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ORIGINAL ARTICLE

Exploring the microbiota–skin–brain axis: Chicory extract biotransformed into a postbiotic neurocosmetic enhancer of social and sensory experience

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Abstract

Objective: Measuring the influence of cosmetic ingredients on the microbiota-skin-brain axis is a difficult challenge. Here, we try to build a connection between the commensal *S. epidermidis*, its post-biome, influence on neurotransmitter release in skin and emotional response to the use of an extract from *Cichorium intybus*.

Methods: Measurement of skin evenness with physical measurements, objective and subjective perception. Measurement of emotional arousal with galvanic skin response, advanced facial and eye tracking system, and electro encephalography. Of note, not only were the subjects investigated but also the person caressing the treated subjects. The influence of the skin's microbiota was determined using a 3D epidermal skin model, a keratinocyte/neuron coculture, and bacterial cultures.

Results: *C. intybus* extract leads to smooth skin and positive excitement of subjects using the cosmetic formulation. Additionally, it evoked positive emotions in a person caressing the treated skin. Treatment of *Staphylococcus epidermidis* with the extract induced the secretion of bioactive post-biotics that promote neurotransmitter release, suggesting a potential stimulatory effect on neuronal activity. Given that this bacterial stimulation does not involve proliferation, we define this prebiotic state as 'activated rest.'

Conclusion: *C. intybus* extract is a candidate to elucidate the complex relationship between skin microbiota, skin perception, and emotional response of subjects using cosmetic products, even influencing social interaction on others.

KEYWORDS

circumplex model of arousal, claim substantiation, psychodermatology

Résumé

Objectif: Mesurer l'influence des ingrédients cosmétiques sur l'axe microbiote-peau-cerveau est un défi complexe. Nous tentons ici d'établir un lien entre la

bactérie commensale *S. epidermidis*, son post-biome, son influence sur la libération de neurotransmetteurs dans la peau et la réponse émotionnelle à l'utilisation d'un extrait de *Cichorium intybus*.

Méthodes: Mesure de l'uniformité de la peau à l'aide de mesures physiques, d'une perception objective et subjective. Mesure de l'excitation émotionnelle à l'aide de la réponse galvanique de la peau, d'un système avancé de suivi du visage et des yeux, et d'une électroencéphalographie. Il convient de noter que non seulement les sujets ont été étudiés, mais également la personne caressant les sujets traités. L'influence du microbiote cutané a été déterminée à l'aide d'un modèle cutané épidermique en 3D, d'une co-culture de kératinocytes/neurones et de cultures bactériennes.

Résultats: L'extrait de *Cichorium intybus* a permis d'obtenir une peau lisse et une excitation positive chez les sujets utilisant la formulation cosmétique. De plus, il a suscité des émotions positives chez la personne caressant la peau traitée. Le traitement de *Staphylococcus epidermidis* avec l'extrait a entraîné la sécrétion de postbiotiques bioactifs qui favorisent la libération de neurotransmetteurs, suggérant un effet stimulateur potentiel sur l'activité neuronale. Étant donné que cette stimulation bactérienne n'implique pas de prolifération, nous définissons cet état prébiotique comme un «repos activé».

Conclusion: L'extrait de *Cichorium intybus* est un candidat pour élucider la relation complexe entre le microbiote cutané, la perception de la peau et la réponse émotionnelle des sujets utilisant des produits cosmétiques, influençant même les interactions sociales avec autrui.

