stigmaterol in leaves and roots. Lawsone (2-hydroxy-1,4-naphthoquinone), the red orange dye present in the henna leaf paste, is being used in modern pharmacopoeia as a starting molecule for the synthesis of clinically important anticancer drugs such as atovaquone, lapachol and dichloroallyl lawsone. Pharmacological prospection of *L. inermis* plant extracts in last two decades have indicated strong nootropic, CNS depressing, antimicrobial, antioxidant, wound healing, anti-inflammatory, antipyretic, analgesic, hepatoprotective, tuberculostatic, diuretic, hypoglycemic and antiparasitic actions. An attempt has been made in this review to accentuate a comprehensive literature up-date on pharmacological investigations carried out in *L. inermis*. To the best of our knowledge and belief this is the first compilation in this direction in Henna [Dhananjay Kumar Singh, Suaib Luqman* and Ajay Kumar Mathur (Molecular Bioprospection Department of Biotechnology Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow 226015, India), *Industrial Crops and Products*, 2015, **65**, 269–286].

NPARR, 6(3 & 4), 2015-221 ***Daucus carota* subsp. gummifer essential oil as a natural source of antifungal and anti-inflammatory drugs**

The present study was conducted to elucidate the composition, antifungal and anti-inflammatory activities and cytotoxicity of *Daucus carota* subsp. *gummifer* essential oil. Aerial parts of the plants were hydrodistilled and the oil analyzed by GC and GC-MS. The oil was characterized by high contents of monoterpenes (83.9%), the major compounds being geranyl acetate (37.0%) and α -pinene (30.9%). The daucane sesquiterpene, carotol, was also found in relatively high amounts (11.0%). For the antifungal activity, minimal inhibitory and minimal lethal concentrations (MIC and MLC, respectively) were determined against several pathogenic fungi strains. The oil was particularly active against dermatophytes and *Cryptococcus neoformans*, with MIC values ranging from 0.32 to 0.64 μ L/mL. Concerning the anti-inflammatory potential, the oil demonstrated a strong anti-inflammatory activity by inhibiting nitric oxide (NO) production in both lipopolysaccharide (LPS)-triggered macrophages and microglia cells. NO scavenging activity was

also assessed using the NO donor S-nitroso-N-acetyl-d,l-penicillamine and a significant effect was disclosed. To assure that the bioactivity of the oil was achieved without detrimental effects to cells, the toxicity of *D. carota* subsp. *gummifer* oil was investigated using the MTT assay in several mammalian cell lines: macrophages (Raw 264.7), keratinocytes (HaCat), hepatocytes (HepG2) and microglia (N9). Interestingly, we detected a cytotoxic effect only for the highest concentrations of the oil, thus assuring a safe toxicological profile at bioactive concentrations.

These results advise that *D. carota* subsp. *gummifer* essential oil should be explored as a natural source of antifungal and anti-inflammatory drugs with potential application both at the peripheral and central nervous system levels, thus supporting in vivo studies focused in the management of dermatophytosis and/or inflammatory-related diseases [J. Valente, M. Zuzarte, R. Resende, M.J. Gonçalves, C. Cavaleiro, C.F. Pereira, M.T. Cruz, L. Salgueiro*(Center of Pharmaceutical Studies, Health Science Campus, University of Coimbra, Azinhaga de S. Comba, 3000-354 Coimbra, Portugal), *Industrial Crops and Products*, 2015, **65**, 361–366].

VEGETABLES

NPARR, 6(3 & 4), 2015-222 Extract of okra lowers blood glucose and serum lipids in high-fat diet-induced obese C57BL/6 mice

Okra is an important tropical vegetable and source of dietary medicine. Here, we assayed the effects of an ethanol extract of okra (EO) and its major flavonoids isoquercitrin and quercetin 3-O-gentiobioside on metabolic disorders in high-fat diet-induced obese mouse. We found that treatment with EO, isoquercitrin and quercetin 3-O-gentiobioside reduced blood glucose and serum insulin levels and improved glucose tolerance in obese mice. Meanwhile, serum triglyceride levels and liver morphology in the mice were significantly ameliorated by EO and isoquercitrin treatment. Total cholesterol levels in isoquercitrin and quercetin 3-O-gentiobioside treated mice were also reduced. We also found that EO inhibited the expression of nuclear receptor transcription factor PPAR γ , which is an important regulator of lipid and glucose homeostasis. Furthermore, we determined that EO and quercetin 3-O-gentiobioside have antioxidant activity *in vitro*. Our results indicate that okra may serve as a dietary therapy for hyperglycemia and hypertriglyceridemia [Shengjie Fan, Yu Zhang, Qinhu Sun, Lijing Yu, Mingxia Li, Bin Zheng, Ximin Wu, Baican Yang, Yiming Li, and Cheng Huang* ((School of Pharmacy, Shanghai University of Traditional Chinese Medicine, Shanghai 201203, China), *The Journal of Nutritional Biochemistry*, 2014, **25**(7), 702–709].

NPARR, 6(3 & 4), 2015-223 Improving quality of greenhouse tomato (*Solanum lycopersicum* L.) by pre- and postharvest applications of hexanal-containing formulations

From harvest to consumption, tomato (*Solanum lycopersicum* L.) fruit are exposed to

several exogenous factors that enhance product deterioration. Phospholipase D is a key enzyme involved in membrane deterioration that occurs during fruit ripening and senescence. Hexanal, an inhibitor of phospholipase D has been successfully used for pre- and postharvest treatment of fruit, vegetables and flowers. In this study, effectiveness of pre- and postharvest application of an aqueous hexanal formulation and an enhanced freshness formulation (EFF) containing hexanal and other ingredients were evaluated by monitoring changes in quality parameters during postharvest storage of greenhouse tomatoes. Tomatoes subjected to preharvest spray with EFF containing 1 mM hexanal twice a week had better colour, and firmness than untreated fruit and hexanal formulation treated fruit. EFF treated tomatoes also showed low hue angle values indicative of enhanced red colour. Preharvest spray with 1 mM hexanal twice a week resulted in higher levels of ascorbic acid and soluble solids in fruit than those subjected to EFF treatment, and the control. Postharvest dip application of harvested tomatoes in 2 mM hexanal as EFF resulted in enhanced brightness and hue angle values, reduced red colour, increased fruit firmness and ascorbic acid content after 21 days of storage, indicative of better quality. The results suggest that hexanal has the potential to enhance shelf-life and quality [Amer Cheema, Priya Padmanabhan, Jayasankar Subramanian, Theo Blom and Gopinadhan Paliyath* (Department of Plant Agriculture, University of Guelph, Ontario N1G 2W1, Canada), *Postharvest Biology and Technology*, 2014, **95**, 13–19].

