SCC 75TH ANNUAL SCIENTIFIC MEETING & SHOWCASE

SESSION G: SUSTAINABILITY DEEP DIVE PREPRINTS

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Sheraton New York Times Square

Where to Begin? Sustainability 101 & How to Check All the Boxes

Helen Yang; A-Frame Brands

Introduction of research Launching a product line under time pressure, but still need it to be sustainable? Join Helen as she walks through a framework of how to pursue sustainability in all elements of your cosmetic product from ingredients to packaging, manufacturing, and supply chain. Starting with an overview of cutting-edge sustainable materials and claims that are available today, this talk will examine various tiers of sustainability in terms of cost effectiveness and speed to market. Finally, we will discuss how to take smart risks when rushing a sustainable product to market within an abridged development timeline.

Sustainability in three areas

1. **Inside the bottle: sustainable ingredients**
    a. Clean vs. sustainable (not the same thing)—uwe'll discuss what a sustainable formulation looks like and how this differs from a "clean" or "safe" formulation. While retailers and brands have started laying out clear guidelines for clean and safe ingredients, sustainability lags behind and is often claimed without substantiation.
    b. Sourcing & supply chain— Sustainability of the raw material source is key, which often affects naturally-derived ingredients more than synthetic ingredients. We will review options for choosing sustainably-sourced ingredients and supply chain transparency
2. **Outside the bottle: primary packaging**. Let's walk through currently available options for primary packaging and the pros and cons of each. You'll see that every material comes with some compromises. There's no golden key in the market nor one correct answer, so we will lay out the environmental friendliness, end-of-life disposal, lead times, and cost of each material so that your brand can make the best packaging decision.
    a. Plastic—Post Consumer Recycled (PCR) vs virgin, sugarcane, PLA and composability
    b. Glass—weight & fragility, recyclability
    c. Aluminum—fragility, recyclability
    d. Paper—durability & compatibility
    e. Finishing, color, and decoration options—various coatings, treatments, inks and how they affect the environment or disposability
    f. Closures—choosing the best closure material, mixed materials
3. **Behind the scenes: waste during production, fulfillment and shipping** This is the section where we talk about sustainability issues that the consumer doesn't see. Often waste on the manufacturing floor or fulfillment center is swept under the rug
    a. Secondary packaging options—paper vs. tree-free material
    b. Packout options—master shippers, dividers, bubble wrap
    c. What if you don't use a secondary at all? This may appear more sustainable to the consumer, but often incurs more waste and expenses behind the curtain

Conclusion

Brands are under pressure to bring products to market faster than ever, and often without the luxury of being able to physically visit vendors and suppliers. The above tips will help personal care teams maximize the sustainability of their products in a short timeline.

References

N/A, non-quantitative research

About the speaker

"Helen is the Director of Product Development at A-Frame Brands, a startup incubator for personal care lines focused on the needs of underrepresented groups. She manages the full innovation pipeline from idea to market, and is an expert in bringing a sustainable lens to startup product development. Helen's passion and expertise lie in scientific storytelling and communicating cosmetic science in consumer-friendly language. Prior to joining A-Frame, Helen managed product development at two different startups focused on clean, sustainable products--Public Goods and cocokind. Before diving headfirst into the startup world, Helen learned the ropes at multi-national health & wellness corporation, Amway. She holds a dual bachelor's degree in Chemistry and English Language & Literature from Columbia University, where she conducted four years of synthetic nanochemistry research. In the cosmetic science industry, Helen is known for her research on the topical effects of blue light, which was presented at the 72nd SCC National Conference and won a 2019 Society of Cosmetic Chemists Award."

Upcycled Ingredients: Circular Beauty's Answer for Eco-Friendly Formulations

Heather Grove; NATIVE EXTRACTS Pty Ltd (Alstonville, New South Wales, Australia)

Untapped Reservoir of Bioactivity

Harnessing and preserving phyto-activity from surplus or by-product food 'waste' introduces endless opportunities for manufacturing innovative, sustainable and traceable ingredients to back Conscious Beauty brands and manufacturers, whilst reducing costly environmental and socio-economic impacts. Up to 40% of food grown never leaves the source - an untapped resource of nutrients for the 95% of consumers who wish to support reducing food waste.[1] Through peer-reviewed research, analysis of upcycled ingredients, and assessment of logistical challenges within the cosmetic industry (such as sourcing, pretreatment and extraction technologies), we reveal the potential for new partnerships, extraction efficiencies and market development by substituting virgin material with revalued 'b-grade' botanicals and byproducts.