INTRODUCTION

Cosmetic experiences are inherently emotional as they alter how skin feels and looks. We can map this onto core affective dimensions of pleasure–displeasure (valence) and activation–deactivation (arousal). The circumplex model of affect formalizes this space and provides a theoretically grounded framework for positioning momentary feelings such as calmness, tension, excitement, or contentment by their coordinates on these two orthogonal axes [1, 2]. In practice, the circumplex model enables researchers to translate multimodal psychophysiology and behavior into interpretable trajectories of emotional state during product interaction [3]. A complementary measurement strategy emerges from pairing electrodermal activity, often termed galvanic skin response (GSR), with automated facial expression and eye-tracking analytics. GSR is a sensitive measure of sympathetic activation driven primarily by eccrine sweat gland activity. Increases in skin conductance reliably track the intensity of emotional arousal during cognitive or affective challenges [4]. By contrast, machine-vision analysis of facial expressions can determine valence continuously from video, providing non-intrusive readouts that align with dimensional models of emotion [5–7]. Eye-movement metrics acquired in parallel can add information about attention and engagement under emotional load, which can be modulated by both valence and arousal [8, 9]. When integrated and projected into the circumplex model, the above-mentioned parameters provide a coherent map of a product's affective footprint [1].

Beyond the individual using a cosmetic product, positive emotions evoked by touch from others are powerful drivers of well-being and prosocial behaviour. Afferent C-tactile fibres constitute a dedicated pathway for affective touch that preferentially signals pleasant interpersonal contact and supports social bonding. However, this does not only apply to the individual being touched, but also to the person doing the touching [10].

In the brain, social distancing tendencies go in line with frontal cortical dynamics: relatively greater left-frontal activation (often indexed by decreased alpha power and frontal alpha asymmetry) is associated with approach motivation and positive affect, whereas right-frontal dominance relates to withdrawal and negative affect [11].

These mechanistic links suggest that product-induced changes in skin feel could shape interpersonal touch

experiences and, in turn, modulate approach-oriented social behavior.

Skin is not merely a passive barrier, but a neuro-immuno-endocrine organ embedded in bidirectional communication with the nervous and immune systems [12]. It produces and responds to classical neuro-mediators and hormones, positioning it to participate in a microbiota–skin–brain axis analogous to the gut–brain–skin axis [13].

Pilot studies indicate that the skin microbiota may influence cognitive functions and stress responses, suggesting the existence of a direct skin–brain communication pathway [14]. This microbiota–skin–brain axis represents a bidirectional system linking dermatological conditions to psychological states. Impaired skin health, as observed in acne or atopic dermatitis, serves as a visible and perceivable marker of underlying inflammatory processes, which are transmitted to the brain through neural pathways or endocrine and neurotransmitter signaling. Conversely, psychological stress or negative emotional states can exacerbate atopic flare-ups [15, 16]. Given the critical role of microbiota in these skin disorders [17], it is reasonable to infer that dysbiosis of the skin microbiota significantly contributes to the dynamics of this axis.

Within this ecosystem, the commensal bacterium *Staphylococcus epidermidis*, a dominant, generally beneficial resident of healthy skin, can shape host immunity and barrier function, while its metabolism and secreted postbiotics adapt to environmental context [18, 19].

Notably, skin is an organ harbouring multiple kinds of cells, among them neurons or at least neuronal fibers. Cutaneous cells can synthesize and/or respond to circulating neurotransmitters, making the skin-brain axis a two-way communication pathway [12, 13].

We set out to explore whether a *Cichorium intybus* Root Extract (CHICORY-EXTRACT) could act at the interface of these systems to (i) improve skin surface quality, (ii) modulate emotional experience during product use as analysed in the circumplex model of arousal via GSR-derived arousal and advanced facial/eye-tracking-derived valence, and (iii) influence social interaction by assessing the brain activity of an interacting partner during interpersonal touch. Building mechanistic plausibility, we further tested whether CHICORY-EXTRACT conditions *S. epidermidis* to release postbiotic factors capable of stimulating neurotransmitter release in a keratinocyte/neuron co-culture—an in vitro approximation for microbiome-driven signalling along the microbiota–skin–brain axis. This integrated approach aims to connect objective skin texture, affective psychophysiology, social neurobiology, and microbial ecology into a single experimental narrative relevant to cosmetic active ingredients.

