

### Use of carrot juice and tomato juice as natural precursors for enhanced production of ubiquinone-10 by *Pseudomonas diminuta* NCIM 2865

Ubiquinone-10 (CoQ10) plays an essential role in the electron transport system, and has been extensively used in food and pharmaceutical industries. Researchers working at Food Engineering and Technology Department, Institute of Chemical Technology, University of Mumbai, Mumbai, India reports on the use of statistical approach and natural precursors for enhanced production of CoQ10 using *Pseudomonas diminuta* NCIM 2865. Primarily, significance of each medium component with respect to

CoQ10 production was identified by Plackett–Burman design. In the second step, concentration of most significant factors and their interaction was studied with response surface methodology (RSM). CoQ10 production increased considerably from 6.68 to 15.58 mg/l when the fermentation was carried out in the RSM optimised medium. Carrot juice and tomato juice acted as natural precursors, and enhanced the yield of CoQ10 from 15.58 to 29.22 mg/l and 24.35 mg/l, respectively.

Thus, an integrated approach of using statistical techniques and natural precursors could enhance the yield of CoQ10 by *P. diminuta* NCIM 2865. The study indicated both carrot juice and tomato juice to act as natural precursors for CoQ10 production, although the results were higher with carrot juice [Bule Mahesh V and Singhal Rekha S, Use of carrot juice and tomato juice as natural precursors for enhanced production of ubiquinone-10 by *Pseudomonas diminuta* NCIM 2865, *Food Chem*, 2009, **116** (1), 302-305].

### Simultaneous analysis of anthocyanins and flavonols in petals of lotus (*Nelumbo*) cultivars

Lotus, also known as *Nelumbo*, is a perennial aquatic herb, which consists of two species, *N. nucifera* Gaertn. and *N. lutea* (Willd.) Pers. based on the morphological characters. It is one of the most important ornamental and economic plants grown widely in Asia, Australia and North America. A fast and reliable HPLC method for the simultaneous separation of anthocyanins and flavonols in lotus petals was developed by scientists at China based on the study of four candidate solvent systems. Fifteen flavonoids were identified by high-performance liquid chromatography with photodiode array

detection/mass spectrometry. Among them, two anthocyanins and nine flavonols were discovered in lotus petals for the first time. This work is valuable for both the hybrid breeding on lotus oriented to flower colour and the utilization of lotus petals as functional food materials.

This work is indispensable for investigating the composition of anthocyanins and flavonols in hundreds of lotus cultivars. The feature of high sample throughput significantly reduces the workload as well as procedure cost of analyzing flower pigments from different lotus cultivars. With the anthocyanins and

flavonols composition data, we could develop a HPLC fingerprinting database of lotus cultivars to solve headachy problems about synonyms and homonyms. Meanwhile, we could select species or cultivars rich in delphinidin, cyanidin, malvidin or quercetin derivatives for functional food materials, such as lotus liquor and lotus tea. It is also a contribution to our understanding of flavonoid biosynthesis, which could obviously help the hybrid breeding of lotus oriented to flower colour by providing guidelines on selecting appropriate parents for breeding new cultivars with novel

flower colours [Yang Rui-Zhen, Wei Xiao-Lei, Gao Fen-Fang, Wang Liang-Sheng, Zhang Hui-Jin, Xu Yan-Jun, Li Chong-Hui, Yu- Ge Xuan, Zhang

Jing-Jing and Zhang Jie, Simultaneous analysis of anthocyanins and flavonols in petals of lotus (*Nelumbo*) cultivars by high-performance liquid

chromatography-photodiode array detection/electrospray ionization mass spectrometry, *J Chromatogr A*, 2009, **1216** (1), 106-112].

## Impact of texturing using instant pressure drop treatment prior to solvent extraction of anthocyanins from Malaysian Roselle

*Hibiscus sabdariffa* Linn., commonly known as Roselle or Red Sorrel, is widely grown in Central and West Africa and South-East Asia. The red and fleshy cup-shaped flower calyces are consumed worldwide as a cold beverage or a hot drink. These extracts are also used in folk medicine to treat many complaints that include high blood pressure, liver disease and fever. The positive physiological effect of this plant extract could be related to the presence of anthocyanins with a potent antioxidant activity.

