Triple temperance strategy for scalp and hair care

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Abstract

Background: We propose an anti-aging approach for scalp and hair follicle based on a temperance strategy through three key targets: moderating scalp sensitivity by protecting the epidermal barrier, balancing microbiota and tempering the oversized immune response.

Methods: Plant extracts were selected for their TRPV1-antagonist properties and the best plant extract (PE) was studied for its effects on the regulation of the microbial balance (formation of *Staphylococcus epidermidis* biofilm and lipase activity) and immuno-dependent inflammatory mechanisms (quantification of IL8 secreted by macrophages induced by heat-killed C*utibacterium acnes*). Finally, the capacity of the PE to promote proliferation of hair matrix after being stressed with capsaicin were evaluated (level of Ki67 and versican expression).

Results: We observed that the PE decreased the capsaicin-induced TRPV1 activity (-26%), S. epidermidis biofilm formation (-22%) and fully inhibited its lipase activity. The production of pro-inflammatory IL-8 by macrophages activated by C. acnes was also decreased. In the presence of capsaicin, both versican and Ki-67 antigen were decreased in pseudo-dermal papillae models and in hair follicles in culture respectively.

Conclusion: We showed that a PE can temper the activation of the heat-sensitive TRPV1 channel, the macrophage-dependent inflammatory processes, the commensal S. epidermidis biofilm formation and lipase activity to limit microbial dysbiosis and improving hair follicle physiology.

Keywords: TRPV1; microbial lipase; IL-8, scalp and hair physiology,

Introduction.

Gradual changes in the structure of the scalp and its ability to regenerate occur with aging. Moreover, cumulative effects of environmental factors contribute to a decrease in skin and scalp barrier function and hydration, favoring the entry of irritating compounds and allergens. This results in an exacerbation of scalp sensitivity, an aggravation in epidermal barrier defects, disturbances in the regulation of immune and inflammatory mechanisms and additionally a change in the microbial balance. Microenvironmental modifications of the scalp can impact hair follicle physiology and consequently lead to impairment of the growing fiber in quality and properties. The worsening of scalp condition and of hair loss can be associated with stress and loss of self-esteem, and may have a huge impact on social, emotional, and psychological well-being. Complaints from consumers are frequent for these types of disorders however it is a challenge to find natural products that could meet this need.

Here we propose a holistic approach for scalp and hair follicle care based on a temperance strategy through three key targets: moderating scalp sensitivity by protecting the epidermal barrier, balancing microbiota and tempering the oversized immune response. The mitigation of the heat-sensitive TRPV1 (Transient Receptor Potential Vanilloid type 1) channel activity seemed to us a key target for tempering scalp and hair follicle disorders. It is expressed in many cell types and is involved in several biological processes such as cellular growth, cell survival, inflammation, or pain and plays key roles in multifunctional disorders [1,2]. In the skin, this nociceptor plays a role in differentiation, proliferation, and homeostasis of the epidermal barrier [3]. Moreover, recent studies have also shown an impact of TRPV1 activation in the modulation of hair growth cycles [4].

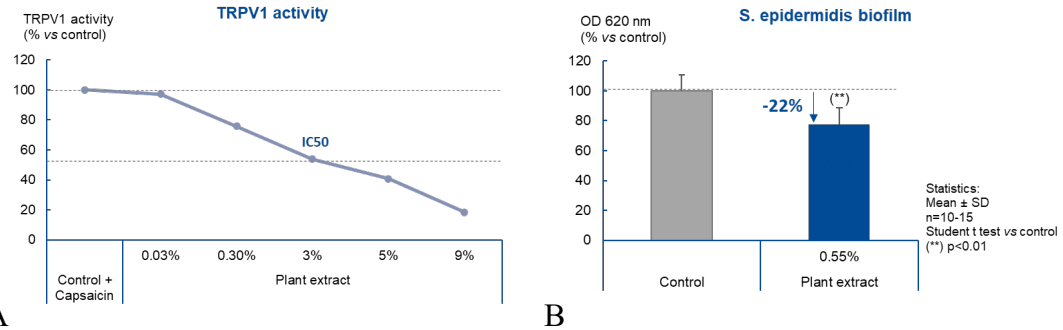
Materials and Methods.

At first, plant extracts were screened for their TRPV1-antagonist properties using a fluorometric detection method in transfected cells stimulated by capsaicin. Then, the best plant extract (PE) was studied for its effects on the regulation of the microbial balance and immuno-dependent inflammatory mechanisms. The formation of *Staphylococcus epidermidis* biofilm was evaluated using crystal violet staining-based assay and its lipase activity was measured by fluorometric method. The inflammatory response of macrophages induced by inactivated *Cutibacterium acnes* was assessed by quantifying secreted interleukin-8 (IL8). Finally, the capacity of the PE to promote proliferation of

epidermal keratinocytes and hair matrix cells was assessed by using Ki67 immunofluorescence microscopy on both human reconstructed epidermis and in ex vivo culture of hair follicles stressed by 50µM of capsaicin. Because versican is a molecule highly expressed during the growing anagen phase and known to be involved in dermal matrix assembly and cell adhesion, the protective effect of the PE was also evaluated by immunostaining of versican in dermal papilla fibroblasts cultured in pseudo-papillae aggregates stressed by capsaicin.

Results.

We observed that the best PE used at different concentration decreased the capsaicin-induced TRPV1 activity (Figure 1A), and used at 0.55% it reduced the *Staphylococcus epidermidis* biofilm formation by 22% (Figure 1B) and fully inhibited its lipase activity (data not shown).