MATERIALS AND METHODS

Preparation of CHICORY-EXTRACT

CHICORY-EXTRACT was obtained through mechanical pressing of *C. intybus* roots. The resulting root sap was subjected to thermal treatment, followed by filtration. Preservation was achieved using pentylene glycol, and the pH was adjusted using citric acid. The final formulation was composed of the following ingredients (INCI): Water, *C. intybus* (Chicory) Root Extract, Pentylene Glycol, Citric Acid.

Analytical characterization

High-performance liquid chromatography (HPLC) was performed using a Dionex UHPLC Ultimate 3000 system equipped with a Dionex CarboPac PA100 anion exchange column, optimized for oligosaccharide analysis. Detection was carried out using a pulsed amperometric detector (PAD). Elution with sodium acetate enabled separation of free carbohydrates, followed by inulin oligomers according to their degree of polymerization.

In vivo studies

All in vivo experiments were conducted in compliance with Good Laboratory Practice (GLP), Good Clinical Practice (GCP), and the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants prior to study initiation.

A randomized, double-blind, placebo-controlled study was conducted involving 56 female subjects aged 35–55 years (mean age: 46.6 years). Participants were assigned to either the test group ($n = 28$), receiving an emulsion containing 3% CHICORY-EXTRACT, or the placebo group ($n = 28$), receiving the same base formulation without the extract. The emulsion (INCI: Water, Caprylic/Capric Triglyceride, Glyceryl Stearate Citrate, Cetearyl Alcohol, Dipropylene Glycol, Xanthan Gum, Glycerin, Caprylyl Glycol, Glyceryl Caprylate, Citric Acid) was applied twice daily to the face and forearms over a 28-day period. Measurements were taken at baseline (D0), after a second application 30 min later (D0 + 30 min), at Day 7 (D7), and Day 28 (D28).

Skin friction was assessed using a frictiometer FR 700 (Courage & Khazaka, Germany), and skin surface roughness was quantified using AEVA-HE imaging (Eotech, France). Dermatological evaluation of skin evenness was performed using a standardized 10-point scale. Subjective assessments were collected via participant questionnaires using a graded response format.

Emotional arousal was measured using a Galvanic Skin Response System (Shimmer3 GSR+, Shimmer Sensing, Ireland), while emotional valence was assessed using an advanced facial and eye tracking system (iMOTIONS, Denmark). These measurements were conducted following product application and during a cognitive engagement phase.

Electroencephalographic (EEG) recordings were obtained from a technician performing tactile stimulation (caressing) of the subjects' forearms using a 32-channel EEG cap (actiCHamp, Brain Products GmbH, Germany). Only one arm was treated with the formulation, while the contralateral untreated arm served as a control. Frontal alpha asymmetry was calculated with the formula $\ln P_{right} - \ln P_{left}$, where P is alpha power and a positive value means higher alpha power in the right hemisphere.

In vitro skin model

Three-dimensional epidermal skin equivalents were reconstructed using normal human epidermal keratinocytes (NHEK) isolated from foreskin tissue of three Caucasian donors (StratiCELL). Tissues were cultured at the air-liquid interface for 14 days in Epilife medium (Fisher Scientific). Subsequently, the reconstructed epidermis was inoculated with *Staphylococcus epidermidis* (ATCC1222) at a concentration of 1000 CFU, with or without 0.1% CHICORY-EXTRACT, for a duration of 3 days. Following incubation, cells were harvested for RNA extraction. Quantitative real-time PCR (RT-qPCR) was performed to assess the expression of 93 genes associated with innate immunity and antimicrobial responses and epidermal metabolism.

Chicory extract conditioned *S. epidermidis* supernatants

Staphylococcus epidermidis (ATCC14990) with 1700 cfu/20 mL was inoculated in CASO broth for 16 h at 37°C with or without the addition of 1% CHICORY-EXTRACT. Supernatants were collected by centrifugation and sterile-filtration (0.22 µm).

Keratinocyte–sensory neuron co-culture and neurotransmitter assay

Human sensory neurons were differentiated from human induced pluripotent stem cells (hiPSCs) using a previously established protocol similar to that described in Oh et al. [20]. Cells were cultured in differentiation medium for 9 days, followed by a 14-day incubation in maturation medium to promote neuronal phenotype stabilization. Subsequently, primary human keratinocytes obtained from an adult donor (29 years old) were added to the culture to establish a keratinocyte–neuron co-culture system.