Because of the natural structure of plants, which oppose resistance to penetration by any liquid, solvent

extraction is very slow. The kinetics involves multiple serial steps and generally internal diffusion is the limiting process. To improve the technological aptitude, and intensify solvent extraction, scientists working at University of La Rochelle-Pole Science and Technology, La Rochelle, France propose to submit plants to a treatment by thermo-mechanical Instant Controlled Pressure Drop (DIC), in order to ensure the expansion of the plant structure. They present the results of a study concerning the effect of DIC treatment on the extraction of Roselle anthocyanins. By identifying the effect of various operative parameters, they found that an appropriate DIC treatment

improved both the kinetics and yield of extraction of anthocyanins from Roselle calyces. By studying extraction kinetics, they identified and quantified the effective diffusivity, which ranged from  $4.62$  to  $6.11 \times 10^{-11} \text{ m}^2/\text{s}$  for DIC treated material compared with  $4.19 \times 10^{-11} \text{ m}^2/\text{s}$  for raw material. In conclusion, the data obtained in the present work have demonstrated that DIC treatment has a great impact on the kinetics and the extraction yield of anthocyanins from the dried calyces of Roselle [Amor B Ben and Allaf K, Impact of texturing using instant pressure drop treatment prior to solvent extraction of anthocyanins from Malaysian Roselle (*Hibiscus sabdariffa*), *Food Chem*, 2009, **115** (3), 820-825].

## Production of a red-purple food colorant from *Opuntia stricta* (Haw.) Haw. fruits by spray drying

*Opuntia stricta* (Haw.) Haw. fruit juice is a potential source of betacyanin pigments which can be used as a natural red-purple food colorant. A powder food colorant was obtained in a study conducted by scientists at Spain by co-current spray drying of *O. stricta* fruit juices with a bench-scale two fluid nozzle spray dryer. Glucose syrup (DE 29) was used as drying aid. Optimum conditions for spray drying were: juice content

(20% v/v; 1.2°Brix), glucose syrup content (10% w/v), liquid feed rate (0.72 l/h), spray air flow-rate (0.47 m<sup>3</sup>/h), drying air flow-rate (36 m<sup>3</sup>/h), and inlet drying air temperature 160°C. Colour was retained during the drying process (>98%) and drying yield was high (58%). The powder colorant showed high colour strength (4.0), which is stable when stored at room temperature for one month. This colorant was successfully applied in two

food model systems: yoghurt and soft-drink. Food presented a vivid red-purple tonality very attractive for consumers that was maintained after one month under refrigeration (4°C) ( $\Delta E < 5$ ) [Obón JM, Castellar MR, Alacid M and Fernández-López JA, Production of a red-purple food colorant from *Opuntia stricta* fruits by spray drying and its application in food model systems, *J Food Eng*, 2009, **90** (4), 471-479].

## Synthesis and chemical characterisation of curcuminoid colouring principles

Curcumin is the principal colour present in the Turmeric plant (*Curcuma domestica* Val.), the dried and ground rhizome of which is used as a spice. Turmeric preparations are also used to treat a variety of disorders, which has generated a great deal of scientific interest in their pharmacological properties and biological effects. Curcumin colour is essentially comprised the major diferoylmethane pigment curcumin along with its demethoxy (DEMC) and bisdemethoxy (BDMC) analogues. Curcumin has an intense yellow colour and is insoluble in water and in ether, is degraded in alkaline solution and is

unstable to light, a factor that usually limits its applications in foods.

The three major colour principles of curcumin have been synthesized, purified and chemically characterized by a researcher working at Department of Environmental, Food and Rural Affairs, York, UK using nuclear magnetic resonance spectroscopy, absorption spectroscopy, high-performance liquid chromatography and liquid chromatography-mass spectrometry. System suitability criteria for the simultaneous determination of the curcuminoids and annatto colorant (bixin and norbixin) by HPLC are presented and

the importance of the water content of sample extracts discussed. The results showed that synthetic curcuminoids may be synthesized with sufficient purity for use as standards for HPLC analysis provided that both the spectrophotometric and chromatographic purities are known. The potential for their use in the determination of turmeric and/or added curcumin colour (with annatto) in foods and especially fish is discussed [Michael J Scotter, Synthesis and chemical characterisation of curcuminoid colouring principles for their potential use as HPLC standards for the determination of curcumin colour in foods, *LWT-Food Sci Technol*, 2009, 42 (8), 1345-1351].

## Colour, pH stability and antioxidant activity of anthocyanin rutinosides isolated from Tamarillo fruit (*Solanum betaceum* Cav.)

