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SPECIAL REPORT

Marine Ingredients in Cosmeceuticals

Science, formulation and R&D initiatives

Although the use of marine ingredients in cosmeceuticals is not a novel concept, new R&D efforts are broadening their function and purpose in beauty applications such as nutricosmetics, anti-aging, inflammatory skin conditions and more.

Written by Alissa Marrapodi

Marine Ingredients in Cosmeceuticals

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SECTION I SEASCAPE: THE COSMECEUTICAL VIEW

THE USE OF MARINE INGREDIENTS IN COSMETICS is not a new concept. Asia is thought to be the pioneer of sea-based ingredients, as they are often a trend setter for many cosmeceutical applications and ingredients (think nutricosmetics). However, Europe is quickly catching on—with many prestige cosmetic lines launching products with marine ingredients—as is the United States.

The thing is, aquatic sources sow a very rich, diverse array of marine life that provides cosmeceutical formulators and manufacturers a plethora of reaping options. "Oceans, seas and lakes offer more diversity and sources of new chemicals than plants of the earth," Rebecca James Gadberry, CEO of YG Laboratories noted in her presentation at SupplySide West 2011.

"The versatility of marine ingredients is exceptional," added Eden Somberg, technical specialist, health business unit, Frutarom.

"From a cosmeceutical perspective, marine ingredients offer much potential in terms of applications, biological targets and mechanisms while creating a new atmosphere of marketing creativity," said Sarah Jindal, Presperse, the exclusive U.S. distributor for Aqua Bio Technologies (ABT), marketing manager – skincare.

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"With more than 10,000 members of the algae group, the market potential for this category is just getting started," Gadberry said. "In the past, our ability to test these materials for their effects on skin's biochemistry and tissues has been rather restricted. That's changing with the advent of gene array analysis and other in vitro as well as ex vivo tests. It is our progress in these areas that have led to the sudden increase in ocean-derived raw materials over the past several years."

SCIENCE BY THE SEA

Ocean life lends myriad opportunities for skin care. Manufacturers, research firms, biotechnology companies and others are constantly uncovering new life, and new applications and uses for marine ingredients in beauty care.

Algae and Others

In the beginning, algae and bacteria were used in personal care to stabilize and thicken emulsions and gels, remineralize skin and help rid the dreaded cellulite, according Gadberry; as more ingredients and uses have been discovered, algae entered the "world of 'next-generation' skin care."

"Algae extracts that have been used traditionally for moisturization properties are now being applied to new areas of skin biology involving our innate immune system," said Yelena Zolotarsky, new technology/applications manager, Presperse. "Marine ingredients are allowing suppliers to create a smart technology approach to exfoliation and anti-aging, which includes, but is not limited to, after sun care, cell renewal, skin balance and moisturization."

Algae are broken up into three families that are determined by color and carotenoid groups: brown, red and green. "Specific types of algae are used to target the specific need," said Alice Tenny, technical director, Biosil Technologies, exclusive U.S. distributor for Gelyma. "There are even particular algae that we use in combination for the synergistic effects to provide efficacious value in focusing on the precise requirements for the skin."

"Algae extracts that have been used traditionally for moisturization properties are now being applied to new areas of skin biology involving our innate immune system."

– Yelena Zolotarsky, new technology/applications manager, Presperse

Chlorella comes from the green alga family. A study published in the *Journal of Investigative Dermatology* found it may serve as a potential strategy for prevention of human skin cancer (2011;131(3):753:61). Although human cells possess a mechanism (nucleotide excision repair) to repair UV-induced DNA damage, mutagenesis still occurs when DNA is replicated before repair of these photoproducts. Although human cells have all the enzymes necessary to complete an alternate repair pathway, base excision repair (BER), they lack a DNA glycosylase that can initiate BER of dipyrimidine photoproducts. Certain prokaryotes and viruses produce pyrimidine dimer-specific DNA glycosylases (PDGs) that initiate BER of cyclobutane pyrimidine dimers (CPDs), the predominant UV-induced lesions. Such a PDG was identified in the chlorella virus PBCV-1 and termed CV-PDG. The CV-PDG protein was engineered to contain a nuclear localization sequence (NLS) and a membrane permeabilization peptide (transcriptional transactivator, TAT). Researchers at Oregon Health and Science University demonstrated the CV-PDG-NLS-TAT protein was delivered to repair-proficient keratinocytes and fibroblasts, and to a human skin model, where it rapidly initiated removal of CPDs.