Closing the Loop on Circular Beauty

The most favourable sources for upcycling cosmetic ingredients are closest to the source, from on-farm surplus, manufacturing and post-harvest by-products due to higher volume, bioavailability, freshness of supply and traceability.

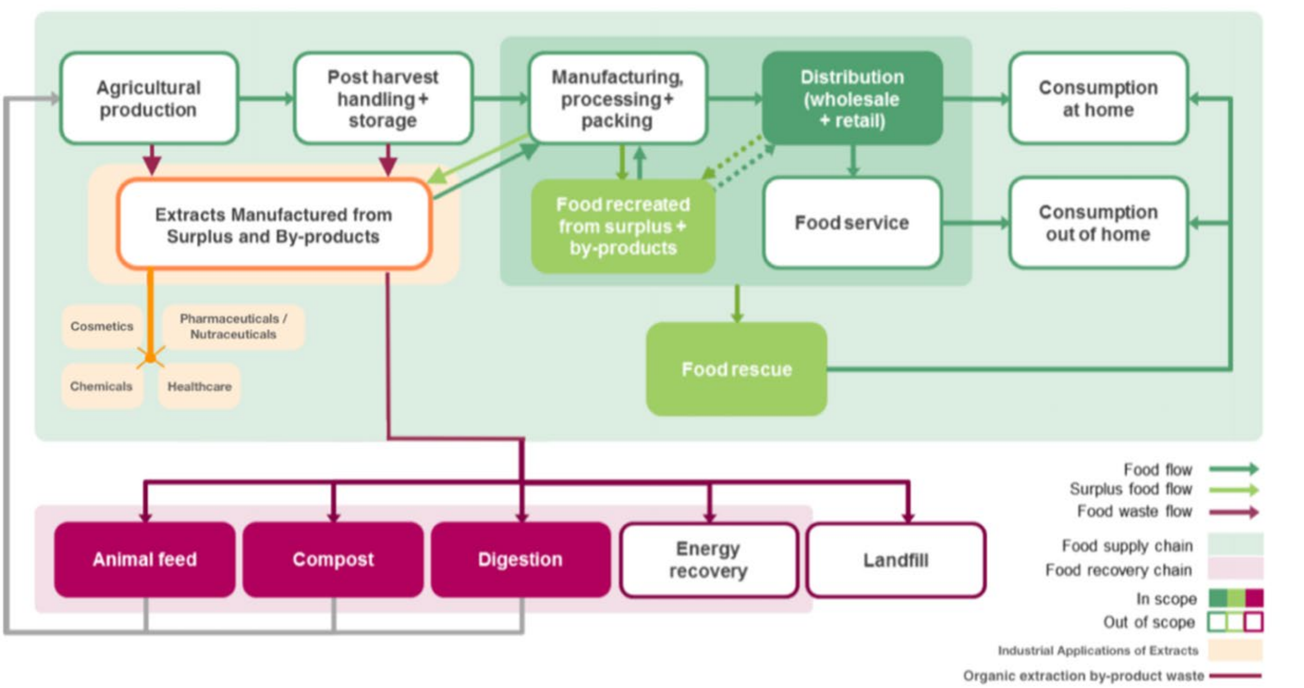

Figure 1: NATIVE EXTRACTS' adaptation of the food supply and recovery chain (Lewis H, et-al 2018)[2]

Although nature functions in circular nutrient systems, our linear models of production and consumption have neglected to value excess, coming at a cost to more than just our environment. The expense of growing plants (water, fuel, energy, deforestation, nutrients and labour) and disposing of them (composting, transport and landfill taxes) results in lost income for our growers ($750 billion USD per year)[3] and environmental degradation through the loss of precious resources, excessive soil-nutrient depletion, erosion and greenhouse gases (GHGs).

