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Green chemistry is the design of chemical products and processes that reduce or eliminate the generation of hazardous substances. Green chemistry, also known as sustainable chemistry, applies across the lifecycle of a chemical product, including its design, manufacture, use and ultimate disposal, and its eventual aim is to reduce the negative impact of chemical products and processes on human health and the environment.

On 25 September 2015, the United Nations adopted a set of goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years, and of particular relevance to ingredient suppliers and cosmetic manufacturers are the needs to enhance the conservation and sustainable use of oceans and their resources; to take urgent and significant action to reduce the degradation of natural habitats and halt the loss of biodiversity; and to achieve the environmentally sound management of chemicals and all wastes throughout their lifecycle. Full details can be found on sustainabledevelopment.un.org.

In-cosmetics Group partnered with the Soil Association to produce a paper on sustainability, which concluded that by improving sustainability throughout its supply chain, the cosmetics industry can have a major, positive impact in creating tomorrow's cleaner, greener economy. Run in association with Organic Monitor, the in-cosmetics Green Ingredient Award is given to a raw material or ingredient that makes a significant environmental or social

Ecology, economy & equity

Against a backdrop of international sustainable development goals, **John Woodruff** discusses cosmetic ingredients that are sustainable throughout their lifecycle

difference in the area of sustainability.

In 2016 the gold award went to Seppic with Ephemera, a gametophyte extract taken from macroalgae cells grown in a laboratory and harvested at an ephemeral stage in the life cycle of *Undaria pinnatifida* seaweed. During this growth stage the macroalgae cells accumulate antioxidant molecules. The production of Ephemera reduces the environmental footprint through local sustainable sourcing of its raw ingredient from renewable natural material and local manufacturing. Ephemera protects

Majestem is derived from the plant cell culture of edelweiss (right)

mitochondrial DNA integrity by increasing the activity of aconitase, a mitochondrial enzyme involved in cell homeostasis and known for its protective role towards mitochondrial DNA.

The silver award went to Sederma with Majestem, an active ingredient obtained by the elicited plant cell culture of

SUSTAINABLE DEVELOPMENTS

Ingredient highlights from the 2016 Sustainable Cosmetics Summit in New York (12-14 May)

The Sustainable Cosmetics Summit's North American edition, organised by Organic Monitor, featured a wealth of information. What follows is SPC's pick of the ingredients-related content:

Ellen Kamhi, naturalnurse.com
Kamhi discussed the herbal cosmetic approach to skin care, focusing specifically on the benefits of *Cyperus rotundus*, blueberries, turmeric and sea buckthorn. According to recently published studies, valencene from the rhizomes of *Cyperus rotundus* have been shown to inhibit skin photoageing, as well

as UV-induced melanogenesis, while proanthocyanidin-rich blueberries reduce free radicals, restore sun damaged and ageing skin and strengthen capillaries. Turmeric, she said, was popular as a home-made face mask among online influencers and has been proven to exhibit potent free radical-scavenging activity. Kamhi concluded her talk with a look at sea buckthorn oil, which is exceptionally rich in unsaturated fatty acids, vitamins, carotene, flavonoids, phytosterols, serotonin, amino acids and trace elements.



Ryan Boldt, J. Rettenmaier (JRS)

As the world moves towards microbead-free waters, with the US, Sweden, Australia and India all in the process of banning said particles, Boldt looked at alternative exfoliants from nature. He dismissed aluminium silicate and silica for being non-biodegradable and irritating, and hydrogenated wax for being prone to softening over time, instead focusing in depth on plant fibres. Within this group, crude fibres such as apricot seeds, although renewable and biodegradable, also posed an allergen and irritation risk. A better option, he said, was cellulose, which is white in colour, natural, biodegradable and renewable, as well as edible for marine life. He described JRS' Vitacel cellulose and Vivapur microcrystalline



Leontopodium alpinum or edelweiss that delivers visible lifting of the skin on the neck and face to combat sagging caused by sun exposure and air pollution. IBR took

the bronze award with IBR–Pristinizer, a natural, aqueous extract of *Asteriscus graveolens* with anti-pollution, antioxidant and anti-inflammatory benefits.