Seaweeds fall under all three families—brown, red and green. "Seaweeds live in especially hostile surroundings, living part of the time immersed in water, and part exposed to air and sun, with drastic changes in temperature, salinity and mechanical stress caused by standing up to waves and tides," Gadberry said.

"Even from casual observation, we may note there are seaweeds, for instance, that thrive in difficult environments (high salinity, extreme environmental exposure, changes in hydration levels)," Somberg said. "Through research, we're finding these casual observations are proving true; and in vivo/vitro testing has demonstrated seaweeds have exceptional properties for the protection and enrichment of the skin. Of particular note are applications for anti-aging within the cosmeceutical industry."

One species of seaweed—*Phytessence wakame*, an exotic kelp that's derived from a brown algae native to the Sea of Japan—is said to have anti-allergy, anti-inflammatory, immune-stimulating and possible cancer-preventing properties. The alga is commonly eaten in Japan and research has shown it stimulates the body's natural creation of a protein involved in collagen production, aka hyaluronic acid (HA). This specific type of sea kelp helps block hyaluronidase, the enzyme responsible for breaking down HA in skin. It is said to bind collagen and elastin fibers together, helping the cells of the body to retain moisture.

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Somberg highlighted a novel application request that capitalizes on the ability of a particular seaweed compound to prevent the adhesion of bacteria to the skin. "Keeping in mind this is for external application, it's very similar in concept to the use of cranberry internally to prevent adhesion of bacteria to the inner wall of the bladder," Somberg said. "This particular application may have versatile applications ranging from cosmeceutical to medical use in dermatology and wound care."

Polysaccharides are also being researched for their potential skin benefits. Biotechnology company Solazyme discovered, via third-party in vitro and in vivo studies, its exopolysaccharide compound produced by microalgae species—Alguronic Acid—not only protects algae, but it offers anti-aging benefits as well. "In in vitro studies, Alguronic Acid demonstrated the potential to increase cell regeneration by 55 percent, stimulate elastin synthesis by 32 percent, decrease UV cell damage by 54 percent and inhibit melanin production by 26 percent," said Riva Barak, product development manager, Solazyme. "In an in vivo clinical study, Alguronic Acid resulted in a 24-percent measured decrease in the number of deep wrinkles within eight weeks and a 35-percent measured decrease in the number of fine lines within eight weeks."

Other exopolysaccharides ingredients, such as Hydrasine from Lipotec and Codif's EPS Seamat, and enzymes, such as Sederma's Venuceane, have emerged out of developmental and research efforts with marine-derived microorganisms. "At Aquapharm we're seeking to translate [the diverse mechanisms of microbes] into 'next-generation' cosmetic ingredients," said Jon Williams, VP Commercial, Oceanx, Aquapharm Biodiscovery. "To do this, we've had to overcome some of the challenges associated with growing these microbes and assembled a large collection of microbes that we then 'encourage' to produce the bioactive ingredients of interest so that we can screen them against specific targets of interest." Williams noted

microbe-derived ingredients are expected to not only benefit from the "positive aura" typically associated with marine-derived ingredients, "but also many of them have evolved to be used in the types of conditions that suit their application in cosmetic formulations, e.g., active at a range of temperatures and pHs and active at low (and therefore cost-effective) concentrations."

Unipex's Aldavine™ 5X, a calibrated combination of two algal sulfated polysaccharides, has been shown to reduce dark circles and under-eye bags. "Aldavine 5X already demonstrated its action on inflammatory mediators such as PGE2 and VEGF, which are involved in inflammation and the premature aging process due to UV exposure; but Unipex now has new results on MMP-2," Isabelle Lacasse, product line management director, Unipex Innovations said, noting the new research illuminates its ability to inhibit MMP-2, an enzyme that destroys the extracellular matrix.