In Colombia, the Tamarillo or Tree tomato (*Solanum betaceum* Cav.) is a promising product for export, due to its colour; the red variety has been the most accepted internationally. In a study by scientists at Colombia and Spain the stability of tamarillo fruit extracts and isolated individual anthocyanin rutinosides to pH changes has been evaluated by means of colorimetric studies, to obtain more precise information about the change of colour in both crude extracts and individual anthocyanins.

Changes in colour and stability of anthocyanins have been evaluated over pH range 2.0-8.7. The study was made on

crude extract (XAD-7 Amberlite-retained fraction) as well as on the following pure pigments isolated from tamarillo fruit: delphinidin 3-O-(6'-O- $\alpha$ -rhamnopyranosyl- $\beta$ -glucopyranosyl)-3'-O- $\beta$ -glucopyranoside, delphinidin 3-O-(6''-O- $\alpha$ -rhamnopyranosyl)- $\beta$ -glucopyranoside, cyanidin 3-O-(6''-O- $\alpha$ -rhamnopyranosyl)- $\beta$ -glucopyranoside and pelargonidin 3-O-(6''-O- $\alpha$ -rhamnopyranosyl)- $\beta$ -glucopyranoside. The relationships between the colour and the hydroxylation degree of the B ring and the pH have been studied for the first time on rutinosides. The peel extract showed much more colour stability than the jelly extract at all the

pH values studied. The replacement of the 3'-OH with a glycosyl group increased the stability of the colour to pH changes, although this substitution yields a less colourful (higher  $L^*$  and lower  $C_{ab}$  compound (Dp 3-rut-3'-glc), having both hypsochromic and hypochromic shifts relative to the non-glycosylated molecule (Dp 3-rut). Moreover, the influence of the hydroxylation degree of the B ring on the quality and stability of colour, as well as on the antioxidant activity, was determined.

A relationship between antioxidant activities *in vitro* and phenolic contents has been observed in

crude extracts; however, whether this antioxidant potential has an effective role *in vitro* remains to be demonstrated. This study shows the potential value of these extracts as antioxidants and in the improvement of nutritional value of foods

and their preservation. Furthermore, the possible use of the peelings (usually waste material) for the production of anthocyanins or natural antioxidant extracts can provide some economic benefits and added value to this material

[Hurtado Nelson H, Morales Alicia L, González-Miret M Lourdes, Escudero-Gilete M Luisa and Francisco J Heredia, Colour, pH stability and antioxidant activity of anthocyanin rutinosides isolated from tamarillo fruit (*Solanum betaceum* Cav.), *Food Chem*, 2009, **117** (1), 88-93].

## Food-grade pigments from *Streptomyces* sp. isolated from the marine sponge

The number of approved colorants for food industry is limited. Some approved food colorants are known by their chemical name (canthaxanthin) while others are known by source (fruit juice or vegetable juice). The biocolorants identified by their chemical name can be synthesised easily by cheaper biotechnological sources. Biotechnology may play a crucial role for large fermentation of natural biocolorants. Technological limitations are the major bottleneck for the commercial exploitation of the source materials. The success of any pigment produced by fermentation depends upon its acceptability in the market, regulatory approval, and the size of the capital investment required in bringing the

product to market. The sponge-associated *Streptomyces* isolate (AQBWWS1), which on fluorescent light exposure, exhibited carotenoid production. If these symbiotic *Streptomyces* strains, from which secondary metabolites like carotenoids are derived, can be cultured under light, these could be used for mass production of pigments which can then be incorporated as food colorant and also as a feed additive for the growth and coloration of ornamental fishes.

In *Streptomyces*, carotenoid production occurs in constitutive, light-dependent or cryptic manner. In a study conducted by scientists at India, it has been found that *Streptomyces* strain (AQBWWS1) of white series isolated from the marine sponge *Callyspongia*

*diffusa*, on fermentation under fluorescent white light produced food-grade pigments (carotenoids). Spectrophotometric analysis of the carotenoid fraction revealed two peaks at 445 and 471 nm. TLC analysis of the carotenoid extract showed the presence of lycopene ( $R_f$  of 0.40) and an unidentified pigment ( $R_f$  of 0.35). HPLC confirmed the production of lycopene and an unidentified pigment. Further work on mass production of these food-grade pigments (carotenoids) and its usage as food colorant and feed additive have to be studied [Dharmaraj Selvakumar, Ashokkumar B and Dhevendaran K, Food-grade pigments from *Streptomyces* sp. isolated from the marine sponge *Callyspongia diffusa*, *Food Res Int*, 2009, **42** (4), 487-492].

