

Green Chemistry

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John Woodruff

Green chemistry refers to alternative and sustainable technologies that are non-toxic to living things and the environment. Green, sustainable and fair trade are buzz words much used by the cosmetics industry and very much in evidence at In-Cosmetics 2015. What follows is a round-up of some of the manufacturers and ingredients that can be said to comply with the above definition.

Sustainability means careful harvesting the best that nature has to offer but never taking more than is needed and always replacing what was taken. Many suppliers of natural ingredients follow this concept. A good example is **Premier Specialties** from America that claims its harvesting processes are carried out with care for the preservation of local flora and fauna as well as respect for local customs and traditional harvesting techniques. Its sustainability and traceability documentation includes the exact source location, designation of the product as wild crafted or cultivated, and assurance that it is replanted or harvested in a sustainable manner.

An interesting talk at In-Cosmetics 2015 was given by Chris Kilham on behalf of **Naturex**. It was about sustainable sourcing of quillaia and the surfactant properties of its saponins. Kilham believes that sustainability involves providing natural resources for human needs in a manner that supports the health and diversity of the natural environment, and incorporates labour and wage practices that enable all people in the system to flourish. In a sustainable system, all life is supported and allowed to prosper.

In general, foaming surfactants are not perceived as having a “green” profile. Quillaia saponins are one of the few entirely natural sources of foaming agents. They have long been used in food manufacture and in brewing, where they give a stable head of foam to beer. Although their natural foaming power does not compare favourably with that of the most commonly used anionic surfactants there appears to be a synergistic action with alkyl polyglucosides.

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Alkyl polyglucosides (APGs) have a “green” claim as they are derived from sustainable sources of sugars and vegetable fatty alcohols. They are non-ionic, so compatible with all classes of surfactant, are mild to the skin and are biodegradable. They have been in common use in personal care products for two decades and are widely available from suppliers such as **A&E Connock; BASF; The Dow Chemical Co; Evonik Industries; Galaxy Surfactants; Huntsman; Innospec; Kao Corporation and Seppic.**

Alfa Chemicals has a complete range of sugar-based ingredients including Sucragel, a natural oil thickening and emulsifying ingredient; Sucrablend, a natural temperature stabiliser; Sucramulse, a PEG-free natural emulsifier; Sucrathix, a vegetable-based water thickener and rheology modifier, Sucrabase, a range of ready-to-use oily gel bases and Sucraclear, a natural water-gelling agent.

The **Lamberti Group** took alkyl polyglucosides and esterified them with an organic acid to produce alkyl polyglucosides esters that are anionic in character, retain the mild toxicological profile of the APG but have a greatly enhanced foaming power. Currently there are three available: Eucarol AGE EC, the citrate ester; Eucarol AGE ET, the tartrate ester and Eucarol AGE SS, the sulphosuccinate ester. The citrate and tartrate esters conform to Ecocert and COSMOS standards and retain their “green” credentials.

For emulsions to be considered “green” there are opportunities to use natural vegetable oils, butters, waxes and emulsifiers from sustainable sources. **AAK** is a specialist oil and wax supplier and an example material is Lipex Bassol C. This oxidation-resistant emollient provides an alternative to unstable vegetable oils, mineral oils and synthetic emollients. It is made from high-quality rapeseed oil using mild and efficient processes resulting in lower greenhouse gas

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emissions and a lower environmental impact. Lipex Bassol C is also highly biodegradable and does not accumulate in the environment.

Lipex Shea WM [INCI: Shea butter oleyl esters] is another example product from the extensive range of ingredients from **AAK**. Lipex Shea WM is an emollient that combines the moisturising and other skin care benefits of shea butter with the lighter, more elegant skin feel of esters. The liquid character and low melting point make Lipex Shea WM suitable for cold processing of emulsion, saving time and energy in manufacturing. It is produced using gentle processing technology with lower temperatures and more eco-friendly catalysts than conventional esters, resulting in a smaller environmental footprint.

A company with 30 years of expertise in lipid biochemistry and in vegetable oil applications is **Oléos** from France. It also claims 10 years of experience in eco-extractions with “green” solvents and respecting sustainability. Oléo Eco Extraction is a physically intensified extraction process under nitrogen to produce Oléoactifs, described as micro-structured oils at supramolecular size. Phytomolecules are supplied in stable colloidal systems and there are Oléoactifs claimed to prevent oxidative stress; to repair the structure of mature skin; to have anti-wrinkle properties and to fight against inflamm’aging.