Some algae form symbiotic relationships in which they supply photosynthates to the host organism; such is the case with coral. Since coral has to live in shallow water because photosynthesis needs sunlight to work, it's more susceptible to sunburn. Preliminary findings of a three-year project funded by the Biotechnology and Biological Sciences Research Council (BBSRC) revealed coral's ability to produce natural sunscreen compounds that protect it from damaging UV rays, possibly warranting the use of these compounds for use in a novel sunscreen for humans.

"We already knew coral and some algae can protect themselves from the harsh UV rays in tropical climates by producing their own sunscreens; but, until now, we didn't know how," said project leader Paul Long, senior lecturer from the Institute of Pharmaceutical Science at King's College London. "What we have found is the algae living within the coral makes a compound that we think is transported to the coral, which then modifies it into a sunscreen for the benefit of both the coral and the algae. Not only does this protect them both from UV damage, but we have seen fish that feed on the coral also benefit from this sunscreen protection, so it is clearly passed up the food chain. This led us to believe if we can determine how this compound is created and passed on, we could biosynthetically develop it in the laboratory to create a sunscreen for human use, perhaps in the form of a tablet, which would work in a similar way. We are very close to being able to reproduce this compound in the lab, and if all goes well we would expect to test it within the next two years."

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Copalis combined a hydrolyzed form of collagen with chondroitin sulfate and glucosamine in its Protein M+ ingredient, which is a marine polysaccharide complex that, according Copalis' placebo-controlled clinical studies, is effective in the treatment of hair loss, with results showing an average hair-growth increase of more than 30 percent. It may also help reduce facial lines and wrinkles, and dilated capillaries and age spots.

On a separate, rather interesting note, new research on an alga oligosaccharide *Laminaria digitata* (from Crodif/Barnett), rich in mannuronic and guluronic acids, offers 100-percent protection from tobacco smoke, according to the company's 24-hour cell study. Ex vivo, it's able to protect keratinocytes from pesticide and tobacco smoke damage, and protect the epidermis against heavy metals lead and cadmium.

Algae research continues to reveal new novel benefits for skin and skin care manufacturers.

"Astaxanthin is clinically validated as an internal sunscreen and an internal beauty supplement."

– Bob Capelli, VP of sales and marketing, Cyanotech

Salmon

Salmon is famous on and off the plate for its non-provitamin A carotenoid pigment—astaxanthin—that's responsible for its pink coloring; and is another marine ingredient that offers sun protection. Gadberry noted astaxanthin's ability to support vitamin C activity and absorb UVA/UVB rays. It is 40 times more effective against lipid peroxidation, and is more stable in scavenging and quenching than beta-carotene and zeaxanthin; it's 500 to 1,000 times more effective against lipid peroxidation than vitamin E. It also exhibits greater anti-inflammatory capabilities than vitamin E.

"Astaxanthin is clinically validated as an internal sunscreen and an internal beauty supplement," said Bob Capelli, vice president of sales and marketing, Cyanotech. "Results show astaxanthin can not only allow you to stay in the sun longer without getting sunburned, but it can also visually improve the physical appearance and quality of the skin. Cyanotech did early human clinical research to establish astaxanthin's UV protective properties and has an active patent for this application."

One study supported its role as an antioxidant, UV-light protector and anti-inflammatory, noting, "The research reviewed supports the assumption that protecting body tissues from oxidative damage with daily ingestion of natural astaxanthin might be a practical and beneficial strategy in health management." (*Fragrance J.* 2001;12:98-103). A six-week, single-blind study, carried out on 49 women, administered either a daily supplement containing 4 mg of astaxanthin or placebo (*Carotenoid Sci.* 2006;10:91-95). Researchers reported significant improvement in fine lines and wrinkles, elasticity and moisture content after six weeks compared to baseline values.

Aqua Bio Technology's marine-derived ingredient Aquabeautin XL®, derived from the hatching fluid of salmon, exfoliates skin while rejuvenating and healing it. It was first discovered at the salmon hatcheries in Norway, where staff members were noted to have

surprisingly smooth hands. The enzyme—The Zonase™, which Aquabeautine XL contains—was found to help break the eggshell during hatching, and has been shown to have a protein structure similar to corneum proteins of human skin. "Aquabeautine XL has shown significant anti-aging benefits during extensive clinical testing, reduction in fine lines and wrinkles, hyperpigmentation, increased skin clarity and brightness as well as firmness," said Michael Anthonavage, technical fellow—active ingredients, Presperse. "In vitro data reveals its gentle nature and high level of efficacy when compared to commonly used exfoliants available in the market."