To assess the impact of microbial and botanical stimuli on neurochemical signalling, the co-cultures were treated with either 0.1% CHICORY-EXTRACT or 0.1% culture supernatant derived from *Staphylococcus epidermidis* spiked with 1% CHICORY-EXTRACT or not. After 48 hours of incubation, culture supernatants were collected and analysed for neurotransmitter release using enzyme-linked immunosorbent assay (ELISA), specifically targeting dopamine and oxytocin. Data were normalized for cell numbers.

Statistical analysis

Statistical comparison was done by paired Student's t-test for intra-group comparisons and by unpaired Student's t-test for inter-group analysis. In case of not normally distributed values, we used non-parametric tests (such as the Wilcoxon signed rank test) as appropriate. We considered $p < 0.05$ as the level of significance ($^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$). Asterisks of the figures directly on top of a column represent significance compared to untreated or initial control. Error bars display standard error of the mean.

RESULTS AND DISCUSSION

Chemical characterization of CHICORY-EXTRACT

Chromatographic analysis of CHICORY-EXTRACT revealed the presence of mono- and disaccharides, including glucose, fructose, and sucrose. Additionally, oligosaccharides corresponding to inulin-type fructans with degrees of polymerization (DP) ranging from 3 to 10 were identified, alongside longer-chain inulin polymers. The PAD chromatogram (data not shown) indicated a relative enrichment of short-chain inulin oligofructose (SCIFOS) species.

Clinical evaluation of skin texture and perception

In a randomized, double-blind, placebo-controlled study involving 56 female participants with Fitzpatrick skin

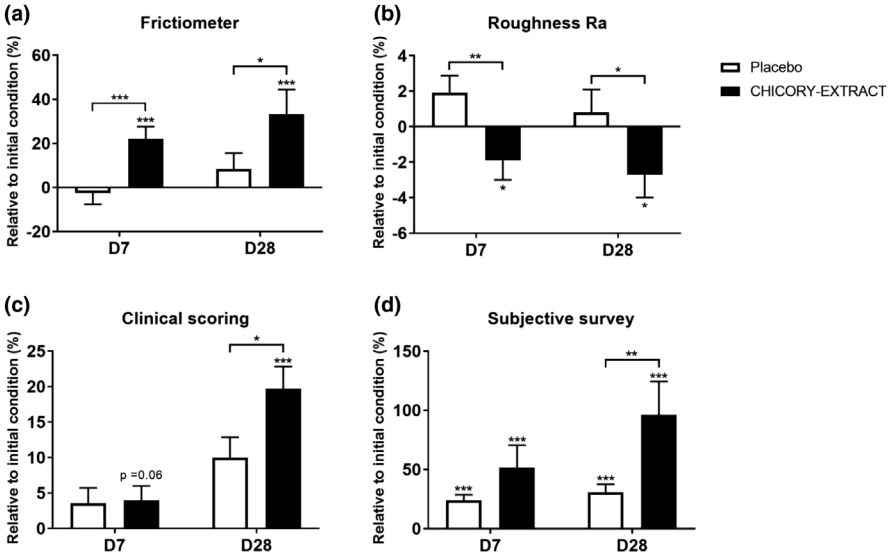

FIGURE 1 CHICORY-EXTRACT reduces skin roughness. (a) Improvement in skin smoothness increases the friction measured by a frictiometer. (b) Skin roughness measured by AEVA. (c) Clinical scoring for skin evenness by a dermatologist. (d) Subjective assessment of skin evenness by study participants. Significances: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