NPARR, 6(3 & 4), 2015-224 Postharvest shelf-life extension of green chillies (*Capsicum annuum* L.) using shellac-based edible surface coatings

Shellac-based coatings were developed in combination with starch, EDTA and sodium alginate and were evaluated for shelf-life

extension of fresh green chillies during storage at ambient temperature (26 ± 2 °C, RH $68 \pm 4\%$) for 12 days. The developed composite coatings were found to be effective in extending the shelf-life of chillies. The control samples showed a higher weight loss (12.35%) compared to coated ones (5.60-6.90%). The coated samples showed significantly ($p < 0.05$) higher retention of ascorbic acid, firmness and chlorophyll content, whereas, total phenolic content was found to be significantly ($p < 0.05$) higher in uncoated samples after 12 days of storage. Shellac-sodium alginate based coating was found to be the most effective in maintaining the quality of fresh green chillies during ambient storage as compared to other coatings [K. Chitravathi, O.P. Chauhan* and P. S. Raju (Defence Food Research Laboratory, Siddarthanagar, Mysore 570011, India), *Postharvest Biology and Technology*, 2014, **92**, 146–148].

NPARR, 6(3 & 4), 2015-225 Growth of *Listeria monocytogenes* and *Listeria innocua* on fresh baby spinach leaves: Effect of storage temperature and natural microflora

Leafy greens such as spinach may be contaminated with *Listeria monocytogenes* during pre-harvest and postharvest handling. Recent recalls issued for *Listeria*-contaminated leafy greens are driving the need for technologies to minimize safety issues in fresh and fresh-cut produce. This study assessed the effectiveness of washing treatments as a postharvest practice to minimize the growth of the pathogen and *L. innocua* on fresh baby spinach leaves under different storage temperatures and to evaluate the feasibility of using *L. innocua* as a surrogate when access to BL2 facilities is difficult. Each microorganism had a different ($P < 0.05$) response to the type of washing treatment at room temperature (~ 22 °C) and the pathogen was harder to remove from the leaves than the surrogate was. Growth data for *L. monocytogenes* and *L. innocua* on fresh baby spinach leaves at 5–

36 °C were modeled using the Baranyi and Ratkowsky (secondary) models which were validated by comparing the root mean square error (RMSEs) and biases between the growth data and model predictions. The secondary models showed good agreement between observed and predicted values. These models can provide useful input to quantitative risk assessment tools to evaluate the growth of pathogens in baby spinach during several stages of processing and distribution such as washing and cold storage. Although the natural microflora on fresh baby spinach leaves affected the growth parameters for both bacteria, the effect was not significant. Thus, in the specific case of spinach leaves, the study shows that *L. innocua* may be a suitable surrogate in growth studies of *L. monocytogenes* [Basri Omac, Rosana G. Moreira, Alejandro Castillo and Elena Castell-Perez* (Department of Biological and Agricultural Engineering, Texas A&M University, College Station, TX 77843-2117, USA), *Postharvest Biology and Technology*, 2015, **100**, 41–51].

NPARR, 6(3 & 4), 2015-226 Quality attributes of map packaged ready-to-eat baby carrots by using chitosan-based coatings

Chitosan-based coatings were developed and their efficacy in maintaining the quality of baby carrots was studied over time. Coatings were applied through the use of spraying and dipping techniques. Baby carrots were packaged under modified atmosphere packaging (MAP) and stored at 4 °C. Different coating types were compared against untreated controls and were evaluated by monitoring parameters such as headspace gas composition, weight loss, pH, colour, texture and microbiological stability. The microbiological status of all stored products were determined through assessment of *Bacillus cereus*, total coliforms, *Pseudomonas* spp., *Staphylococcus aureus*, total viable counts, and yeast and moulds. Additionally, sensory evaluation was performed to study the effects of

coatings in relation to customer acceptance. Results showed that chitosan-based coatings delayed microbial spoilage without causing adverse impacts on the quality attributes of baby carrots. Coatings exhibited positive effects on product colour and texture. Sensory analysis showed that overall acceptability of coated baby carrots were similar to uncoated samples. The very positive findings derived from this study could be expanded to investigate and apply other similar bioactive compounds to horticultural-based products in order to maintain product quality over longer shelf life periods [I. Leceta, S. Molinaro, P. Guerrero, J.P. Kerry and K. de la Caba* (BIOMAT Research Group, University of the Basque Country (UPV/EHU), Polytechnic School, Plaza Europa 1, 20018 Donostia-San Sebastián, Spain), *Postharvest Biology and Technology*, 2015, **100**, 142–150].