TIME TO CONCENTRATE

Any size or type of organisation that wishes to reduce the environmental impact of its

activities, maintain compliance with environmental legislation or enhance the potential environmental benefit of its products or services can look to ISO 14001. It is an environmental management system that demonstrates an organisation's commitment to controlling the environmental impact of its activities.

cellulose products as being a "washcloth in a bottle" and demonstrated that both products have sufficient hardness to make them a strong contender for exfoliation.

Benjamin Lightburn, Mazza Innovation Solvent residues from ingredient extraction processes, said Lightburn, are non-sustainable and can find their way into finished products, so the onus is on the industry to find solvent-free methods. He introduced a novel technique, discovered by Mazza, to extract substances by changing the polarity of water using temperature and pressure, known as PhytoClean. It is said to be preferable to environmentally friendly supercritical CO₂ extraction on account of its low complexity, easy scalability and built-in micro kill step.

IFF

Presented as part of Ken Alston's talk on the circular economy and Cradle to Cradle certification, IFF debuted PuraVita, the world's first Cradle to Cradle Platinum certified fragrance. PuraVita has top notes of apple, pineapple, pine, lime and green notes; middle notes of apple peach and apricot; and base notes of vanilla, musk and wood, and to achieve Cradle to Cradle certification the fragrance had to meet the criteria of material health, circular economy, clean energy, clean water and social benefit.

Judi Beerling, Organic Monitor

Following on from the trend for food-like textures – like butters, soufflés and jellies – in cosmetics, Beerling covered those

food ingredients that are whetting beauty consumers' appetites. Ingredients flagged up were those inspired by juicing and those derived from sources including trendy 'superfood' chia; Saskatoon berry, a traditional food of the Cree Native Americans; quinoa; babassu; baobab; nutritious maca root, traditionally eaten by Inca imperial warriors before battle; pre- and probiotics; and tamarind. Benefits of such materials include easy recognition and acceptance by consumers, as well as good visual appeal for advertising. And some finished products are even safe enough to eat! However, Beerling did note that just because an ingredient is natural and edible doesn't mean it's safe for use on skin, as some may be allergens.

Cosmetic ingredient suppliers, with their interest in providing active ingredients of natural origin, are at the forefront of using green chemistry and this was readily apparent from many of the presentations delivered at in-cosmetics 2016.

An ingredient supply company with ISO 14001 is Stephenson Personal Care, which is well-known for its soap bases. At in-cosmetics, Lucy Simmonds introduced two new emulsifiers from Stephenson; one is based on sunflower seed oil and the other made using 100% Roundtable on Sustainable Palm Oil (RSPO)-certified segregated sustainable palm kernel oil. They are PEG-free, suitable for cold processing, and compatible with both oil and water phases. Stable water-thin emulsions can be achieved. Durosoft SF [INCI: Polyglyceryl-4 oleate] is a w/o emulsifier based on sunflower oil. Durosoft PK-SG [INCI: Polyglyceryl-4 laurate] is an o/w emulsifier derived from RSPO palm kernel oil. A wet wipe concentrate was also described. This is Durosoft WWC-SG [INCI: Aqua, potassium palm kernelate, glycerin, polyglyceryl-4 laurate, potassium citrate, citric acid], which just needs diluting with water.

By using concentrates companies can reduce their material inventory, avoid excessive minimum order quantities on some ingredients, and decrease processing times and energy use. Beautygreen TGA [INCI: Aqua, sodium methyl oleyl taurate, decyl glucoside, sodium amphotacetate] from Gemro is a 100% naturally-derived base for shower gels, shampoos and other surfactant products. It is free from ethoxylates, sulphates and amides, is completely transparent and cold processable. Gemro also supplies Beautyvory DS3 [INCI: Aqua, sodium methyl oleyl taurate, decyl glucoside, PEG-3 distearate], a pearlescent base for extra mild shampoos and body washes.