Extraction of active ingredients from botanical sources is an area where sustainable harvesting and “green” processing is important. **Exsymol** follows green chemistry principles and claims its MeiYano is an eco-responsible extract of elderberry (*Sambucus nigra*) flowers that are rich in flavonoids and other polyphenols with strong anti-oxidant and anti-inflammatory properties.

MeiYanoL is capable of reducing both oedema and dark circles around the eyes.

Brasca is an Italian company that aims to protect the value of nature and people in product manufacturing. It cares about the environmental impact of its productions by adopting eco-sustainable processes and to optimise sustainability

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from the entire product life cycle perspective. Amongst its extensive offerings are Olifeel E-Nat [INCI: Olive glycerides]; described as an innovative water-in-oil (w/o) emulsifier and emollient resulting from 100% sustainable patented technology. It is said to show excellent performance and an interesting sensorial profile and pleasant skin feel. It is used to formulate natural formulas and is compatible with vegetable oils, esters, UV Filters and silicones.

Another w/o emulsifier is Plantec VLA from **CRM International**. It is described as an ideal and green alternative to lanolin alcohol. Developed from vegetable sources it is an emulsifier and emollient that gives body and stability to a wide range of emulsions. **CRM International** is located in the south of France and specialises in the manufacture of plant derived ingredients for the cosmetics industry. It has an extensive portfolio of natural ingredients with green chemistry claims including Plantec Natural Emulsifier CP5, a mixture of fatty acid ester and olive oil unsaponifiables for cold process w/o emulsification. Plantec Natural Emulsifier HP10 is an o/w emulsifier based on sucrose-fatty acids ester and olive oil unsaponifiables, which forms liquid crystal structures.

According to **Gattefosse** its position in the personal care and pharmaceuticals markets gives it a deep understanding of the importance of health and well-being for people and the environment. Its emulsifier Emulium Mellifera [INCI: Polyglyceryl-6 Distearate, Jojoba Esters, Polyglyceryl-3 Beeswax, (Cetyl Alcohol)] is based on natural sustainable materials and won the gold award for innovation at In-Cosmetics 2014.

Innolex is another company with “green” credentials. It claims to combine a deep understanding of lifestyle trends with expertise in synthesis and formulation to provide innovative materials. These include new non-toxic

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technologies for preserving cosmetics and renewable green-chemistry

ingredients that replace petrochemicals.

The “green” preservative from **Innolex** is Spectrastat, claimed as a complete broad spectrum preservative-free system. It combines the preservation activity of caprylyl glycol with the anti-fungal activity of caprylhydroxamic acid. Even at neutral pH Spectrastat's biostatic agents can completely preserve both emulsions and surfactant systems. **Cremer Oleo** suggests CremerCOOR GC8 [INCI: Glyceryl caprylate] and CremerCOOR GC810 [INCI: Glyceryl caprylate/caprate] as preservative boosters in emulsions, surfactant-based compositions or hydro-alcoholic formulations.

Emulsense SC from **Innolex** is a natural cationic emulsification system for skin care. It comprises brassicyl isoleucinate esylate, brassica glycerides and brassica alcohol and is recommended as an emulsifier for formulating all-natural creams, lotions and body butters. It is derived solely from fermentation and plant materials using sustainable green chemistry principals. Emulsense SC is especially useful for formulas with high oil loads, where it acts as a sensory modifier to reduce greasiness.

Innolex also produce a similar system for hair care based on brassicyl isoleucinate esylate and brassica alcohol and named Emulsense HC. It is a natural cationic system particularly suitable for natural cream conditioners where it can be the primary anti-static agent and emulsifier. The active component is a cationic surfactant with predominantly C22 chains. Its conditioning performance is said to be comparable to classic behenyl quaternary systems.

Kao Chemicals offers three different hair conditioning products with good biodegradability and low toxicity to the aquatic environment. These “green” products are a long alkylchain amidoamine, Amidet APA-22 [INCI:

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Behenamidopropyl dimethylamine], and two different esterquats; Tetranyl CO-40 [INCI: Diolelyl hydroxyethylmonium methosulfate] and Quartamin BTC-131 [INCI: Behenoyl PG-trimonium chloride].

Another material for hair care is Rep’Hair, **Solabia Group**. It is a ceramide-like molecule composed of behenyl and stearyl aminopropanediol esters obtained from behenic acid and stearic acid by a green chemistry process without solvent. This product is recommended as a restructuring agent for damaged hair and for preventive action against split ends.

