The Value of GREEN Processing

As consumers' quest for natural in every aspect of a product continues, a comprehensive story of overall ecological impact of product will be required—and green processing is part of that story.

BY STEPHANIE K. CLENDENNEN, PHD AND NEIL W. BOAZ, PHD

With growing and widespread consumer interest, natural ingredients have become an important consideration for cosmetics. And as consumers delve deeper into the ingredient list in a quest to fulfill their desire for "natural" to the furthest extent possible, the demand for the use of green processes will also grow—thus becoming of direct importance to formulators. Consideration of and investment in increasingly green processes, therefore, can be a boon to brand equity.

Though it is difficult to find a single standard, natural typically refers to the source of the raw materials, while "green" refers to the process used to convert starting materials to a finished ingredient. While there are useful guidelines for designing greener processes for ingredients, there is a shared burden—by suppliers, formulators and marketers—to communicate the green story to consumers. Third-party certification is one way of communicating this message and ensuring the benefits of the process itself are also realized in brand equity.

Yes, Processes Can Be Green

While not absolutely necessary, perhaps, green processing is relevant in the manufacture of naturally derived cosmetic ingredients. Natural materials are usually derived from plants or microbes via fermentation with minimal processing. Cold-pressed seed oils are excellent examples. The derived oils can be converted to glycerol and fatty acids, which are both good starting materials for making cosmetic esters. Esters encompass actives, emollients, emulsifiers and surfactants—and antiaging ingredients such as retinyl palmitate are esters.

Traditionally, esters are made synthetically in the presence of a strong acid catalyst and elevated temperatures to both drive the reaction and remove the water by-product. Acid-catalyzed, high-temperature esterification reactions are both energy intensive and the reaction conditions are deleterious to many starting materials, such as unsaturated fatty acids. Under harsh conditions, these sensitive starting materials produce undesirable color, odor and by-products that impact yield. In addition, additional process steps must be included to remove the strong acid catalyst.

In contrast, a major benefit of biocatalytic processes are mild reaction conditions that often avoid degradation of sensitive products and result in improved color, odor and by-products. There have been plenty of reports of biocatalytically prepared cosmetic esters, but many have required the use of organic solvents for both the reaction and for post-reaction processing to purify the final product. A real breakthrough in the deeper "greening" of biocatalytic processes is the elimination of the organic solvent in the reaction performed in the absence of added organic solvent, which makes a significant environmental impact.

Practical application has demonstrated that the solvent-free, greener biocatalytic process saves more than 10 liters of organic solvent per kilogram of product in reaction and post-processing waste. Solvent-free systems also offer better volumetric production, and, in many cases, the purity of the final product at the end of the reaction is greater than 90%, eliminating the need for post-reaction processing (Tufvesson et al., 2006; Aracil et al., 2000, Veit 2004).

Ingredients and Benefits

As Thomas Veit has pointed out in *Engineering in Life Sciences*, however, there are still hurdles to the industry-wide adoption of solvent-free biocatalysis for the manufacture of high-volume cosmetic ingredients. Chief among these is the high cost of a biocatalyst compared to a traditional chemical catalyst. In the production of high-performance functional ingredients, the contribution of the biocatalyst cost is justified. The biocatalytic production of lower-cost ingredients requires a large number of enzyme turnovers during the useful life of the biocatalyst to overcome the inherent catalyst cost difference. This becomes an engineering exercise, and the efficiency of using solvent-free conditions becomes a distinct advantage.

However, the biocatalytic production of cosmetic ingredients allows suppliers and marketers to communicate a more in-depth green story that includes chapters on saved energy and the elimination of solvent and waste.

A comprehensive story will be required to demonstrate the overall ecological impact of green-processed ingredients compared with more traditionally processed synthetic counterparts. And this story, in addition to processes, will also include such diverse considerations as the geographical source of raw materials, annual renewability, packaging, mode of shipping, shelf life and biodegradability. ■ **GCI**

Certifying Green

Although green certification programs exist from a multitude of sources, there are few that address personal care products as a discrete category—EcoLogo (*www.ecologo.org*) is a North American certification agency that does include personal care as a category for certification.

In the area of ecologically responsible cosmetic ingredients, ECOCERT (*www.ecocert.com*) has emerged as one of the most widely used organic certification organizations, and conducts inspections in more than 80 countries—making the European-based organization one of the largest organic certification organizations in the world.

Certification agencies associated with organic products usually have well-defined guidelines for acceptable processes. In the U.S., the Organic Materials Review Institute (*www.omri.org*) provides suppliers an independent review of products intended for use in certified organic production and processing. OMRI reviews products against the USDA National Organic Program standards. The U.K.'s Soil Association certifies organic products and continually updates its voluntary standards. Similar to the USDA standards, a product that carries the Soil Association symbol and is labeled "organic" must contain a minimum of 95% organic ingredients, while a "made with organic ingredients" labeled product must contain a minimum of 70% organic ingredients. The remaining ingredients that are permitted in the products must be proven to be non-genetically modified and can be used with restrictions.

Of course, any certification is only as good as the reputation of the certifying agency, and if the agency's standards are ill-defined, unknown, or simply not in accordance with consumer expectations, then that seal of approval is meaningless.

References

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STEPHANIE K. CLENDENNEN, PHD earned her doctorate in Biological Sciences from Stanford University with subsequent postdoctoral research at Cornell University. She spent her early career as a director of technology development at a pharmaceutical and agricultural biotechnology company.

NEIL W. BOAZ, PHD received his doctorate in Organic Chemistry from Harvard University. During his career, he has been involved in R&D in biocatalysis, fine chemical synthesis and chemical asymmetric catalysis, the latter resulting in an American Chemical Society Industrial Innovation Award.

Both Clendennen and Boaz are currently involved in the innovative use of biotechnology processes for the manufacture of new materials, with a recent focus on the production of green and natural performance cosmetic ingredients.