SUBSTITUTION & SUPPLY

Distinctly non-green was the use of polyethylene beads in cosmetic scrubs and manufacturers are replacing them with more suitable alternatives. An example supplier is Lessonia. Charles-Henri Morice discussed making the correct choice and listed the criteria for doing so. These are particle size, abrasiveness, marketing impact, compatibility, stability and regulatory constraints. Morice suggested that the best alternative was 100% renewable and biodegradable Celluloscrub, which has very similar properties of hardness and abrasiveness to polyethylene and is available in a range of particle sizes and colours. He also discussed the benefits and



Obtained via a green extraction process, Naturex's NaDES line includes horsetail (above), cherry blossom, olive leaf and saffron flower, while Aromtech Summer Vita Strawberry Seed Oil is extracted using supercritical carbon dioxide

disadvantages of other natural exfoliating agents with information about their hardness, abrasiveness and the difficulties of suspending them.

Biodegradable exfoliating beads derived from renewable resources include Sunjin's KSW series. The beads have a non-uniform particle size and a smooth surface to give mild exfoliation. They contain approximately 60% natural wax, 35% talc and 5% pigment. The talc content increases the density of the KSW series so that they sink in water, which is beneficial for the environment since the beads sink in sewage disposal systems.

Also looking for substitutes for less green ingredients is BioNat Consult. Its R&D team creates alternatives to materials such as silicones and petrochemicals using innovative technologies based on olive oil and rice bran wax. Polyna R [INCI: Olea Europea (olive) fruit oil, Oryza sativa (rice) bran wax, stearic acid, olive oil polyglyceryl-3 ester] is offered as a substitute for petrolatum. Polyssan O [INCI: Olea Europea (olive) fruit oil, olive oil polyglyceryl-3 ester] is a natural texturising agent presenting the characteristics of light silicones. With the same INCI lists but in different proportions Polyssan OL is an alternative to animal squalane, while Polyte Extra [INCI: Butyrospermum parkii (shea) butter, Olea Europea (olive) fruit oil, olive oil polyglyceryl-3 ester] is an alternative to lanolin.

CLEAN, GREEN EXTRACTION

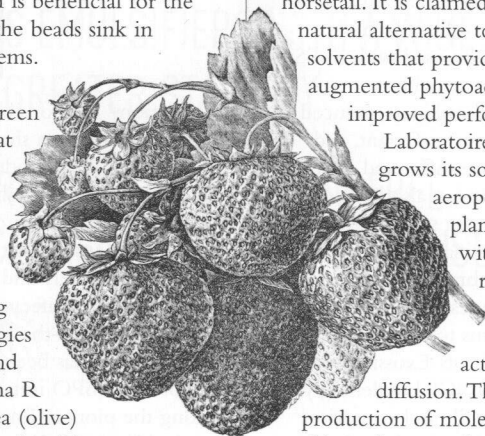
Aromtech uses supercritical carbon dioxide to extract oils and bioactive compounds

from plants. It offers an effective and gentle method of obtaining lipophilic ingredients while preserving the ingredients in their natural form. The chemical-free CO₂ extraction process also helps to ensure the purity and safety of Aromtech's products, which include Summer Vita Strawberry Seed Oil from *Fragaria ananassa*. It is a high quality strawberry seed oil that contains linoleic, alpha-linolenic and oleic acid, as well as the antioxidants of strawberry seeds in a concentrated form.

Deep eutectic solvents or NaDES are a new type of natural solvent that reproduce the plants' intracellular environments. The use of deep eutectic solvents is a game-changing innovation, claims Naturex, which is using the technology to obtain a new range of plant-based active ingredients. The most active molecules are synthesised at the very core of the plant cell and some of these metabolites are not always fully soluble in water or in lipid phases. Plants may instead store and transport these compounds in a third type of liquid phase: the so-called natural deep eutectic solvents. Naturex has launched six botanical extracts under its Eutectys trade name including extracts from cherry blossom, olive leaf, saffron flower and horsetail. It is claimed that NaDES is a natural alternative to conventional solvents that provides extracts with augmented phytoactive profiles and improved performance.