Omega-3s

Omega-3 essential fatty aids (EFAs) are found in salmon, as well as other fatty fish and marine life such as krill. According to Aker BioMarine, krill oil may be the next major innovation in cosmeceuticals, as it can enhance external beauty from within—it serves as an antioxidant (astaxanthin), an anti-inflammatory and an anti-aging agent via increased collagen and elastic fibers.

"Krill oil may prove to be one of the most exciting new cosmeceutical ingredients both topically and as a nutritional supplement," said Dyanne Kheng, Aker BioMarine Antarctics' cosmeceuticals business manager. "Aging results in loss of moisture and elasticity of the skin; krill oil—with high levels of omega-3 essential oils and antioxidants—may help to reverse this effect. Krill oil is also recognized as an anti-inflammatory agent, taken orally or applied topically, it can help to soothe sunburns or acne problems."

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In a study published in the *British Journal of Nutrition,* intravenous omega-3-fatty acid administration reduced psoriasis, which may be related to changes in inflammatory eicosanoid generation (2002;87(1):S77-82). "The rapidity of the response to intravenous omega-3 lipids exceeds by orders of magnitude the hitherto reported kinetics of improvement of psoriatic lesions upon use of oral supplementation," the researchers noted.

Further research has also pointed to omega-3s' photoprotecitve and anti-aging effects. Korean researchers at Seoul National University College of Medicine found topical application of eicosapentaenoic acid (EPA) reduced UV-induced epidermal thickening; inhibited collagen decrease induced by UV light; attenuated UV-induced MMP-1 and MMP-9 expression by inhibiting UV-induced c-Jun phosphorylation; and inhibited UV-induced COX-2 expression without altering COX-1 expression (*J Lipid Res.* 2006;47:921-30). EPA also increased collagen and elastic fibers (tropoelastin and fibrillin-1) expression by increasing transforming growth factor-b expression in aged human skin.

Currently, many biomarine companies are working to incorporate it into cosmeceutical offerings, and research new uses for omega-3s. "Aker BioMarine Antarctic is in the process of developing krill extracts and delivery technologies for oral and topical beauty applications," said Eric Anderson, VP of sales and marketing, Aker BioMarine Antartic. "Krill is very unique in that it provides significant phospholipid content, mostly phosphatidylcholine (PC), which makes it not only an excellent source of PC, but also an excellent carrier for fat-soluble nutrients. We are evaluating applications and will be conducting clinical research to validate the benefits of krill extracts for cosmetics, cosmeceuticals, nutricosmetics and personal care products."

ARE YOU SUSTAINABLY AND QUALITY CONSCIOUS?

When dealing with marine life, sustainability, toxicity and quality are all factors to consider. Sustainability and toxicity can differ depending on the source. "If the marine ingredient is harvested from the ocean, there may be issues with sustainability and concerns about heavy metals," Somberg said. "For marine ingredients cultivated and grown in a carefully monitored environment, both concerns can be lessened considerably; and in particular, sustainability may become a non-issue."

Lacasse echoed Somberg's sentiments, stating: "The main issue for future development will be sustainable development and ethical sourcing. Marine ingredients are exposed to the same issues we see in food, but in smaller volumes. Efforts are done to find new ways to cultivate algae, as an example, and preserving as much of the natural ecosystem."

> "Quality is the most important issue when using marine-derived actives."
>
> – Liliane Pellegrini, manager, Gelyma

One of the main benefits of working with microbes, according to Williams, is sustainability. "We believe ingredients from this source can be developed cost-effectively at scale based on traditional fermentation technologies," he said. "They have an edge over other marine-derived ingredients, particularly those that are exotic or require large-scale harvesting, as there is minimal environmental impact associated with their initial collection (unlike wild seaweed or some fish-derived ingredients) and no risk of contamination (e.g., from pesticide run-off). As they can be grown in conventional fermentation facilities, manufacturing is readily scalable and production can be carried out near to the end-manufacturer, minimizing the carbon footprint associated with transportation."