NPARR, 6(3 & 4), 2015-227 An analysis of potato consumption habits and diet quality among adults and children in the UK

Many people are confused about the nutritional role of potatoes in a healthy, balanced diet. Starchy foods are often under-regarded by the public and maligned by proponents of low carbohydrate diets, yet carbohydrate should supply around 50% of dietary energy, preferably from sources such as potatoes, pulses and wholegrains. Potatoes provide significant quantities of shortfall micronutrients, yet they do not count as vegetables in 5 A DAY targets. To provide balanced advice, research is needed on potato consumption and its possible nutritional consequences. Therefore we analysed individual dietary records from the *National Diet and Nutrition Survey* 2008–2012 to investigate potato consumption patterns and associations with nutrient intakes. We hypothesised that high consumption of potatoes would be associated with higher total intakes of potassium, B vitamins and fibre. Across the whole population, potatoes provided 7% of energy, 15% of potassium, 13%

of dietary fibre (non-starch polysaccharide) and vitamin C, 14% of vitamin B₆, 10% of folate, 8% of magnesium and 6% of iron. Both very low and very high consumption of potatoes (Q1 and Q5) was associated with lower energy and nutrient intakes, compared with average consumers. Lower micronutrient intakes were most pronounced in Q5 (mean 14.8% energy from potatoes), although Q1 had lowest intakes of potassium, vitamin B₆ and thiamin. Food intakes suggest a less healthy, varied dietary pattern among high potato consumers. Conversely, low consumers of potatoes had lower intakes of potassium, thiamin and vitamin B₆ (all found in potatoes) despite an apparently health-conscious dietary pattern that included higher consumption of fruit, vegetables and fish. Our study suggests that based on current habits, a broad range of potato consumption is compatible with good nutrition, while high reliance on potatoes may be associated with an unbalanced diet. To help raise intakes of shortfall nutrients such as potassium and fibre, consumption of potatoes could be encouraged alongside existing healthy eating messages relating to vegetables, fruit and wholegrain foods [S. Gibson* and L. Francis (Sigrid Gibson, Director, Sig-Nurture Ltd., 11 Woodway, Guildford, Surrey GU1 2TF, UK), *Nutrition Bulletin*, 2015, **40** (3), 177–186].

NPARR, 6(3 & 4), 2015-228 Domestic cooking methods affect the nutritional quality of red cabbage

The aim of this work is to investigate the effects of domestic cooking methods, including steaming, microwave heating, boiling and stir-frying on the nutritional quality of red cabbage. Compared with fresh-cut red cabbage, all cooking methods were found to cause significant reduction in anthocyanin and total glucosinolates contents. Moreover, steaming resulted in significantly greater retention of vitamin C and DPPH radical-scavenging activity, while stir-frying and boiling, two popular Chinese cooking

methods, led to significant losses of total phenolic, vitamin C, DPPH radical-scavenging activity, and total soluble sugar as well as reducing sugars. Normally, red cabbage consumed fresh in salads could maintain the highest nutrition. However, considering the habits of Asian cuisine, it is recommended to use less water and less cooking time, such as steaming based on our present results, so as to retain the optimum benefits of the health-promoting compounds [Feng Xu* , Yonghua Zheng, Zhenfeng Yang, Shifeng Cao, Xingfeng Shao and Hongfei Wang (Department of Food Science and Engineering, Ningbo University, Ningbo 315211, Zhejiang, PR China), *Food Chemistry*, 2014, **161**, 162–167].

NPARR, 6(3 & 4), 2015-229 Bioavailability of calcium and its absorption inhibitors in raw and cooked green leafy vegetables commonly consumed in India – An *in vitro* study

The objectives of this research were to assess the bioavailability of calcium using equilibrium dialysis after simulated gastric

digestion method in 20 commonly consumed green leafy vegetables (GLVs) from the typical Indian diet, provide data on the content of calcium absorption inhibitors, like oxalate, phytate, tannin and dietary fibres, and evaluate the inhibitory effect of these compounds on calcium bioavailability in raw and cooked GLVs. Cooking did not affect significantly calcium bioavailability in any GLVs. *Sesbania grandiflora* had a very high content of total oxalates, tannins and dietary fibers, which reduced calcium bioavailability. Calcium content was determined by atomic absorption spectroscopy, oxalate by titrimetry, phytate and tannin by colorimetric and dietary fibres by an enzymatic gravimetric method. *Chenopodium album*, *Alternanthera philoxeroides* and *Centella asiatica*, with lower total calcium content, had nearly twice as much bioavailable calcium than other GLVs, because of low fibres, oxalate, phytate and tannin content Augustine Amalraj and Anitha Pius* (Department of Chemistry, The Gandhigram Rural Institute – Deemed University, Gandhigram, Dindigul 624 302, Tamil Nadu, India), *Food Chemistry*, 2015, **170**, 430–436].

WOOD

NPARR, 6(3 & 4), 2015-230 Effects of heat treatment on wet shear strength of plywood bonded with soybean meal-based adhesive

The aim of this study was to improve the water resistance of soybean meal-based adhesive with heat treatment after hot pressing. The effects of four different heat-treatment processes on plywood bonded with soybean meal-based adhesive were examined. Five-ply plywood specimens were fabricated to measure the adhesive's water resistance. Extending the hot press time allowed the adhesive to cure more completely and improve its water resistance. The surface and core layer wet shear strength of plywood at a 70 s/mm hot press time increased by 18.8% and 109%, respectively, compared with that of a 60 s/mm hot press time. The surface and core layer wet shear strength improved by 56.3% and 102.3%, respectively, with 4 min low pressure heat treatment, which makes it practical for use in industrial applications. Heat treatment could also improve the water resistance of the adhesive by improving the cross-linking density of the adhesive layer in plywood and releasing its interior force, according to a vertical density profile analysis. Therefore, 8 h oven drying heat treatment at 120 °C, the surface and core layer wet shear strength improved by 60.0% and 175.0%, respectively [Jing Luo , Jianlin Luo, Qiang Gao* and Jianzhang Li (MOE Key Laboratory of Wooden Material Science and Application, Beijing Forestry University, Beijing 100083, China), *Industrial Crops and Products*, 2015, **63**, 281–286].