## New dyeing technique for enhancing colour strength and fastness properties of cotton fabric dyed with natural dyes

Dyeing behaviour of four different natural dyes extracted from the leaves collected in a sustainable manner from respective dye containing plants [*Meyna laxiflora* Robyns (*Helu*), *Maba angustifolia* Miq. (*Kalindrin*), *Wendlandia thyrsoidea* Steud. (*Shevara*) and *Eupatorium*

*repandum* Willd. (*Ranmodi*)] has been studied on cotton fabric by researchers working at Central Institute for Research on Cotton Technology, Mumbai, India. A novel and eco-friendly mordanting technique has been devised for creating aluminium-tannate complex on cotton matrix. The new mordanting

technique not only involves application of a modified sequence of mordanting chemicals but also employs addition of specific salts in water used in the dyeing process. The dyeing of the mordanted fabric has been carried out under acidic and alkaline conditions at different temperatures. The modified dyeing

technique shows an overall improvement of 140-300% in colour strength along with the excellent fastness properties, such as washing, rubbing, perspiration and light. The overall results indicate that all the

four natural dyes can be effectively and economically used for dyeing on cotton fabric. The entire chain of collection, extraction and dyeing methodology is environmentally and ecologically

compatible [Mahangade RR, Varadarajan PV, Verma JK and Bosco H, New dyeing technique for enhancing colour strength and fastness properties of cotton fabric dyed with natural dyes, *Indian J Fibre Text Res*, 2009, **34** (3), 279-282].

### Extraction of phenolic compounds from Elder berry and different Grape marc varieties

Optimal operating conditions for the extraction of phenolic compounds from grape marc and Elder berry have been investigated by researchers working at University of Maribor, Faculty of Chemistry and Chemical Engineering, Smetanova, Maribor, Slovenia. The aim of the study was to obtain extracts with high anthocyanin content, which show stability during storage and would be potentially interesting for commercial applications as natural colorants. For this purpose three varieties of grape marc, native to Slovenia ('Refošk', 'Merlot' and 'Cabernet'), were studied. The results were compared with the extraction of elder berry, which is known for its high anthocyanin content. Single-step batch extractions were performed with ethanol, ethyl-acetate and

acetone in different ratios with water. Temperatures of 20, 40 and 60 °C were applied. Influence of the change in pH values of the extraction media was investigated regarding the yield and degradation of anthocyanins. Two-step extractions, combining supercritical fluid extractions (SFE) and conventional batch extractions, were applied. The most efficient conventional solvents in single-step extractions were mixtures of organic solvent and water at 60°C. Pre-treatment of the natural material with supercritical CO<sub>2</sub> (with or without ethanol as co-solvent) improved the extraction of polyphenols from the grape marc. This method provides an alternative to the pre-treatment of the plant materials, replacing toxic organic solvents (e.g.

hexane). Acidified extraction media resulted in higher anthocyanin content in the extracts. However, the degradation of the anthocyanins during storage was higher, which led to the loss of the intensive colour. The addition of a commercially available rosemary extract to the extraction solvent improved the stability of the grape marc extract during storage. The obtained results confirm earlier findings, that elder berry and grape marc are potentially good source of natural colorants [Vatai Tünde, Škerget Mojca and Knez •eljko, Extraction of phenolic compounds from elder berry and different grape marc varieties using organic solvents and/or supercritical carbon dioxide, *J Food Eng*, 2009, **90** (2), 246-254].

## Feed/Fodder

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### Effects of inclusion of whole-crop pea silages differing in their tannin content on the performance of dairy cows fed high or low protein concentrates

The effect of including high or low tannin forage peas as an alternative to soyabean meal on performance and N efficiency was investigated by researchers working at ASRC, Harper Adams University College, Newport, Shropshire, UK using

18 dairy cows in two Latin square design studies. Two varieties of forage pea; 'Racer' (coloured flowers; high tannin) and 'Croma' (white flowers; low tannin), were ensiled 12 weeks post sowing. The *in situ* degradability characteristics of the

pea silages were determined using 4 cannulated sheep. The low tannin forage had a higher soluble N (*a*) fraction and a greater extent of degradation (*a + b*), resulting in a greater amount of N being predicted to be released in the rumen