Laboratoires Expanscience grows its source material using aeroponics, whereby the plants are grown without soil and the roots are periodically immersed in water to extract the active molecules by diffusion. This enables the production of molecules that the plant would not have synthesised with traditional culture methods. It is used to create Neurovity, which consists of the polyphenols from *Vitex negundo* [INCI: Propylene glycol, aqua, Vitex negundo extract]. It is said to inhibit neuro-ageing and to promote a healthy cutaneous nervous system.

The use of high hydrostatic pressure (HHP) for the extraction of active ingredients from their source material is a form of processing without the need for heat or solvents, which is a principal aim when using green chemistry. The process was introduced at in-cosmetics 2016 by Gérard Demazeau of HPBioTECH who said that the process enables the extraction of unstable or labile active substances, can



increase their bioactivity and provide a significant reduction in process time.

FROM FERMENTATION

Obtaining active ingredients through fermentation processes is an example of green chemistry. Microorganisms are used to hydrolyse organic polymers into various smaller molecules to yield energy for their growth. The Natural Solutions Co uses fermentation to transform rice extract into an active cosmetic ingredient that it names RiFerm [INCI: Yeast ferment extract/Oryza sativa (rice) extract]. It is an antioxidant with anti-wrinkle and moisturising properties, and is said to increase skin density and thickness. The same company also supplies MyFerm [INCI: Undaria pinnatifida extract / Lactobacillus ferment], which is a liquid fermented extract of *U. pinnatifida* by *L. acidophilus* to break down complex polymers for better penetration and absorption of active compounds into the skin.

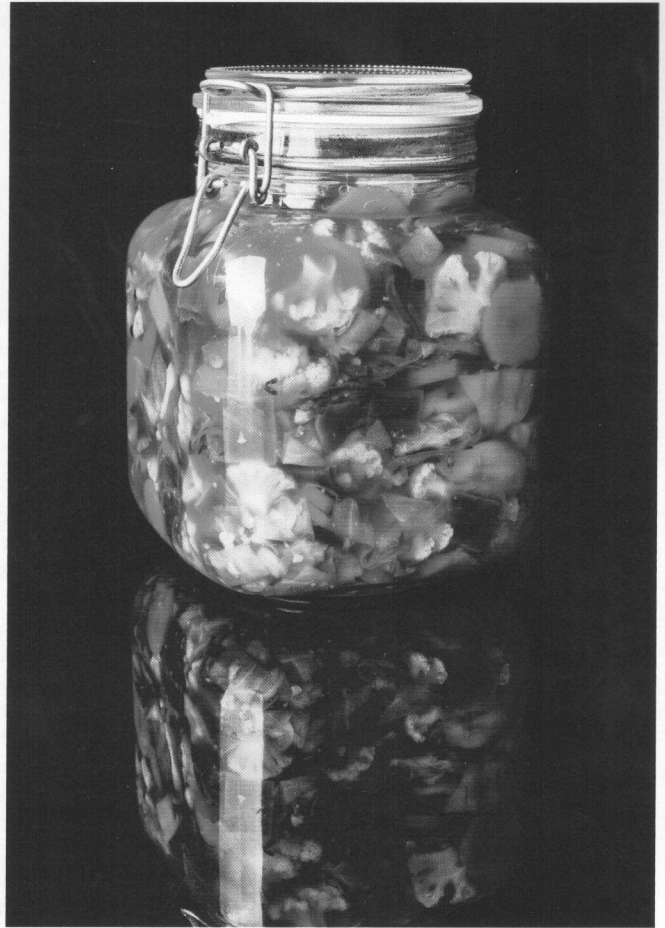
Fermentation of sugar cane to yield glutamic acid to make amino acid-based surfactants is undertaken by Sino Lion. Because they are 100% natural and from sustainable and renewable raw materials, they are examples of green chemistry. EverSoft ULS-30S is sodium lauroyl glutamate, which can be used with SLES as a secondary surfactant to achieve significantly improved mildness, reduced skin adsorption of main surfactant, and easier and quicker rinse-off – and thus less water consumption. It can also be used as the primary surfactant in sulphate-free compositions for sustainability-conscious and natural-oriented brands.