Converting Costs to Capital with Upcycled/By-product Beauty
Revaluing nutrients for cosmetics and nutraceuticals creates new revenue streams for the primary industry, expands crop value, mitigates poor harvest risk, and opens the door to revolutionize products supported by circular stories. Once, farmers lived harvest to harvest, now they are tapping into expanding beauty market opportunities through a number of ingredient formats (i.e. CO_2, super & subcritical, macerated/percolated, liposomal, isolated/purified and full entourage extracts, distilled and cold-pressed oils, hydrosols, powders, Cellular Extracts™, exfoliants, butters, waxes, etc). One study found that upcycled products can even be more valuable than the main original product.[4] Revalorisation can be achieved through the extraction of high-value components such as proteins, polysaccharides, fibres, volatile compounds and phytochemicals, which can also be used as nutritionally and pharmacologically functional ingredients. However, there must first be a paradigm shift in who growers consider their customers and what industries they consider end markets, and the Cosmetic Industry must bring in growers as stakeholders in upcycling discussions. In pursuit of natural ingredients, brands need growers and growers need brands: circular relationships that leverage each other's knowledge for better outcomes.

Sourcing Outside the Box
Horticultural by-products are excellent sources of flavonoids, phenolic compounds, dietary fibers, sugar derivatives, organic acids, and minerals, among other components that can be used in cosmetics. Within the food industry, there are various sectors that may be reliable sources of biomaterial. Beyond food, there are materials from other industries that can be converted into valuable ingredients, like flower or lumber. Rainforest Blue Oil, for example, has a repurposed backstory (sourced from reclaimed felled Australian rosewood logs through licensed harvesters) and delivers valuable constituents like guaiazulene, a very rare compound that gives the oil its blue color.

Alternative plant parts of a species that are typically wasted may also offer comparable benefits. Stems and leaves of fruit trees can offer similar compounds and allow growers to capitalize on seasonal pruning. Analysis of stem, leaf, and green blueberries all show to have similar compounds as ripe blueberry fruit, showing high levels of quercetin, a flavonoid well-regarded for its anti-inflammatory and antioxidant properties. Banana peels (making up 30% of the fruit's weight) have also shown higher nutrient levels than the pulp (75% more phenolic content).[5] In addition to considering various parts of a species, there are numerous extraction methods to consider for obtaining diverse compound profiles all from one product.

Future Proofing for Cost Effective, Eco-Efficient and Efficacious Ingredient
Although recent investigations have highlighted a cost advantage of extracting bioactive compounds from processed food waste,[6] there are several factors that will affect cost-effectiveness for manufacturers: a reliable and flexible supply chain, pre-treatment processing that protects phyto-nutrient availability, quality control and equal or better product performance. In the private sector, companies are forming online marketplaces, strategic partnerships and expanding vertical integration to allow suppliers and buyers to connect with each other. Manufacturers are innovating new processes and commercialising new ingredients, showcasing upcycled innovation and expanding growers' markets, while serving as a force for change, benefiting infrastructure development, transportation, food processing, packaging industries and even malnutrition and hunger.[7] Beyond reducing waste at the source, manufacturers can further reduce waste and plant material through biomass-efficient extraction processes (i.e., offering concentrations). For lasting change and resilient businesses, institutional and social shifts must be made through government support, certifications, market development, and cross industry collaborations. As demand rises for sustainable ingredients, the added costs of sourcing will be able to drop.

Conclusion
As the demand for more plant-based products rises, so does the concern for sustainable sourcing. The shifting movement toward natural beauty, prioritising potency and purity of natural and organic

ingredients over synthetic standardisation, coinciding with the mounting issue of food waste, is creating an inclusive community of manufacturers, growers, formulators, brands, municipalities and consumers working together to create solutions. While still in its infancy, there is promising potential for repurposing surplus and by-products for cosmetic extracts and ingredients. With more research and investment in recovery technologies and logistics, a new eco-sustainable source for biomolecules is emerging that will give 'waste' a new meaning.