As Williams pointed out—and as many manufacturers know—quality varies. In order to ensure a consistent product, companies need to do their homework."Microalgae products grown in controlled ponds are sustainable, yet the quality varies tremendously from producer to producer," Capelli said. "Brand owners must do their due diligence before deciding which supplier's product to use in their formula; or risk having an inferior product that won't get the results that consumers seek; or worse yet, getting a product that will fail regulatory requirements or label claims."

"Quality is the most important issue when using marine-derived actives," Liliane Pellegrini, manager, Gelyma, added. "At Gelyma, we take into account the changes according to the seasons and the stations because the chemical composition changes when collecting algae. We never use algae collected on the beach after great tides; we collect algae fixed to substratum in a great population in order to preserve the biodiversity."

Not only are due diligence and accounting for seasonal changes necessary, but testing is as well. "There exist strict norms for algae in human consumption," Tenny said "Testing of heavy metals is key and generally these metals are linked to polysaccharides."

Iodine, according to Gadberry, is another offender that needs to be addressed when it comes to quality, as it's a common allergy. "Some people can go into anaphylactic shock in minutes after exposure," she said. "The raw material supplier doesn't always list the iodine content, so formulators need to contact the supplier to find out if iodine is present and, if so, at what level. If iodine is present, we suggest to our manufacturing clients that a warning be put on the container."

THE TEMPESTS OF FORMULATING

Every market has its challenges, and that includes the formulation process. "One of the more difficult challenges is stability of the final skin care formulation," Pellegrini said. "Considerations in stabilizing the emulsion should be taken when incorporating marine-derived actives."

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From stability to compatibility, Gadberry added: "Currently, harvesting [algae] often yields low volumes and can reap animal life in addition to the material. Compatibility and the mineral content of some of the materials can be challenging. You can't necessarily overcome these situations because the chemistry is inherent in the ingredient, so we find formula systems and vehicle ingredients that are compatible with the raw material."

Barak expressed a similar challenge, stating in order to incorporate Alguronic Acid into a skin-care formula as an active extract, the company had to take into account the microalgae that produce Alguronic Acid also contain additional compounds—including carbohydrates and lipids—that do not provide the same anti-aging benefits. "Our biotechnology scientists and engineers developed a proprietary renewable cultivation technology and five-phase extraction and purification process," she said. "This cultivation, extraction and purification process allowed for the incorporation of Alguronic Acid as an active compound in the Algenist products."

Anthonavage, said although for the most part challenges associated with formulating with marine ingredients is no different than working with traditional terrestrial ingredients, "In some cases, where exotic mechanisms are in place, care should be taken to preserve the half-life of the technology and activity profile as the skin is designed to be a defense organ."

Capelli noted one issue when formulating with astaxanthin is it's water soluble. "This is not a problem for internal applications, as astaxanthin can be microencapsulated to work in tablet and hard-shell applications; but this can pose a problem for topical applications unless they're oil-based," he added.

"With marine ingredients that are solvent-extracted and offered in power form, you are indeed dealing with challenges in texture, scent and color, not to mention solvent residues and miscibility in formulation," Somberg said. "Of late, there are novel methods that involve physical purification processes resulting in essentially a hydrogel that presents none of the above challenges and is accordingly, exceedingly well-received by cosmetic chemists. A colorless, odor-free hydrogel eliminates many of the steps traditionally required to utilize marine ingredients while offering a range of benefits. This saves time and money both in the lab and in production."

One other side of the formulation sand dollar is regulatory considerations. Depending on what side of the globe you're on, ingredient inclusions may be regulated differently. "Our customers are creating many more unique formulations with exciting claims that include algae extracts," said Liliane Pellegrini, manager, Gelyma. "In France, however, there is an approved list of seaweeds and algae we are obliged to use, which is different from other countries." She noted the use of *Aphanizonemon flos-aquae* is not authorized for use by the French authorities because it secretes toxins under certain bloom conditions.

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Once the formulations challenges are dealt with, and quality, efficacy and sustainability are addressed, only consumers are left. "Even though algae can be used for everything from deep hydration and skin brightening to stem-cell awakening, customers still put it in the category of cellulite and body care," Gadberry added. "Making this worse, many companies don't educate their salespeople or the end-customer about the unique and multiple benefits different types of algae offer the skin or hair. Education is the key here."