IFF-Lucas Meyer uses fermentation by kopara microorganisms to obtain purified exopolysaccharides for its Exosine active ingredients. Exo-H [INCI: butylene glycol, Alteromonas ferment filtrate] comprises three exotic polysaccharides from French Polynesia that provide long lasting hydration, smooth skin texture and protect against pollution. Exo-P is a natural active that chelates heavy metals, limits free radical activity and protects skin cells from UV and pollutants. Exo-T [INCI: Butylene glycol, Vibrio alginolyticus ferment filtrate] has demonstrated a higher activity than retinoic acid in the stimulation of desquamation markers. It protects the collagen network and contributes to skin regeneration, improving skin smoothness and leading to an even skin complexion.

PRODUCT STEWARDSHIP

Product stewardship is part of the International Council of Chemical

Obtaining active ingredients through fermentation processes is an example of green chemistry



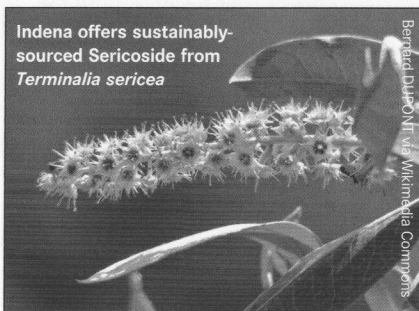
Associations' Responsible Care Initiative, which is a shared responsibility between chemical producers, suppliers and customers. It includes sharing information throughout the supply chain to manage risks, and to ensure that chemicals are used and managed safely and responsibly throughout their lifecycle.

Croda supports the principles of product stewardship: it has been at the forefront of supporting RSPO initiatives and was among the pioneer European users of sustainable mass balance type palm-based raw materials. Over the last five years its approach to product design has focused on the 12 principles of green chemistry, but it also proactively improves both the sustainability of its products and their

impact. This includes measuring the sustainability benefit of its products in use, and measuring the percentage of renewable raw materials in its new products. A recently launched example that complies with these ideals is Cithrol 10GTIS [INCI: PEG-20 glyceryl triisostearate], a mild surfactant that enables the creation of high-performance microemulsion or oil-based facial cleansers that don't require cotton pads for application and are easy to rinse off with less water.

Indena is committed to sustainability by the proprietary SuSo programme, which means Sustainable Sourcing and all its supply chains are monitored for environmental, social and ethical aspects. It supplies Sericoside, which is a pure saponin isolated from *Terminalia sericea*, a tree endemic to central and southern Africa, that is very useful in agro-forestry as it improves soil quality. In efficacy trials Sericoside was shown to have anti-inflammatory activity, accelerating wound healing and showing a reduction in vascular permeability. In clinical trials it improved skin texture and elasticity, and reduced sagging, eye bags and dark circles around the eyes.

EcoTain is Clariant's own approach to



Indena offers sustainably-sourced Sericoside from *Terminalia sericea*

Berard Duroon via Wikimedia Commons

sustainable innovation, driven by the company's commitment to protect human, environmental and ecological health without compromising on performance and efficiency. An example material launched by Clariant is Plantasens Olive Active HP [INCI: Olea Europaea (olive) oil unsaponifiables], which complies with the sustainability and performance standards demanded by EcoTain. It is a byproduct of olive oil processing, no water is involved in its production and there are no unusable waste products. Plantasens Olive Active HP counteracts glycation and lipid peroxidation, which are involved in the skin ageing process, by scavenging reactive oxygen species and it also protects skin from UV-induced lipid peroxidation and the formation of advanced glycation end products (AGEs).