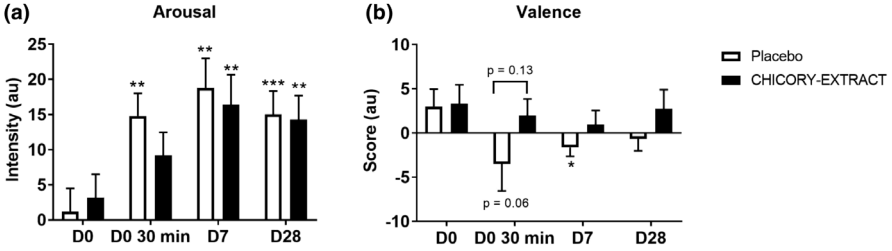

FIGURE 2 CHICORY-EXTRACT evokes positive emotions of skin feel. (a) Arousal intensity as measured by GSR. (b) Positive and negative valence as measured by AFETS. Significances: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

types I–IV, a cosmetic emulsion containing 3% CHICORY-EXTRACT or placebo was applied twice daily to the face and forearms over a 28-day period.

Instrumental assessment using frictiometry demonstrated a statistically significant increase in skin friction of 22.1% at Day 7 and 33.2% at Day 28, indicative of enhanced skin smoothness due to increased contact surface area (Figure 1a). This finding was corroborated by AEVA-based surface roughness measurements, which showed a significant reduction in the Ra parameter by 1.9% at Day 7 and 2.7% at Day 28 (Figure 1b). No significant changes were observed in the placebo group, which in some cases exhibited a trend toward increased roughness. Comparative analysis confirmed the superior efficacy of CHICORY-EXTRACT over placebo for both parameters.

These instrumental findings were supported by dermatological evaluations and participant-reported outcomes (Figure 1c,d). Dermatological assessments revealed a 19.7% improvement in skin evenness at Day 28, while subjective surveys indicated a 96.2% positive response rate. Notably, significant or near-significant improvements were already evident by Day 7, with further enhancement observed by Day 28. Collectively, these data demonstrate that CHICORY-EXTRACT improves skin smoothness across objective (frictiometry, AEVA), clinical (dermatologist rating), and perceptual (subjective survey) dimensions.

Emotional response to skin treatment

To explore the emotional impact of improved skin feel, emotional arousal and valence were assessed using galvanic skin response (GSR) and an advanced facial expression and eye tracking system (AFETS). GSR quantified the intensity of emotional activation, while AFETS differentiated between positive and negative emotional valence.

At baseline, neither formulation elicited substantial emotional arousal (Figure 2a). However, after the second application 30 min later, the placebo group exhibited a significant increase in arousal, which persisted through Day 7 and Day 28. CHICORY-EXTRACT induced a comparable arousal response beginning at Day 7. Initial emotional valence was mildly positive for both formulations but diverged over time: placebo elicited significantly negative emotional responses at 30 min and Day 7, whereas CHICORY-EXTRACT maintained a consistently positive valence throughout the study (Figure 2b). By Day 28, emotional responses to placebo approached neutrality, suggesting habituation.

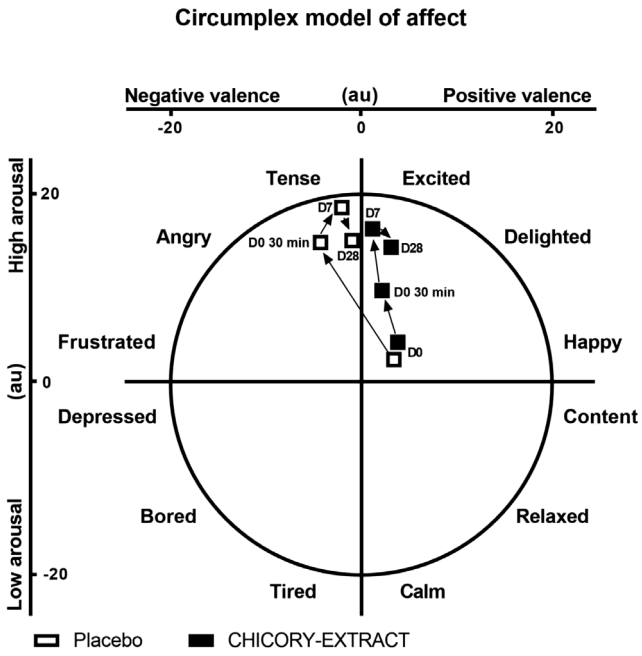

FIGURE 3 Circumplex model of affect shows positive emotions for CHICORY-EXTRACT. During the entire study duration, subjects felt positively excited when using CHICORY-EXTRACT while having a tense feeling with placebo.