NPARR, 6(3 & 4), 2015-231 Isolation and characterization of mold fungi and insects infecting sawmill wood, and their inhibition by gamma radiation

This article describes the isolation, identification, and characterization of wood-

rotting fungi and insects, and their inhibition was studied using gamma radiation. Products manufactured from plantation timber species are deteriorated by wood-rotting fungi such as *Hypocrea lixii*, *Fusarium proliferatum*, and *Aspergillus flavus*, and insects such as powderpost beetles. Proper preservation methods are necessary for ensuring a long service life of wood products. In this study, wood samples were treated with 2.5% copper ethanamine boron (CEB) (10% w/v) and subsequently irradiated with gamma rays (10. kGy). It was observed that CEB-treated and gamma-irradiated samples controlled fungi and powderpost beetles significantly. As wood is a dead organic material, penetration of chemicals into it is very difficult. Gamma rays easily pass through wooden objects with hidden eggs and dormant spores of insects and fungi, respectively. Gamma irradiation was proved very effective in reducing damage caused by both fungi and insects [Kalawate, A. and Mehetre, S. (Mehetre, S.; Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, India), *Radiation Physics and Chemistry*, 2015, **117**, 191-197].

NPARR, 6(3 & 4), 2015-232 Effect of microwave treatment on air permeability and preservative impregnation of *Eucalyptus tereticornis* wood

Low permeability of many wood species causes problems during timber drying as well as impregnating with preservatives and resins. In the present study, microwave treatment of *Eucalyptus tereticornis* Sm. wood which is difficult to treat, was done at 2.45 GHz frequency at different levels of intensity and radiation time. The gas permeability of *E. tereticornis* wood was measured in an in-house built apparatus. Preservative uptake/retention was tested using Acid Copper Chrome preservative by dipping method. The effect of radiation intensity and time was studied with respect to air permeability and preservative uptake. The results revealed remarkable increase in

longitudinal wood air permeability and preservative uptake with the increase of intensity and time of treatment. The results indicate that this technology could be tested and applied on pilot scale for application in wood preservation industry [Poonia, P. K*, Tripathi, S. , Sihag, K. and Kumar, S. ((Wood Preservation Discipline, Forest Products Division, Forest Research Institute, India), *Journal of the Indian Academy of Wood Science*, 2015, **12**(2), 89-93].

NPARR, 6(3 & 4), 2015-233 Open-air drying of cut and windrowed short-rotation poplar stems

Two-pass harvesting of short-rotation forestry plantations offers the opportunity to accumulate large biomass stores without occupying costly industrial areas, while letting the biomass dry before comminution. This study aimed at developing a simple model for predicting moisture content reduction of short-

rotation forestry poplar stems felled and windrowed in the field. In a controlled experiment, cut stem windrows were built and left in the field for up to 6 months (from early December to early June). Thus stored, poplar stems incurred a reduction of moisture content between 10 and 20 percent points. Drying rate varied with the period of storage, and it was faster for later felling dates. Precipitation accounted for 20 to 40 % of the drying rate. No dry matter losses due to microbial activity were recorded during the whole storage period, lasting up to 6 months. The models developed with this study are simple and robust, and allow precision management of collection operations in order to guarantee a constant flow of biomass to user plants [Civitarese, V., Spinelli, R*. , Barontini, M., Gallucci, F., Santangelo, E., Acampora, A., Scarfone, A., del Giudice, A., and Pari, L. (CNR IVALSA, Via Madonna del Piano 10, Italy), *Bioenergy Research*, 2015, **8**(4), 1614-1620].

OTHERS (incl. Cultivation, Distribution, New species, Postharvest Technologies, Packaging Technology, New technologies/Know How Developed, Book reviews, Forthcoming events)

CULTIVATION

NPARR, 6(3 & 4), 2015-234 **Key cultivation techniques for hemp in Europe and China**

Hemp (*Cannabis sativa* L.) is a multiuse, multifunctional crop that provides raw material to a large number of traditional and innovative industrial applications. A relatively simple, low input cultivation technique and the sustainability of its products are the main drivers for a future expansion of the hemp crop. In Europe, the large political support of bioenergy in recent years has fuelled numerous studies on the potential cultivation of hemp for bioenergy production. In China the main drivers for a renewed interest in hemp are its traditional applications. For any given destination, the main target of hemp cultivation is the maximization of biomass production, but each end-use destination has specific quality requirements in terms of properties of the bast fibre, characteristics of the oil and proteins in the seeds, or profile of secondary metabolites in the inflorescence.

In this paper, traditional and innovative end use destinations and cultivation systems for hemp are introduced, together with some notes on hemp botany, biology, and resource use efficiency. This information, together with a review of the practical experience of hemp cultivation in Europe and China and knowledge gathered from scientific literature, highlights the effect of agronomic factors in determining the yield potential and quality level of hemp for specific end use destinations. To conclude, future perspectives and recommendations for hemp cultivation and research are discussed [S. Amaducci*, D. Scordia, F.H. Liu, Q. Zhang, H. Guo, G. Testa, S.L. Cosentino (Istituto di

Agronomia, Genetica e Coltivazioni erbacee, Facoltà di Agraria, Università Cattolica del Sacro Cuore, Via Emilia Parmense, 84, 29122 Piacenza, Italy), *Industrial Crops and Products*, 2015, **68**, 2–16].