The 2014 German Sustainability Awards were presented in Düsseldorf on November 28, 2014. **Symrise** was placed among the top 3 in the special award category “Resource Efficiency.” With this award, the foundation recognised the responsible use of resources by Symrise along the entire value chain and its continual development and application of innovative approaches for greater efficiency.

Example materials with “green” credentials from **Symrise** are its Allplant Essence range of certified organic plant extracts. Allplant Essence consists of traditional plants that undergo a special distillation process and Symrise claims that the products are colourless and easy to formulate in modern sophisticated cosmetic formulations that will meet today's consumer demand for honest, traceable, and sustainable natural ingredients.

Another award winner is **Marinova Pty Ltd** from Australia that secured a silver medal at the Green Cosmetic Ingredient Awards, In-Cosmetics 2015. A gold, silver or bronze medal is awarded to a natural skincare ingredient that makes a significant environmental or social difference in the area of sustainability. It was awarded to Marinova for a unique seaweed extract that is shown to exhibit soothing, protective and anti-ageing properties. In human clinical trials the compound reduced wrinkle depth and skin roughness and increased skin

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elasticity and moisture retention following UV exposure. Branded as Maritech Reverse, this novel cosmetic ingredient is derived exclusively from wild seaweed, *Undaria pinnatifida*, which has been harvested on an environmentally sustainable basis.

A subsidiary of **Seppic** since January 2013, **BiotechMarine** specialises in developing bioactive materials extracted from seaweeds and marine plants and has over 80 materials in its portfolio. It is also developing innovative new technologies to protect coastal plant and algal resources and to maintain their natural environment.

With a strong focus on the sustainable use and preservation of natural resources, **Southern Cross Botanicals**, now part of the **Lucas Meyer Cosmetics Group**, specialises in developing ingredients exclusively derived from native Australian plants. It offers its Harvest Complex range of products rich in bioactive materials from native fruits, flowers, herbs and spices. Natoleic [INCI: Oleic/linoleic triglyceride] is a natural emollient from cold pressed seasonal oil-seeds grown in Australia with high levels of oleic acid. Other seed oils are available together with numerous botanical extracts from Australian native plants.

Beraca is an innovative Brazilian company that is a leading provider of natural and organic certified active ingredients from the Amazon Rainforest and other Brazilian biomes. Focusing on developing sustainable products with high performance and proven efficacy. Beraca's portfolio includes vegetable and essential oils, butters and clays and other ingredients for different applications in the cosmetic, pharmaceutical and fragrance industries.

Beraca's Rainforest Specialties line is composed of vegetable oils and butters made from active ingredients sustainably sourced, with a focus on health and wellbeing. They are manufactured in Beraca's production site, located in the

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heart of the Amazon Rainforest, in order to meet the demands of the cosmetic industry, contributing directly to regional development and environmental preservation.

Laboratoires Expanscience adheres to the principals of green chemistry by using molecular distillation and enzyme hydrolysis to extract the active materials from natural oils. Expanscience is particularly attentive to the environmental impact of its industrial facility and claims substantial reductions in its use of electricity, gas and water over the last five years.

Acacia seeds are needed to prepare Aqualicia, an active cellular moisturiser comprising hydrolyzed acacia macrostachya seed extract and maltodextrin. The seeds are gathered by woman's cooperatives created by **Laboratoires Expanscience** in Burkina Faso. It set up a responsible supply chain to protect and restore the local biodiversity while promoting local economic development and benefit sharing.

Other examples of materials from the **Laboratoires Expanscience** catalogue are Soline Bio, [INCI: Helianthus annuus (Sunflower) seed oil unsaponifiables], that optimises the skin's barrier function by acting on the synthesis of key epidermic lipids: α -Lupaline, [INCI: Lupinus albus seed oil, triticum vulgare (Wheat) germ oil unsaponifiables], which protects DNA from harmful rays and inhibits elastase and Hierogaline [INCI: Triticum vulgare (Wheat) germ oil unsaponifiables, sesamum indicum (Sesame) oil unsaponifiables], which is a powerful anti-radical agent that protects against cellular damage even when applied after UV exposure.

The **Alban Muller Group** develops and manufactures ingredients and skin care products from plants. It encourages local cultures close to its manufacturing site in France to limit picking in the wild and avoid threatening biodiversity. It selects varieties of plants with a high content in active principles and precisely

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harvests that part of the plant with the richest content thereby using less solvents and reducing energy consumption.