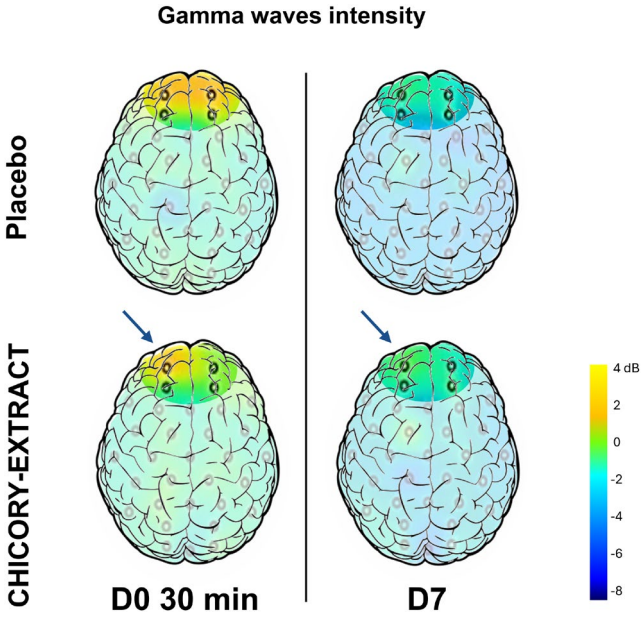

FIGURE 4 Gamma waves intensity map. CHICORY-EXTRACT activates the left frontal cortex of the person who touches treated skin.

Interpreted within the circumplex model of affect created by Russell et al. [1], CHICORY-EXTRACT was associated with emotional states characterized by delight and excitement, while placebo was linked to a tense feeling (Figure 3). It is important to note that the magnitude of facial expression changes was subtle, reflecting the non-irritating nature of the formulations and absence of sensory stimuli such as cooling or heating.

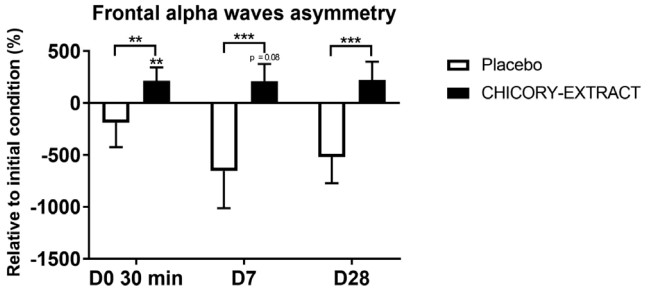

FIGURE 5 CHICORY-EXTRACT reduces activity in the right frontal cortex. Frontal cortex asymmetry for alpha waves relative to the initial condition of the person who touches treated skin. Bars pointing upward represent increased alpha wave activity in the right frontal cortex; bars pointing downward indicate increased activity in the left frontal cortex. Significances: $*p < 0.05$; $**p < 0.01$; $***p < 0.001$.

Interpersonal emotional transfer via touch

To investigate whether improved skin feel could influence interpersonal emotional dynamics, EEG recordings were obtained from a technician caressing the forearms of participants treated with either CHICORY-EXTRACT or placebo. Measurements were taken at Day 0, 30 minutes, Day 7, and Day 28.