NPARR, 6(3 & 4), 2015-235 **Waste water reuse for fiber crops cultivation as a strategy to mitigate desertification**

Combating desertification, a marked problem in arid, semi-arid and other desertification-affected areas of the world, encompasses the management of water resources and the conservation of soil properties. Establishing vegetation on land and reuse of wastewaters in irrigation may be advantageous as a strategy to mitigate desertification and biodiversity loss. In this context, fiber crop production under wastewater irrigation is reviewed, with the aim of identifying prospects and limitations. Reports of laboratory, pilot and field research indicate that bast and grass fiber crops show potential simultaneously to deliver high yields, restore soil properties and promote water quality improvement. Their production in water-scarce regions could provide environmental benefits and social and economic opportunities, safeguarding freshwater resources. Nevertheless, this practice has environmental and social concerns due to the presence of harmful substances in wastewater. Several technical and economic barriers should also be considered when designing and managing a system, such as wastewater quality, and the quantity and quality of biomass produced. In order to promote the sustainable reuse of wastewater for irrigation of fiber crops, further research is needed, factoring in issues such as yields, inputs and costs, as well as potential environmental and socio-economic impacts. It is recommended that site-specific factors should be accurately assessed to evaluate the adequacy among crop, location and wastewater irrigation, in order to overcome negative impacts and public rejection [Bruno Barbosa, Jorge Costa, Ana Luisa Fernando* and

Eleni G. Papazoglou (UBIA, Departamento de Ciências e Tecnologia da Biomassa, Faculdade de Ciências e Tecnologia, FCT, Universidade Nova de Lisboa, Campus de Caparica, 2829-516 Caparica, Portugal), *Industrial Crops and Products*, 2015, **68**, 17–23].

NPARR, 6(3 & 4), 2015-236 **Bio-inoculants and vermicompost influence on yield, quality of *Andrographis paniculata*, and soil properties**

Andrographis paniculata is a source of diterpenoids and 2'-oxygenated flavonoids, which are of utility in pharmaceutical industry and ayurvedic formulations. With the aim of producing quality herb, an experiment was conducted with different combinations of bio-inoculants and vermicompost (VC) in controlled condition. It was observed that the highest Leaf: Stem (L:S) ratio, fresh herb yield and andrographolide yield (0.82, 300 g pot⁻¹ and 29.8 g kg⁻¹ dry herb, respectively) was recorded when the soil was incorporated with VC along with *Azotobacter chroococcum* (T₃). Further there was a significant improvement in all soil fertility parameters. However, when all the bio-inoculants (*A. chroococcum* + *Bacillus megaterium* + *Pseudomonas monteilii* + *Glomus intraradices*) were mixed with VC, there was a significant improvement in soil dehydrogenase, alkaline and acidic phosphatase activity. A positive correlation coefficient ($p < 0.01$) could be derived amongst plant growth, yield and soil properties ($r = 0.45$ – 0.85). The study suggests that application of the bio-inoculants and organic fertilizers can enhance productivity while maintaining the desired quality of the herb [Khushboo Khan, Umesh Pankaj, Sanjeet K Verma, Anand K Gupta, Raksh Pal

Singh and Rajesh Kumar Verma (CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow 226015, India), *Industrial Crops and Products*, 2015, **70**, 404–409].

NPARR, 6(3 & 4), 2015-237 **Cultivation of four microalgae for biomass and oil production using a two-stage culture strategy with salt stress**

A two-stage culture strategy was used for maximum biomass production under nutrient-sufficient conditions, followed by cultivation under low-salt stress, to cause the accumulation of oil in the biomass. Controlled conditions of nitrate, salt concentration, and time to exposure to stress were optimized for oil production with four species of microalgae, *Isochrysis galbana*, *Nannochloropsis oculata*, *Dunaliella salina*, and *Dunaliella tertiolecta*. Using conditions with addition of nitrate to 24.0 mg/L, *I. galbana* and *N. oculata* showed higher biomass productions than *D. salina* and *D. tertiolecta*. The oil contents of the microalgae increased from 24.0% to 47.0% in *I. galbana* with 10 psu for 2 days, from 17.0% to 29.0% in *N. oculata* with 0 psu for 3 days, from 22.0% to 43.0% of *D. salina* with 10 psu for 1 day, and from 23.0% to 40.0% (w/w) in *D. tertiolecta* with 0 psu for 2 days as the second stage culture with low-salt stress. Thus, *I. galbana* could be a suitable candidate microalga for oil production [Chae Hun Ra, Chang-Han Kang, Na Kyoung Kim, Choul-Gyun Lee and Sung-Koo Kim* (Department of Biotechnology, Pukyong National University, Busan 608-737, Republic of Korea), *Renewable Energy*, 2015, **80**, 117–122].

POSTHARVEST TECHNOLOGY

NPARR, 6(3 & 4), 2015-238 Effects of a composite chitosan–gelatin edible coating on postharvest quality and storability of red bell peppers

For the first time, a composite chitosan–gelatin (CH–GL) coating was applied to peppers and its effects on fruit quality and storability were examined. Pure chitosan (CH) and gelatin (GL) coatings were studied for comparison. The CH coating inhibited microbial spoilage and prolonged the possible storage period. The GL coating contributed to fruit firmness, but did not allow for prolonged storage. The composite CH–GL coating was associated with a two-fold decrease in microbial decay, significantly ($p \leq 0.05$) enhanced fruit texture and prolonged the possible period of cold storage up to 21 days and fruit shelf-life up to 14 days, without affecting the respiration or nutritional content of the fruit [Elena Poverenov*, Yana Zaitsev, Hadar Arnon, Rina Granit, Sharon Alkalai-Tuvia, Yaacov Perzelan, Tamar Weinberg, Elazar Fallik (The Institute of Postharvest and Food Science, ARO, the Volcani Center, P.O. Box 6, Bet Dagan 50250, Israel), *Postharvest Biology and Technology*, 2014, **96**, 106–109].