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About the speaker

Heather Grove
(Environmental Science B.a. & Geography B.s.)
General Manager Marketing, NATIVE EXTRACTS Pty Ltd

Heather's work spans over a decade of connecting brands and consumers closer to the natural source. Prior to launching her own consultancy, HEATHER GROVE LLC, she worked within the food and farming industries developing the innovative and disruptive business models for East End Market and Fleet Farming^{TM}. She has worked around the world with organizations like The Green School Bali, Tabasco, International Alliance for Reforestation, Central Florida's Local Food Policy Council, ProNatura, Real Food Project, Food Tank, and more. Side-stepping into the Cosmetic Industry, Heather now shares the research of NATIVE EXTRACTS (NE), an Australian biotech innovator, advancing "True to Nature" Cellular Extraction, offering new analytical data on water-soluble profiles of traditional and Australian native species, and a leading R&D partner of large-scale commercialization projects. Heather translates the traceable and transparent ingredient stories for the innovators of Cellular Extraction^{TM} (NE) and the U.S. ingredient supplier, Naturally Australian Products, Inc, communicating the power of plants as ethical and eco-conscious ingredients for health and wellness, while continuing to support the growth of the primary industry.

Bottle your sustainability goals – Minimize your environmental and VOC footprint in Sun Care Products

Anna Howe; Evonik Corporation; Richmond, VA

James Grundy; Sun Bum; Encinitas, CA

Arnoldo Fonseca; Evonik Corporation; Allentown, PA

Stephanie Facuri; Evonik Corporation; Dana Point, CA

Introduction of research

Volatile Organic Compounds (VOC) have been on the radar screen of various public health agencies in the US. In California for instance, the California Air Resources Board (CARB) enforces VOC limits for specified consumer products, including cosmetics, with discretionary powers in calculating fines and penalties. At the same time, the post-COVID consumer and attentive brands are focused on the sustainability of their personal care products. Ingredient choice can make a big difference in addressing both concerns, particularly in sun care applications where consumers are looking at product performance and in-use sensory attributes. To reduce VOC levels, we will first examine emollient ester feedstocks and manufacturing processes that have been optimized to minimize CO_2 emissions. We will then examine the physiochemical properties of these emollients to identify sustainable replacements for volatile ingredients, such as ethanol, while maintaining product sun protection factor (SPF) performance as well as sensory attributes.

Methodology

A Life Cycle Assessment (LCA) according to ISO 14040 ff. was used to calculate the potential environmental impacts of a finished product throughout its life cycle. The Global Warming Potential (GWP) was calculated for raw material, production, product, transport, use and finally end of life. The GWP is measured in kg CO_2 equivalents. The sunscreen sprays, EK-6127-1254 (62% VOC) and EK-6127-1255 (55% VOC) were formulated using the following filter composition: Homosalate (10%); Octisalate (5%); Octocrylene (4%); Avobenzone (3%). The Ethanol level was lowered from 62% to 55% with the addition of Isoamyl Laurate (IAL).

The spreadability of the formulated system was reviewed using an internal system utilizing polypropylene substrate with a dosing level of 50µl. To evaluate the spreading properties, a polypropylene film was placed onto flat glass plate. Measurements (mm) were taken at 15 sec, 30 sec, 1 minute and 5 minutes. The area, $A = \pi r^2$, of the spreading was calculated at each time interval.

The gloss measurements on skin were conducted with a Glossmeter Zehntner ZGM 1130 with a dose level of 2 mg/cm^2. Readings were taken at 1 and 5 minutes. The test formulations were applied on the volar forearm.

A sensory evaluation was conducted using a descriptive analysis of a paired comparison. Eight attributes were evaluated during application (ease of distribution, whitening, oiliness, waxiness, absorption, slipperiness, stickiness and silky-/velvetiness). An additional six attributes were evaluated at 5 minutes (oiliness, waxiness, absorption, slipperiness, stickiness and silky-/velvetiness). The scale utilized was significantly less (-2), slightly less (-1), identical (0), slightly more (+1), significantly more (+2). The dosing level was 2mg/cm^2.

Results

Comparing the GWP of feedstocks, the most relevant sources are plant oils. We find that palm oil impact is still quite high due to the growth of land cultivation over the last decades. But if responsibly sourced palm oil (RSPO) is used, there is a 36% decrease (5.4 to 3.5) in CO_2 equivalent per kilogram of raw material.

Comparing conventional esterification synthesis vs. enzymatic synthesis while using renewable energy leads to an improved impact on global warming by 100% lower CO_2 footprint described in figure 1 (left). This biotechnological process uses less energy, prevents wastes, and uses benign solvents.