Sinerga has invested in a huge area of the Amazon rainforest with a group called the Amazonian Alliance. They have set out to reap the harvest of rainforest ingredients such as andiroba oil, cupuassu butter, murumuru butter and pracaxi oil, without harming one single tree while providing work, education and health services to the indigenous population. This enterprise is backed by the Brazilian government and carbon credits are available to companies who use the product line. For further information there is a four-minute YouTube presentation.

The Union for Ethical Bioproducts (UEBT) is a non-profit association that promotes the sourcing with respect of ingredients that come from biodiversity. Ethical BioTrade advances sustainable business growth, local development and biodiversity conservation. A member of UEBT is Symrise, which has opened its new production plant in an eco park in the Amazon region. It also integrates sustainability aspects along the entire value chain, from sourcing and production to contributing to the social and economic development of the region.

The Symrise production facility provides access to a rich variety of plants that are native to the Amazon region and utilises sophisticated, sustainable technologies to ensure that there is as little impact on the environment as possible. The air conditioning in the buildings runs on geothermal energy and botanical mineral filters purify wastewater and rain water for production. From this facility Symrise is able to offer many of the oils and butters, such as buriti, murumuru, cupuacu and andiroba, for which the Amazon basin is famous.

In the Peruvian Amazon and Andean regions 3QP works with native communities to promote their

Companies investing in the sustainable sourcing of Amazonian ingredients include 3QP, which works with native communities in Peru (right) and Symrise, which offers a range of Amazonian products including murumuru (below) processed in an eco-conscious facility



By Bruno Girm via Wikimedia Commons

development and quality of life by supporting the cultivation and sustainable exploitation of native plants in an environmentally responsible manner. Example materials from its extensive portfolio include INKA Camu Camu, an extract rich in vitamin C from *Myrciaria dubia* fruit; an extract from *Physalis peruviana* fruit with powerful antioxidant properties; and INKA Drago, an extract of the resin from *Croton lechleri*, rich in proanthocyanidins and taspine.

ENZYMATIC ACTIVATION

According to Phenbiox, a seed is the nucleus of a new life and contains all the energy needed to generate new plants. This energy is trapped in vegetal oils as triglycerides, which are a food reserve for germination and growth. In the plant this energy is activated by the release of an enzyme and Phenbiox claims to have reproduced this enzymatic process to create a completely new phytocomplex called OleoSoft-4. It has been developed by applying enzymatic activation technology to a mix of almond oil, olive oil, linseed oil



and borage oil, chosen for their content of different classes of fatty acids. OleoSoft-4 may be used in skin care formulations to improve skin elasticity and moisturisation, and in hair care applications to improve hair elasticity.

Biolie is a French company created in January 2012 as a spin-off from the BIOMolecular Engineering Laboratory (LIBio) of Lorraine University. It specialises in the production of natural ingredients with better efficiency through fractionation of the plant in order to design, develop, produce and commercialise natural ingredients for cosmetic and nutraceutical markets. It uses enzyme technology for selective hydrolysis of plant material and its one step extraction process yields a plant oil, an aqueous extract and a solid fraction. The process is solvent-free and follows green chemistry principles.

PURER PROCESSES

It is possible to use certain solvents within the principles of green chemistry. The ethanol used to synthesise Lipex SheaLight from AAK is made from agricultural sources and so is renewable and has a low environmental impact. Lipex SheaLight [INCI: Shea butter ethyl esters] is an eco-designed shea butter that combines high functionality in skin care formulations with a light skin feel and a good sustainability profile. It is made using lower temperatures and shorter processing times than traditional ester syntheses using biodegradable catalysts to reduce energy consumption. In 2015 it was recognised as a leading example of advancing technology to make sustainable natural products.

The majority of materials mentioned have COSMOS and/or Ecocert approval but those interested are urged to contact the supplier for confirmation. **cb**

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