NPARR, 6(3 & 4), 2015-239 Reduction of postharvest anthracnose and enhancement of disease resistance in ripening mango fruit by nitric oxide treatment

Nitric oxide (NO) acts as an important signal molecule with diverse physiological functions in plants. In this study we investigated the effects and possible mechanisms of exogenous NO on anthracnose caused by *Colletotrichum gloeosporioides* in mango fruit. ‘Guifei’ mango fruit were treated with NO donor (sodium nitroprusside of 0.1 mM) at 25 °C for 5 min, inoculated with spore suspension of *C. gloeosporioides* after 24 h of NO treatment, and stored at ambient temperature (25 °C). NO treatment effectively suppressed lesion

development on mango fruit inoculated with *C. gloeosporioides*, and lesion diameters at 2 through 8 d in NO-treated fruit averaged 30% lower than those in control fruit. Additionally, NO treatment reduced natural anthracnose incidence and severity of mango fruit ripened at ambient temperature, and the values of both parameters from 4 to 10 d of storage in NO-treated fruit averaged 40 and 45% lower, respectively, than those for control fruit. NO did not exhibit *in vitro* antifungal activity against *C. gloeosporioides*. NO treatment enhanced the activities of defense-related enzymes including phenylalanine ammonia-lyase (PAL), cinnamate-hydroxylase (C4H), 4-coumarate: CoA ligase (4CL), peroxidase (POD), β -1,3-glucanase (GLU) and chitinase (CHT). NO treatment also promoted the accumulation of total phenolics, flavonoids and lignin that might contribute to inhibition of the pathogen. In addition to antifungal efficacy, NO treatment delayed flesh softening, yellowing, and changes in soluble solids content (SSC) and titratable acidity (TA), and peaks of respiration rate and ethylene production during ripening. These results suggest that the resistance of NO-treated mango to anthracnose may be attributed to activation of defense responses as well as delay of ripening [Meijiao Hu, Dongping Yang, Donald J. Huber, Yueming Jiang, Min Li, Zhaoyin Gao and Zhengke Zhang*(Environment and Plant Protection Institute, Chinese Academy of Tropical Agricultural Sciences, Haikou 571101, PR China), *Postharvest Biology and Technology*, 2014, **97**, 115–122].

NPARR, 6(3 & 4), 2015-240 Vitamin C in broccoli (*Brassica oleracea* L. var. *italica*) flower buds as affected by postharvest light, UV-B irradiation and temperature

The changes in vitamin C, l-ascorbic acid (AA) and l-dehydroascorbic acid (DHA) levels in broccoli flower buds were examined during pre-storage and storage periods, simulating

refrigerated transport with wholesale distribution and retail, respectively. Broccoli heads were pre-stored for 4 or 7 days at 0 °C or 4 °C in the dark and then stored for 3 days at 10 °C or 18 °C. During storage the broccoli heads were exposed for 12 h per day to three different levels of visible light (13, 19 or 25 $\mu\text{mol m}^{-2} \text{s}^{-1}$) or a combination of visible light (19 $\mu\text{mol m}^{-2} \text{s}^{-1}$) and UV-B irradiation (20 $\text{kJ m}^{-2} \text{d}^{-1}$), or they were stored in the dark. The vitamin C content in broccoli flower buds during storage was significantly affected by pre-storage period and temperature. Higher vitamin C levels in flower buds after storage were observed for broccoli heads pre-stored for 4 days or at 0 °C as compared to those pre-stored for 7 days or at 4 °C. Storage temperature also affected vitamin C in broccoli flower buds, with higher levels observed for broccoli stored at 10 °C than at 18 °C. Hence, vitamin C in broccoli flower buds was demonstrated to decrease together with increasing pre-storage period, pre-storage temperature and storage temperature. AA in broccoli flower buds was influenced mainly by storage temperature and to a minor extent by pre-storage temperature. The DHA level and DHA/AA ratio were stable in flower buds of broccoli pre-stored for 7 days, whereas increasing tendencies for both DHA level and ratio were observed after pre-storage for 4 days. These results indicate a shift in the ascorbate metabolism in broccoli flower buds during storage at low temperatures, with its higher rate observed for broccoli pre-stored for shorter time. There were no effects of the light and UV-B irradiation treatments on vitamin C, AA and DHA levels in broccoli flower buds [Anna Rybarczyk-Plonska*, Magnor Kåre Hansen, Anne-Berit Wold, Sidsel Fiskaa Hagen, Grethe Iren A. Borge Gunnar B. Bengtsson (Department of Plant Sciences, Norwegian University of Life Sciences, PB 5003, NO-1432 Aas, Norway), *Postharvest Biology and Technology*, 2014, **98**, 82–89].

NPARR, 6(3 & 4), 2015-241 **Effect of bacteriocin-incorporated alginate coating on**

shelf-life of minimally processed papaya (*Carica papaya* L.)

Alginate coatings can act as carriers of antimicrobials to prolong the shelf stability of minimally processed fruit. Different concentrations of alginate (1, 1.5, 2% (w/v)) incorporated with bacteriocin (0, 20% (v/v)) as a coating material of minimally processed papaya were evaluated for quality parameters viz. firmness, weight loss, colour, head space gas composition, acidity, total soluble solids and microbial load for a period of 21 days. After 21 days of incubation, coated and uncoated samples showed decreases in O₂ levels and acidity percentage which were 1.8 and 2.7 times more in uncoated as compared to the coated samples, respectively. The level of CO₂ increase was 1.7 times higher in uncoated samples as compared to the coated samples. High respiration rate in uncoated samples led to increases in TSS values, firmness and weight loss. On the other hand, the alginate coating (with or without bacteriocin) acted as a barrier to water vapour transmission and gas exchange, which hindered changes in TSS values, firmness and weight loss in coated samples, which were 3.8, 8.7 and 7.4 times less than for the uncoated samples, respectively. Decreases in 'b' and increases in 'a' values were more pronounced in the case of controls and became less prominent with the alginate coating. A decrease in 'b' values and concomitant increase in 'a' values was due to the change from yellow to red colour, indicating ripening of papaya. Microbial counts by the end of the storage period in the alginate coated sample incorporating bacteriocin were 10³ CFU/g as compared to 10⁷ CFU/g in the case of the control. Alginate (2% (w/w)) with bacteriocin could be used to store minimally processed papaya for 3 weeks without compromising physico-chemical qualities or microbial safety [K. Narsaiah* , Robin A. Wilson, K. Gokul, H.M. Mandge, S.N. Jha, Sheetal Bhadwal, Rahul K. Anurag, R.K. Malik and S. Vij (Central Institute of Post-harvest

Engineering and Technology, Ludhiana, India), *Postharvest Biology and Technology*, 2015, **100**, 212–218].