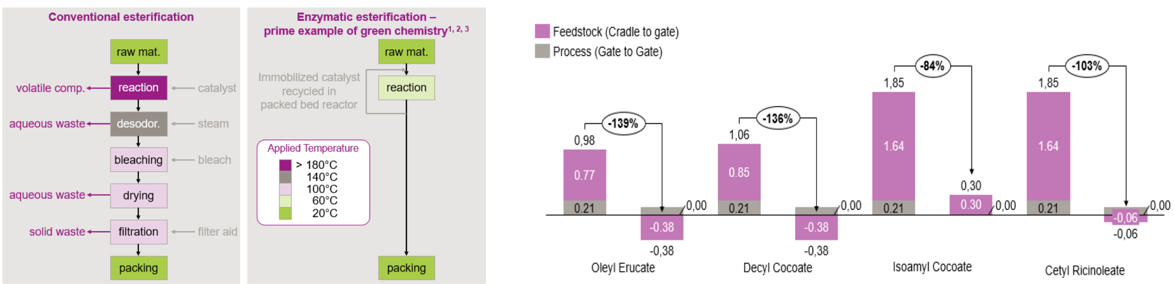

Figure 1: (left) Conventional esterification vs. enzymatic esterification [1] [2] [3], (right) Feedstock and process for enzymatic emollients.

Enzymatically produced esters have an improved impact on global warming by significantly lowering CO_2 footprint compared to conventional chemical production and non-RSPO certified feedstock described in figure 1 (right).

In cosmetic applications, emollients are utilized for their solvating and sensorial attributes on skin, but we can also look at this class of sustainable ingredients as possible solutions for chemistries falling out of favor due to environmental climate. To illustrate this, a high spreading enzymatic emollient, Isoamyl Laurate was used in place of 6% ethanol to obtain a lower VOC of 55%. This emollient was chosen due to its physiochemical properties such as spreadability which could mimic the behavior of ethanol in this matrix.

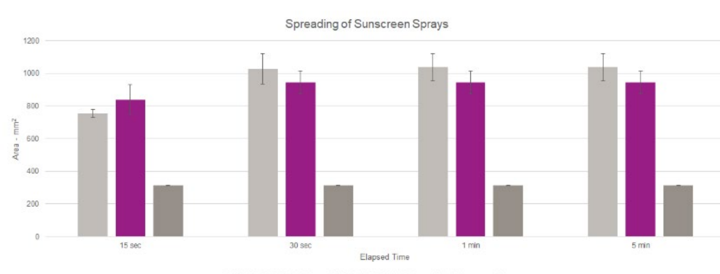

Figure 2: Spreadability data for the Internal Spray Sunscreens EK-6127-1254 (62%) and EK-6127-1255 (55%).

The internal spray sunscreens EK-6127-1254 (62%) and EK-6127-1255 (55%) exhibit at 30 seconds, 1 minute and 5 minute intervals a spreading behavior that remains constant (~950mm^2).

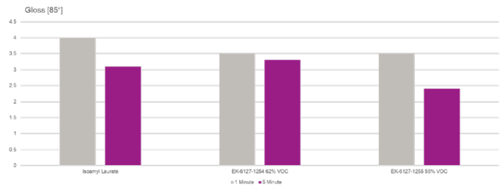

Figure 3: Gloss measurements on control emollient and spray sunscreens EK-6127-1254 (62%) and EK-6127-1255 (55%).

The two sunscreen spray systems measured the same gloss at 1 minute, but at 5 minutes the 55% VOC formulation showed lower reduction in gloss.