UNCHARTED WATERS

Sure the cosmeceutical industry is past neophyte status when it comes to working with marine-based ingredients; but, there are still uncharted waters. New applications are on the horizon—from color to texture—as are continued efforts in areas such as hair care, and bath & body. Somberg said Frutarom has seen applications from marine derivates for safe, stable color; and Presperse said it has seen new applications surrounding new textures, such as ABT's Beterhelin, an alga extract with increased viscosity stability. "Our customers are always looking for something new in terms of biology, market story or both," Jindal added.

Gadberry said that although she hasn't received any novel formulation requests, "the fact that we're finding so many new applications from plants that live in the extreme environments found in the ocean—including Phykosaccharide AI for waking up 'sleepy' stem cells in the

skin—makes our job as formulators much easier to produce next-generation skin care with higher performance capabilities than in the past."

With so many "fish in the sea," the possibilities are endless. "We think there is good potential in hair care," Tenny said. "There remain numerous algae to evaluate and market. More than a thousand species of macroalgae exist and only 60 are used according the CTFA guide; and only 25 species of microalgae are used. Gelyma uses algae from diverse origins and different oceans. All actives are carefully calibrated and perfectly reproducible, with proved efficacy."

"I believe the market will embrace marine actives in all categories of personal care as consumers are becoming more aware of the bounties of the sea."

– Sarah Jindal, marketing manager, skincare, Presperse

Somberg agreed, stating: "Marine products have and will continue to be extraordinarily versatile for use both internally and externally. For hair care there are opportunities for cuticle and color protection, and many applications for body products. We would like to see continuous evaluation of these materials, however, with an eye toward sustainability, preservation of natural resources and further explorations in green technology."

"I believe the market will embrace marine actives in all categories of personal care as consumers are becoming more aware of the bounties of the sea," Jindal said. "They offer chemistry that can be more diverse and complex than those found in terrestrial ingredients, as our oceans have many micro-environmental pressures that are placed on organisms, some similar to terrestrial life others that are not. What's exciting is many of these environmental pressures produce protective and cleansing mechanisms in nature, it would not be a stretch to think they would make novel hair and bath technologies."

However, from Lacasse's point of view and experiences, beauty from within is not a plausible avenue for marine ingredients at this time. "We tried in the past and I believe the market is not ready for that," she said. "The distribution channels are too different and the beauty of beauty products comes from, of course, the efficacy. But also the whole sensorial experience they provide via fragrance, texture and the after feeling once you apply them; and unfortunately, the vitamins or supplements do not provide such feeling."

Drawing on the industry's current experience, it will be exciting to see how the industry evolves—from new applications to new ways to protect the ecosystem while ensuring quality and efficacy. ❑

SECTION II SEASCAPE: ALL MATTERS MARINE: THE MARKET AND MORE

MARINE LIFE LENDS AN ABUNDANCE of natural resources suitable for cosmetics. Although algae and omega-3s are the most prolific marine-derived ingredients on the market, the industry is continuously seeking new options. "There's a lot of untapped potential—it's only recently, with the advent of genomic technologies, that we've been able to grasp just how many marine microbes there are in the ocean; up to 90 percent of marine life is microbial, according to the recent Census of Marine Life," said Jon Williams, VP commercial, Oceanx, Aquapharm Biodiscovery. "These microbes have been adapting and evolving for more than 3.5 billion years, during which they've been exposed to a wide range of environmental pressures (e.g., pH, sunlight, high salt) and competition. Consequently, as a group, they've evolved the capacity to generate a wide diversity of mechanisms to enable them to either compete for scarce nutritional resources and/or defend themselves from competitive pressures; many of these challenges have similarity with those that we face ourselves every day, e.g., using antioxidants to protect our cells against free radical damage from too much UV/sunlight."

The fear of getting old—or at least looking old—is driving consumers of all ages to seek remedies for graceful aging.

According to a new report from Packaged Facts—Omega-3: Global Product Trends and Opportunities—consumer demand for omega-3 products (including health and beauty care products) will continue growing briskly over the 2011 to 2015 forecast period, and will influence the activities of marketers worldwide across various categories of consumer packaged goods, including the private-label arena.