NPARR, 6(3 & 4), 2015-242 Storage at low temperature differentially affects the colour and carotenoid composition of two cultivars of banana

Different storage conditions can induce changes in the colour and carotenoid profiles and levels in some fruits. The goal of this work was to evaluate the influence of low temperature storage on the colour and carotenoid synthesis in two banana cultivars: Prata and Nanicão. For this purpose, the carotenoids from the banana pulp were determined by HPLC–DAD–MS/MS, and the colour of the banana skin was determined by a colorimeter method. Ten carotenoids were identified, of which the major carotenoids were all-*trans*-lutein, all-*trans*- α -carotene and all-*trans*- β -carotene in both cultivars. The effect of the low temperatures was subjected to linear regression analysis. In cv. Prata, all-*trans*- α -carotene and all-*trans*- β -carotene were significantly affected by low temperature ($p < 0.01$), with negative estimated values (β coefficients) indicating that during cold storage conditions, the concentrations of these carotenoids tended to decrease. In cv. Nanicão, no carotenoid was significantly affected by cold storage ($p > 0.05$). The accumulation of carotenoids in this group may be because the metabolic pathways using these carotenoids were affected by storage at low temperatures. The colour of the fruits was not negatively affected by the low temperatures ($p > 0.05$) [Heliofabia Virginia De Vasconcelos Facundo*, Poliana Deyse Gurak, Adriana Zerlotti Mercadante, Franco Maria Lajolo and Beatriz Rosana Cordenunsi (Department of Food Science and Experimental Nutrition, University of São Paulo, Av. Prof. Lineu Prestes, 580, Bloco 14, São Paulo, SP 05508-900, Brazil), *Food Chemistry*, 2015, **170**, 102–109].

NPARR, 6(3 & 4), 2015-243 Impact of edible chitosan–cassava starch coatings enriched with *Lippia gracilis* Schauer genotype mixtures on the shelf life of guavas (*Psidium guajava* L.) during storage at room temperature

The effect of edible chitosan–cassava starch (CH–CS) coatings containing a mixture of *Lippia gracilis* Schauer genotypes (EOM) on the shelf life of guavas during storage at room temperature for 10 days was studied. Sixteen formulations were prepared with a range of chitosan and essential oil mixtures concentrations, and the *in vitro* antimicrobial activity was tested. Formulations containing 2.0% cassava starch, 2.0% chitosan and 1.0%, 2.0% or 3.0% EOM were most effective in inhibiting the growth of the majority of bacteria. The edible CH–CS coating and CH–CS with 1.0% (CH–CS–EOM1) or 3.0% EOM (CH–CS–EOM3) were added to guavas and the shelf life was evaluated. On the tenth day of storage, total aerobic mesophilic bacteria and mould and yeast counts were statistically lower ($p < 0.05$) in the CH–CS–EOM1- or CH–CS–EOM3-coated fruits than CH–CS-coated fruits. In addition, fruits coated with CH–CS or CH–CS–EOM showed no significant changes of total soluble solids content, while CH–CS–EOM-coated fruits showed lower titratable acidity than CH–CS-coated fruits at the end of storage. CH–CS–EOM3-coated guavas showed lower a^* and b^* values and higher L^* and hue values than those with other coatings [Alana Bezerra de Aquino^a, Arie Fitzgerald Blank and Luciana Cristina Lins de Aquino Santana* (Department of Food Technology, Laboratory of Food Microbiology, Federal University of Sergipe, Av. Marechal Rondon, S/N, São Cristóvão, Sergipe CEP 49100-000, Brazil), *Food Chemistry*, 2015, **171**, 108–116].

NPARR, 6(3 & 4), 2015-244 Enzymatic browning and antioxidant activities in

harvested litchi fruit as influenced by apple polyphenols

'Guiwei' litchi fruit were treated with 5 g a.i. L⁻¹ apple polyphenols (APP) and then stored at 25 °C to investigate the effects on pericarp browning. APP treatment effectively reduced pericarp browning and retarded the loss of red colour. APP-treated fruit exhibited higher levels of anthocyanins and cyanidin-3-rutinoside, which correlated with suppressed anthocyanase activity. APP treatment also maintained membrane integrity and reduced oxidative damage, as indicated by a lower relative leakage rate, malondialdehyde content, and reactive oxygen species (ROS) generation. The data suggest that decompartmentalisation of

peroxidase and polyphenoloxidase and respective browning substrates was reduced. In addition, APP treatment enhanced the activities of antioxidant enzymes (superoxide dismutase, catalase, ascorbate peroxidase and glutathione reductase), as well as non-enzymatic antioxidant capacity (DPPH radical-scavenging activity and reducing power), which might be beneficial in scavenging ROS. It is proposed that APP treatment is a promising safe strategy for controlling postharvest browning of litchi fruit [Zhengke Zhang, Donald J. Huber, Hongxia Qu, Ze Yun, Hui Wang, Zihui Huang, Hua Huang and Yueming Jiang* (South China Botanical Garden, Chinese Academy of Sciences, Guangzhou 510650, PR China), *Food Chemistry*, 2015, **171**, 191–199].