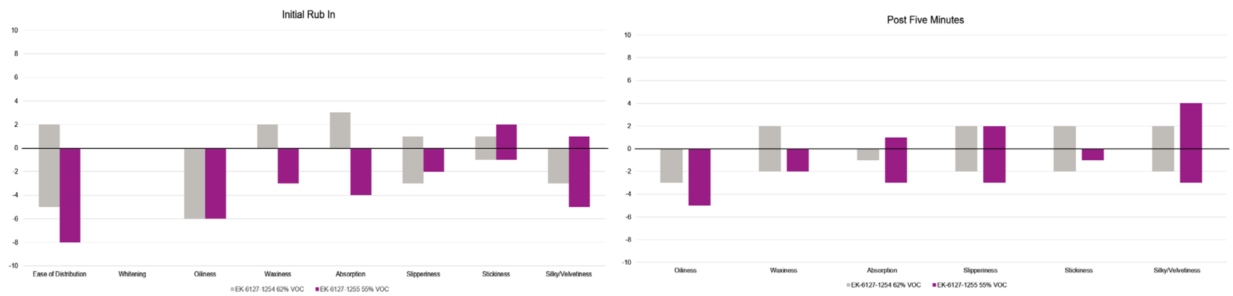

Figure 4: Sensory profile for EK-6127-1254 (62%) and EK-6127-1255 (55%) compared to market sunscreen spray control for initial rub in (left) and post five minute evaluation (right).

The sensory results showed that we can reduce the VOC level from 62% to 55% with careful selection of emollients using their physiochemical properties without compromising formula aesthetics. Lowering the VOC level using a substitution with IAL, which has a low viscosity and high spreadability, can also decrease the oiliness, waxiness and increase the silky/velvetiness.

Conclusion

Today's consumers are increasingly aware and continue to demand sustainable solutions in various industries, including the personal care industry. Many companies are placing sustainability at the center of their research and identifying key parameters that will support market needs. We have shown that with careful selection of raw material feedstocks in combination with green biotechnological process, such as enzymatic catalysis, we can significantly influence the CO_2 emissions in manufacturing. These sustainable enzymatic emollients can be used in traditional cosmetic applications to reduce the CO_2 footprint or can be sustainable solutions to reduce the VOC levels, while maintaining key parameters such as spreadability, minimizing gloss on skin, and sensory attributes.

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About the speaker

Anna Howe

Applied Technology Manager, Evonik Nutrition & Care, Care Solutions Business Line, North America

Anna Howe is an Applied Technology Manager, North America, for the Personal Care business of Evonik Corporation at the Evonik Business & Innovation Center in Richmond, Virginia. Anna's responsibility focuses on new product developments, formulations, performance evaluations, test method development for claims, and technical services.

Anna earned a Bachelor of Science in Chemistry at Virginia Polytechnic Institute & State University in Blacksburg, VA. Anna joined the Personal Care Group of Evonik Corp. in 1997. Prior to joining Evonik, Anna held positions of increasing responsibility at Inolex Chemical Company, Rhône-Poulenc (Rhodia) and Alcolac Chemical Corporation. Further, Anna is a member of the Society of Cosmetic Chemists and holds several application patents as well as authored several scientific papers in the personal care arena.

Among Anna's great accomplishments, one of most esteem accomplishments is "Family".

A far-reaching plant-based human collagen type I fragment: David vs. Goliath

Silvia Pastor; LipoTrue S.L.

Grau-Campistany, Ariadna [1] ; Soriano, Jorge[1] ; Carulla, Patricia[1] ; Mateu, Miriam[1]; Bronchalo, Isabel[1]; Pastor, Silvia[1]. [1]LipoTrue S.L.*

Introduction of research

Collagen has become a classic and trust-worthy ingredient that is essential in antiaging formulations, partially due to it being the main component of the skin [1], the fact that the amount of collagen decreases with age and external aggressions (e.g. UV) and its interesting properties (e.g. moisturizing). However, traditional collagen has been always animal sourced, such as bovine collagen or fish collagen with the consequent drawbacks [2-3]. Additionally, there is a rising interest for this type of molecules to be completely animal-free and cruelty-free. Therefore, safer alternatives have been developed such as recombinant collagen obtained through bacteria, yeast or plant-cell cultures. The limitation with prokaryotic systems, is that they lack native post-translational modification mechanisms and consequently the collagen obtained presents poor solubility and lower quality and similarity to human collagen, than its animal or plant-cell cultured counterpart [4]. Therefore, there is a need for a novel collagen, a safe and sustainable alternative with high purity and with similar or higher efficacy.

After exhaustive research, we have designed and synthesized, a collagen fragment (fColI(h)), the sequence of which was chosen to be rich in prolines, critical for collagen biosynthesis, structure and function, and to contain specific integrin-binding and cell-attachment motifs. This identical-to-human collagen type I fragment has shown to have solid in vitro and ex vivo efficacy, as well as a clear anti-aging clinical efficacy, making it the alternative for safer and improved cosmetic formulations.