Steve Dillingham, strategic advisor to Strategro International, also noted omega-3s are increasingly being incorporated in cosmeceutical applications, partly due to new delivery options. "New technologies are also on the horizon for incorporating popular nutritional ingredients into cosmetic formulas, including marine-derived ingredients such as omega-3," he said. "Among the reported effects of omega-3 on skin is the stimulation of tissue repair and enhancement of collagen production. Omegatri AS out of Norway developed a technology for the nanoencapsulation of omega-3 fatty acids for use in cosmetic formulations. The encapsulation technology protects the fatty acids against oxidation and, together with an optimized antioxidant mixture, keeps the fatty acids fresh. The nanoencapsulation technology also works as a vehicle for delivering the omega-3 lipids into the skin, and can withstand high temperatures, making it suitable for use in skin care formulation."

The fear of getting old—or at least looking old—is driving consumers of all ages to seek remedies for graceful aging. According to the Natural Marketing Institute (NMI), younger consumers are joining the Boomers and Matures by focusing on healthy aging;

and "Healthy Aging is Getting Younger" was one of the firm's health and wellness trends for 2011, as the "healthy aging" concept has now been embraced across the entire demographic spectrum.

But it's not just about developing ingredients for topical use; it's about changing the way consumers approach their health, including how they age, holistically. Marine ingredients offer both oral and topical solutions. "The modern North American diet is deficient in health-promoting omega-3 fatty acids (the richest sources found in high-fat marine fish oils.)," said Paula Simpson, B.A.Sc., RNCP. "Our overly processed diet provides excessive amounts of omega-6 fats (arachidonic acid) that are well-known to have a 'pro-inflammatory' effect in the body. Orally supplemented omega-3 fatty acids may inhibit inflammatory reactions that aggravate chronic inflammatory skin conditions, such as acne vulgaris, psoriasis or rosacea. Because of the unique chemical structure, phospholipid-rich and bioavailability, krill oil is an efficient supplemental source of omega-3s for supporting skin cellular integrity, and controlling inflammatory skin conditions, that when supplemented overtime, can promote visually radiant skin."

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– Paula Simpson, B.A.Sc., RNCP

The Japanese are the pioneers of the beauty-from-within concept. They've been incorporating marine collagen, a material derived from the substance found on fish scales, in skin care and nutricosmetic applications for years.

Nica Lewis, head consultant, Mintel Beauty Innovation, noted a couple of emerging ingredients that crossover into both skin and beauty-from-within care. "*Chlorella vulgaris* is emerging often in beauty launches and *Chlorella pyrenoidosa* often appears in hair care products these days," she said. "Both are taken as health and dietary supplements because they are rich in protein, amino acids, vitamins and minerals. When ingested, they help maintain healthy digestion and healthy skin."

According to Lewis, there are more than 200 kinds of algae that have been used for more than 30 years in various cosmetics and toiletry products. Focused research has brought about a new generation of high-tech cosmetics and an increasing number of manufacturers have chosen to market their products under the marine tag, as algae extracts are now found in thousands of skin care, hair care, and soap and bath products. According to a recent study by Mintel, the use of algae has more than doubled since 2004, with algae extracts becoming one of the top actives found in organic face- and neck-care ranges.

In an effort to further the research and development of marine-derived ingredients for use in cosmeceuticals, companies are continually forming strategic alliances that enhance and encourage new discoveries. In October 2011, Aquapharm Biodiscovery signed an agreement

with the Centre for Agricultural Bioscience International (CABI) in an effort to co-promote one another's microbe collections, which will promote sustainable discoveries—compounds and active ingredients—and combine access to a wide variety of strains for future development of cosmeceutical products.

In early 2012, GlycoMar and MicroA of Norway were granted funding for pilot-scale production of GlycoMar's biologically active polysaccharides from a marine microalga using MicroA's patented photobioreactor (PBR) technology, which will also help further sustainable, renewable active ingredients for use in cosmeceuticals.

From skin care and nutricosmetics to new delivery systems and R&D collaborations, the cosmeceutical industry is only seeing a fraction of what's to come. The sea's the limit. ❑

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Alissa Marrapodi is the online brand editor for Inside Cosmeceuticals, Integrated Healthcare INSIDER and Natural Products INSIDER.