Forthcoming Conferences, Seminars, Exhibitions and Trainings

1. Pharmaceutical Summit and Expo, 8th to 10th October 2015, New Delhi, India, Website: <http://global.pharmaceuticalconferences.com/index.php>
2. International Conference on Natural Products and Exhibition - INCONPE-2015, 8th to 10th October 2015, Namakkal, Tamil Nadu, India; Website: <http://www.mypadacademia.com/inconpe2015>
3. 7th Indo-Global Summit and Expo on Food & Beverages, 8th to 10th October 2015, New Delhi, India; Website: <http://food.indoglobalsummit.com/>
4. International Congress on Information and Communication Technology (ICICT - 2015), 9th to 10th October 2015, Udaipur (Rajasthan), Rajasthan, India; Website: <http://csi-udaipur.org/icict-2015/index.php>
5. National Conference On Innovative Research in Agriculture, Food Science, Forestry, Horticulture, Aquaculture, Animal Sciences, Biodiversity, Environmental Engineering and Climate Change (AFHABEC-2015), 17th to 18th October 2015; New Delhi, Delhi, India; Website: <http://krishisanskriti.org/afhabec.html>
6. Current Scenario and Future Prospects of Biotechnology in Diverse Sectors (CSFPB-2015), 22nd to 24th October 2015, Sathyamangalam-Erode, Tamil Nadu, India; Website: <http://www.bitsathy.ac.in/csfpb2015/>
7. 3rd International Conference and Exhibition on Pharmacognosy, Phytochemistry & Natural Products during October 26- 28, 2015, Hyderabad, India; Website: <http://pharmacognosy-phytochemistry-natural-products.pharmaceuticalconferences.com/>
8. Indo-Global Summit and Expo on Veterinary-2015, 26th to 28th October 2015, Hyderabad, N/A, India; Website: <http://veterinary.indoglobalsummit.com/>
9. 5-Days Hands-on Workshop on Molecular Biotechnology and Bioinformatics; 26th to 30th October 2015, Pune, Maharashtra, India; Website: <http://icsccb.org/workshops/biotech-bioinfo-workshop/>
10. National Conference on Recent Trends in Biomedical Engineering, Cancer Biology, Bioinformatics and Applied Biotechnology (BECBAB-2015), 31st to 31st October 2015; New Delhi, Delhi, India, Website: <http://krishisanskriti.org/beccbab.html>
11. National Conference on Indian Botanic Gardens, 18th to 20th November 2015, Lucknow, Uttar Pradesh, India, Website: <http://nbri.res.in/conference.php>
12. 3rd International Conference on Environmental Friendly Agriculture & Horticulture in Planning of a Smart City, Conference, 12th to 14th December 2015, Bhopal, Madhya Pradesh, India; Website: <http://www.efahpsc2015.com>

ANNOUNCEMENTS

INDIAN JOURNAL OF NATURAL PRODUCTS AND RESOURCES

Original research Papers and Reviews on topics dealt within this repository are invited for publication in peer reviewed, quarterly journal (March, June, September and December), *Indian Journal of Natural Products and Resources* (Formerly known as *Natural Product Radiance*). For details visit: nopr@niscair.res.in. The papers may be sent to Dr (Mrs) Sunita Garg, Editor Periodicals Division, National Institute of Science Communication and Information Resources (NISCAIR), CSIR, Dr K. S. Krishnan Marg (Inside Pusa Campus). New Delhi-110012; Phone: (091)-11-25846001, (091)-11-25846304-07, Ext.258, 255. Fax: (091)-11-2584 7062. E-mail: sunitag@niscair.res.in; ijnpr@niscair.res.in

RAW MATERIALS HERBARIUM AND MUSEUM DELHI (RHMD)

Herbarium is a repository of dried specimens of plants collected from far and wide and is arranged in a systematic order. Plant specimens in herbaria and their raw material samples serve as reference materials for any plant-based research and as source materials for information on utilization, conservation, planning and management. The herbarium specimens have become resources for generating the profiles of chemical constituents and DNA fingerprinting. The herbarium specimens could be used as standard reference materials while identifying the plant specimens and the crude drug samples. Further, the herbaria could provide information on folk-lore, ethnomedicine or traditional medicine from which new medicines could be evolved.

Because of wide spread belief that herbal medicines are safer than synthetic drugs, demand for Indian medicinal plants has increased many fold in the national and international markets. Due to high demand but limited cultivation of medicinal plants in India, more than 95 per cent plants are being harvested from the wild. Consequently there is gap in demand and supply, therefore, the collectors and traders involved in commercialization of medicinal plants often mix other related plant materials to the genuine one or an altogether a distinct plant material is sold in the market in place of genuine one. Thus usage of such adulterated or spurious raw material for manufacturing medicine affects the efficacy of the finished product and could cause deleterious effect on human health.

Considering the demand for natural products including medicines and other products for various purposes, universities, colleges, institutes and various other R & D labs are focusing on research works especially pharmacological, phytochemical and ethnobotanical studies. First and foremost requisite for these findings is the correct identification of the plant/crude drug collection, preservation and identification. It is a fact that without correct name literature search is incomplete. Therefore, before starting actual R & D work, researchers need to have correct identification and nomenclature of the plant specimen for any novel finding or to validate an ethnobotanical report.

While starting the revised series of The Wealth of India-An Encyclopaedic Dictionary of Indian Raw Materials in 1978, National Institute of Science Communication and Information Resources (NISCAIR), formerly known as NISCOM, a constituent establishment of Council of Scientific Industrial Research (CSIR), has set up a Raw Materials Herbarium & Museum, housing authentic

samples of economically important raw materials of plant, animal and mineral origin of India as a whole, in one place, to disseminate and showcase knowledge on these resources through authenticated collection of samples, herbarium sheets borrowed and collected from fields from throughout India. It is open to the scientists, researchers, industries, entrepreneurs, traders, students and the public. **The NISCAIR Herbarium & Museum was assigned the acronym RHMD (Raw Materials Herbarium & Museum, Delhi) by the International Association for Plant Taxonomy and it appeared in the publication "Index Herbarium, New York, USA" (1990).** The RHMD houses over 8000 specimens comprising more than 5000 species of economic and medicinal plants of India and the Museum containing over 3500 samples of crude-drugs, animal and mineral specimens.

The facility backed up by the knowledge stored in the Wealth of India, is a veritable storehouse of information on the raw materials of India, and is a place useful to students to gain knowledge on economic biology and geology.