Methodology

Design and development of a novel identical-to-human collagen type I fragment (10.7 kDa, INCI: Collagen amino acids), in a non-GM plant-expression system using Nicothiana benthamiana. Cell adhesion on keratinocytes. Modulation of procollagen type I by ELISA and cell proliferation by Alamar Blue in fibroblasts. Collagen-matrix contraction assay and β-galactosidase for oxidative senescence protection in HDFa. Collagen-binding integrins expression by immunofluorescence. Surface tensor effect on human skin explants using fluorescence beads via confocal microscopy. Clinical efficacy was evaluated in two different studies after 30 min, 7, 14 and 28 days of daily use in two panels of 20 Caucasian females each aged between 40 and 60 years old. Evaluations were carried out by means of non-invasive bioengineering techniques able to measure skin profilometric parameters (wrinkle depth, Primos 3D), and product reshaping/tensor effect (PrimosCR high resolution large field). Volunteers were divided in two panels: 20 subjects applied on one hemi-face a cream containing 2% fColI(h) and a placebo on the other side; 20 subjects applied on one hemi-face a cream containing 2% ascorbyl glucoside (AA-2G, a stabilized form of vitamin C, known to induce collagen synthesis) and on the other side a formulation combining 1% fColI(h) and 1% AA-2G.

Results

The collagen fragment synthesized, identical to human collagen and more importantly that contains the post-translational hydroxylations and integrin-binding motifs present in collagen, has shown to firstly act by increasing epidermal adhesion in keratinocytes (Figure 1, left). Epidermal cohesion is of paramount importance for the integrity of the skin, as cell–cell adhesions are necessary for structural integrity and barrier formation of the epidermis. Additionally, this compaction is accompanied by an increase in surface tension demonstrated on skin explants by confocal microscopy (Figure 1, right).

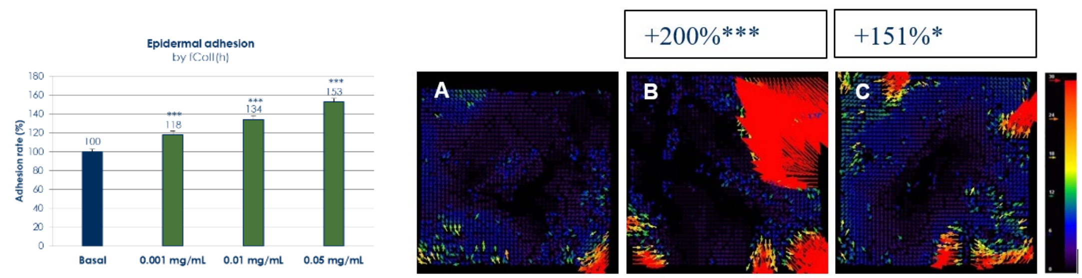

Figure 1: (left) Effect of fColI(h) on keratinocyte adhesion capability. (right) Bead movement, after 24 h of treatment, represented by colour and vectorial arrow. According to the calibration bar, the redder the vectorial arrow the higher the bead displacement: (A) Non-treated, (B) 1% fColI(h) and (C) 40% Sodium Ascorbyl Phosphate.

Once in the dermis, the collagen fragment is able to reinforce its specific binding sites, via a significant increase in integrin-β1 and -α2 levels (+15% and +39%) observed using immunofluorescence (Figure 2). More importantly, fColI(h) might be able to act simultaneously on both integrin α2 and β1 subunits on fibroblasts therefore actively regulating collagen networks in the dermis [5] and strengthening the mechanosensing properties of fibroblasts as observed by the increase in contraction induced by fColI(h) in a collagen-matrix assay (+36%, 0.05 mg/mL). More importantly, there is an overall dermal rejuvenation. Fibroblast turnover helps improve the regeneration of the ECM, but aged cells present a decreased cell growth rate. Fibroblasts treated with fColI(h) present an increase in cell turnover along with an increase in endogenous collagen type I (150%, 0.05 mg/mL) accompanied by a decrease in metalloproteinases (qPCR, -1.42-fold, 0.001 mg/mL). A decrease in oxidative dermal senescence is observed, as a decrease in β-galactosidase positive cells (-36%, 0.05 mg/mL).