A B

Figure 1: (A) TRPV1 activity and (B) *S. epidermidis* biofilm formation after treatment with the plant extract.

The production of pro-inflammatory IL-8 by macrophages activated by *Cutibacterium acnes* was also significantly decreased (-24% at 0.5% up to -48% at 0.9%) (Figure 2).

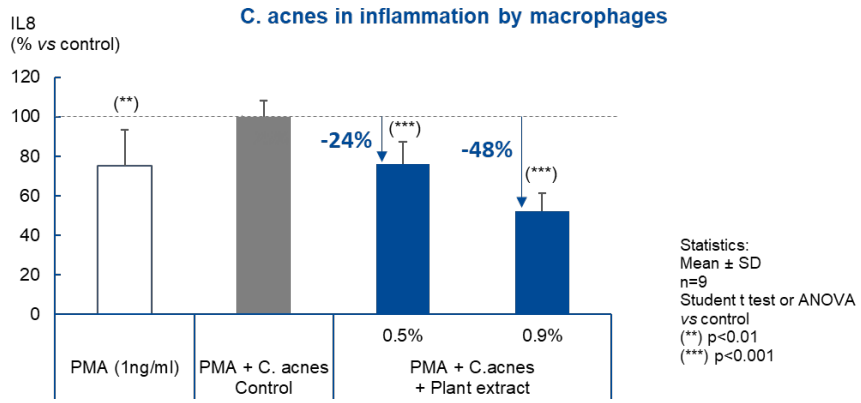


Figure 2: Measurement of IL-8

Finally, we showed that in the presence of capsaicin, both versican and Ki-67 antigen were decreased in pseudo-dermal papillae models and in hair follicles in culture (Figure 3).

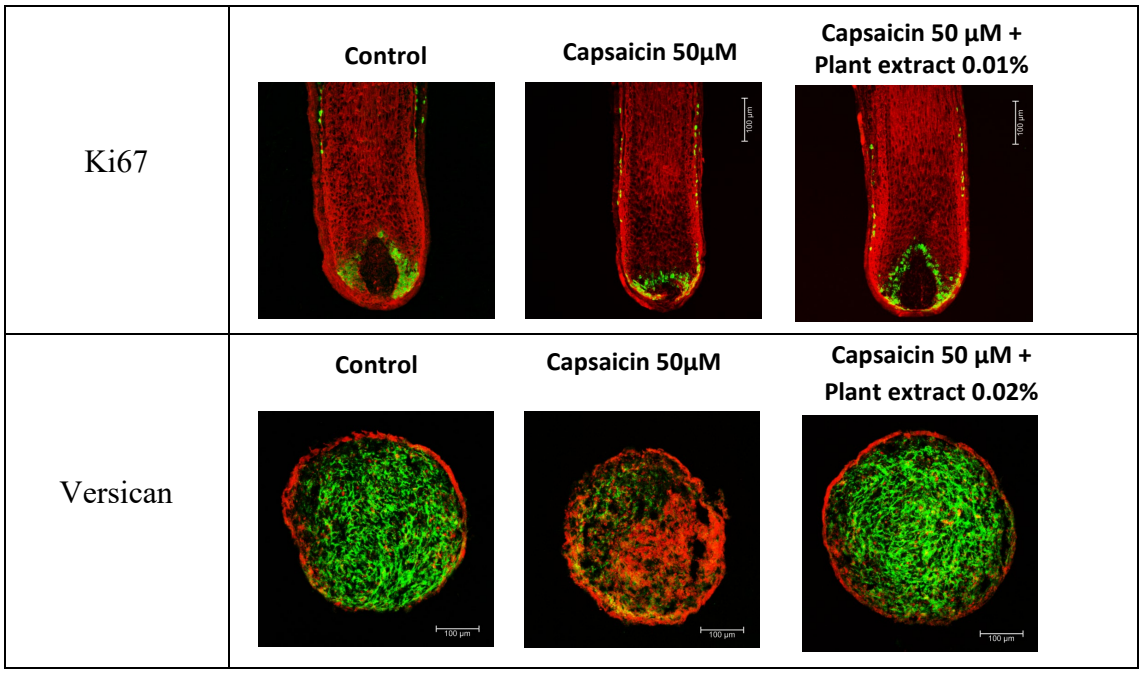


Figure 3: Immunostaining of Ki67 (hair follicle in culture) and versican (pseudodermal papillae model) after treatment with the plant extract in a stress-induced model (capsaicin). Green: Ki67 or Versican; Red: Evans Blue was used as a contrast agent. Scale bar: 100µm

These results suggest that TRPV1 agonist can impact hair growth cycles. Interestingly, the treatment with the PE significantly restored a higher level of versican and Ki-67 in the stress-induced hair model.

Discussion.

In this present work, we showed that a PE can temper the activation of the heat-sensitive TRPV1 channel, the macrophage-dependent inflammatory processes, the commensal *S. epidermidis* biofilm formation and lipase activity to limit microbial dysbiosis. The plant extract was also able to restore a higher level of versican and Ki-67 in the stress-induced

hair model. Furthermore, a consumer study demonstrated perceivable benefits of the botanical product on the scalp and hair when formulated in a shampoo and conditioner.

Conclusion. This study demonstrated that triple temperance strategy using a botanical ingredient is effective in scalp and hair care.

Acknowledgments. We acknowledge Lydie Teixeira, Lucile Deposito, Nathalie Andres and Carine Tedeschi for their technical skills

Conflict of Interest Statement. All authors are employee of BASF Beauty Care Solutions.

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