The extraction process developed by **Alban Muller** consists of macerating the plants in water, or a blend of water and plant-origin ethanol. A concentration phase, under vacuum evaporation, is then necessary to eliminate the solvents and ethanol is recycled. Microbiological decontamination is made by flash-pasteurisation, which is a low-energy procedure preserving the integrity of the actives. The extracts are then dried by under vacuum by adsorption of water on zeolites and the extracts obtained are placed in a rapeseed-derived glycerin carrier. Its extensive product portfolio includes bioactive materials, standardised plant extracts, gelling agents and exfoliants.

Solagum AX by **Seppic** is a combination of acacia gum and xanthan gum that is instantly soluble in cold and hot water that may be used to create aqueous gels without any string effect. **Seppic** considers respect for the environment and the safeguarding of natural resources to be major priorities with a long-lasting commitment to sustainability. It positions itself as an international corporation offering high performance, safe and innovative products made using green chemistry.

Green Chemistry is the design, development and implementation of chemical products and processes to reduce or eliminate the use and generation of substances hazardous to human health and the environment. The 12 Principles of Green Chemistry are:

1. Prevent waste generation when designing new chemical syntheses.
2. Design products that provide maximum functionality with little or no toxicity.
3. Minimise the use of chemicals hazardous to humans and the environment.
4. Use renewable and sustainable raw materials whenever possible.

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5. Make use of catalytic reactions to reduce waste.
6. Minimise the number of steps in chemical syntheses.
7. Make efficient use of atom economy such that final products contain the maximum proportion of starting materials.
8. Make use of safer solvents or eliminate solvent use.
9. Design syntheses and processes to minimize a product's carbon footprint
10. Design products that are biodegradable and present no, harm to, or accumulation in the environment.
11. Develop real-time monitoring of processes to minimise formation of by-products.
12. Design products with safety built in to the manufacturing processes

In addition **Croda** has added:

13. Design products with environmental benefits in use.

Following these principles **Croda** offers its NatraGem series of 100% natural cosmetic ingredients. The Natragem E Series is a collection of high performance emulsification systems based on glyceryl stearate, polyglyceryl-6 palmitate/succinate and cetearyl alcohol. NatraGem E145 is a versatile high HLB, oil-in-water emulsifier effective in the creation of sprayable to pourable lotions. NatraGem EW is recommended as the emulsification solution for difficult to work with actives often found in sun care and BB creams. Both NatraGem emulsifiers possess excellent electrolyte tolerance and function effectively in the presence of electrolytes and other destabilising actives.

The NatraGem S Series from **Croda** is designed to provide effective solubilisation of a wide variety of lipophilic ingredients and cosmetic actives. NatraGem S140 provides excellent solubilisation of essential oils, making it ideal for use with fragrances. NatraGem S150 is a solubiliser specifically

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developed to incorporate lipophilic cosmetic actives and their carrier oils into clear formulations with cleansing and counter irritancy properties. Both are a mixture of polyglyceryl-4 laurate/sebacate and polyglyceryl-6 caprylate/caprate.

Dr Straetmans publishes its guiding principles, an abstract from which states that it does its business in a way that is guided by human beings and ecological principles as part of its self-image as well as a self-imposed obligation. When in doubt, it gives protection of natural resources priority over capitalising on business opportunities. It promotes biodiversity, water protection and the preservation of soil fertility, and preference is given to partner companies that produce the raw materials in a way that is socially and ecologically sound.

Following its own guidelines **Dr Straetmans** produces Dermofeel products that comprise a carefully chosen line of emulsifiers, functional oils and antioxidants for cosmetic and dermatological applications. Dermofeel Easymuls Plus is an o/w emulsifier that can be applied in an energy saving cold temperature process.

Based on sunflower oil, Dermofeel Easymuls Plus, [INCI: Glyceryl oleate citrate], is suitable for low viscosity and sprayable concepts. Dermofeel

Viscolid is hydrogenated rapeseed oil in powder form that may be used to convert liquid oils into soft, creamy textures that are easy to apply on the skin without any influence on the sensorial profile of the oils which makes it ideal for massage oils.

The majority of materials described have Ecocert and/or COSMOS certification but those interested are advised to check with the supplier for full information.

There is a large overlap between materials produced using green chemistry and products from sustainable resources and ingredients of natural origin.

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