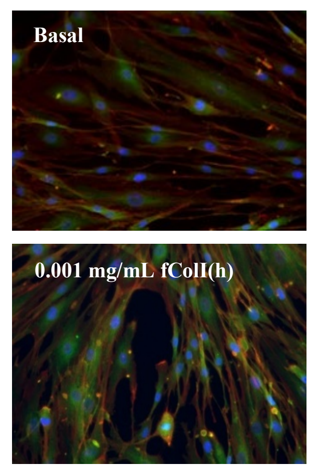

Figure 2: Images acquired with a fluorescence microscope of integrin β1 staining in HDFa cells (ITGB1 Alexa 488 (green), Phalloidin-TRITC (red) and nuclei DAPI (blue)).

Finally, at the clinical level (Figure 3), the studies performed show that 2% of commercial solution of fColI(h) is able to significantly decrease wrinkle length and depth and provide a lifting effect vs placebo. The combination of AA-2G and fColI(h) results in a robust decrease in wrinkles appearance but, more importantly, fColI(h) outperforms the efficacy of AA-2G.

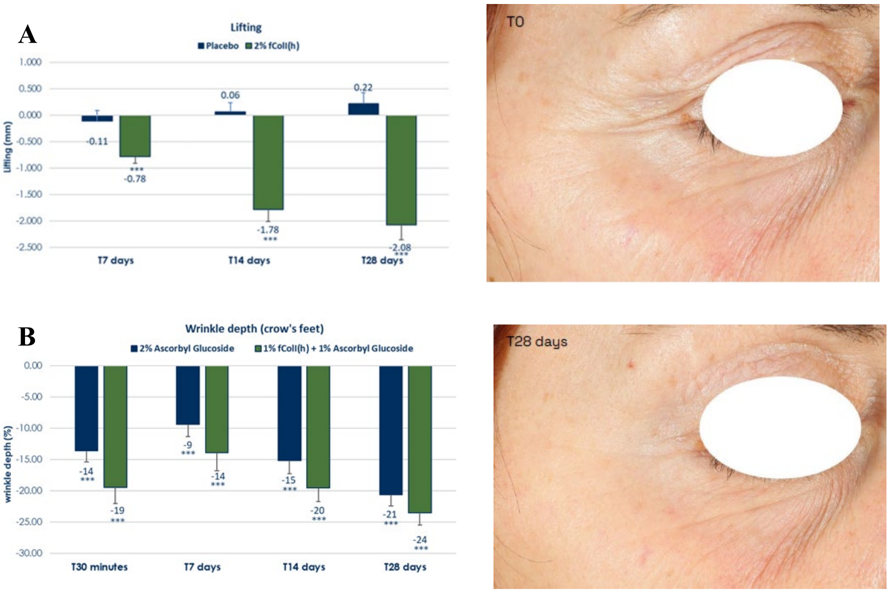

Figure 3: (left) Graphic representation of the mean data at each experimental time A) Lifting effect of Placebo vs 2% fColl(h) and B) wrinkle depth of 2% of AA-2G vs 2% of fColl(h) and 1% of AA-2G. (right) Representative images of volunteer 5 after 28 days of treatment with 2% fColl(h).

Conclusion

Human collagen is one of the cosmetic industry's gold ingredients. Current demands for sustainable and vegan resources have made the finding of a collagen meeting these characteristics a field of active research. In Lipotrue, we listened to these demands and designed a distinctive plant-based human collagen fragment. Just like David, our collagen fragment, with just 116 amino acids, has shown to be able to imitate the action of full collagen, a protein of 1464 amino acids, in this analogy our Goliath, while increasing the amount of collagen I itself. Overall, this novel and unique collagen fragment has proved to be the new collagen alternative, with an overall anti-aging and rejuvenating efficacy.

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About the speaker

Graduated in Biochemistry with a PhD in Experimental Immunopathology in collaboration with UTSW Medical Center (USA). Silvia has a wide knowledge in cell culture and tissue regeneration and more than 12 years of experience in R&D Management & Business Development of active ingredients for cosmetic applications.