CHICORY-EXTRACT treatment resulted in increased gamma wave activity in the left frontal cortex of the technician, indicative of approach-oriented, positive emotional states (Figure 4). In contrast, placebo treatment led to generalized frontal cortex activation without hemispheric specificity. The left-frontal activation persisted at Day 7, albeit at reduced intensity, suggesting a habituation effect. Frontal alpha wave asymmetry analysis further supported these findings: CHICORY-EXTRACT promoted suppression of the right-frontal hemisphere associated with reduced social withdrawal and enhanced interpersonal engagement by showing higher alpha activity (Figure 5). This frontal alpha asymmetry was significant throughout the entire study duration. These results suggest that tactile interaction with CHICORY-EXTRACT-treated skin may elicit positive emotional responses in others, transferring the concept of a skin–brain axis to an intersocial level.

Ex vivo investigation of immunological and microbial effects

To explore potential gene regulatory effects of CHICORY-EXTRACT, a 3D reconstructed epidermal model was employed. Initial comparisons between untreated and

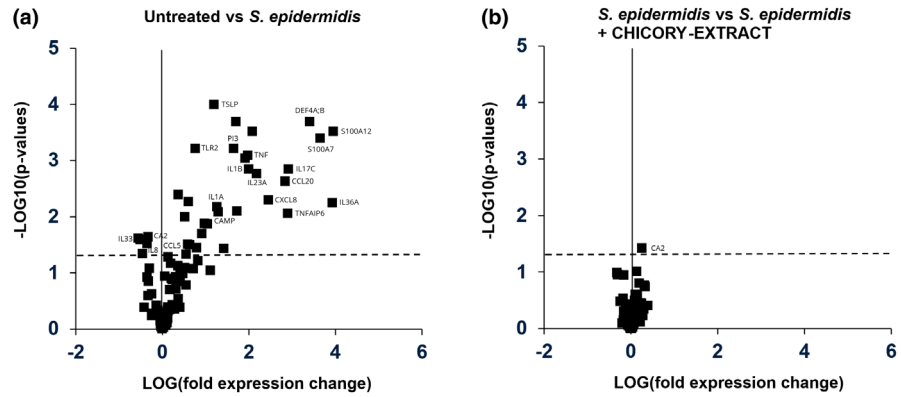

FIGURE 6 CHICORY-EXTRACT does not alter the innate anti-microbial immune response of 3D reconstructed epidermis. (a) Infection with *S. epidermidis* increases expression of pro-inflammatory genes and genes of innate immunity for anti-microbial defence (marked). (b) The addition of CHICORY-EXTRACT does not alter this expression scheme. Volcano plots of 93 genes analysed. The dashed line indicates the threshold of significance.

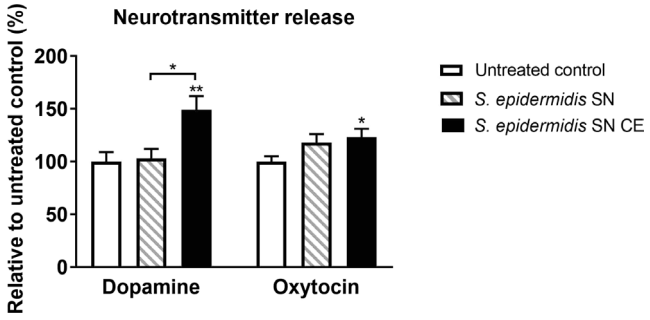

FIGURE 7 CHICORY-EXTRACT induces *S. epidermidis* for post-biotic secretion of neurotransmitter stimulating factors. Application of *S. epidermidis* culture treated with CHICORY-EXTRACT increased neurotransmitter release in a keratinocyte/neuron culture. SN, supernatant; SN CE, CHICORY-EXTRACT-spiked supernatant. Significances: $*p<0.05$; $**p<0.01$; $***p<0.001$.

0.1% CHICORY-EXTRACT-treated tissues revealed no significant changes in the expression of genes related to inflammation or antimicrobial defence (not shown). Given the lack of immune activation in the uninfected model, a second set of experiments was conducted using *Staphylococcus epidermidis* (ATCC1222) inoculation.

Infection with *S. epidermidis* induced robust upregulation of genes associated with anti-microbial innate immunity and inflammatory responses (Figure 6a). However, co-treatment with CHICORY-EXTRACT did not significantly alter this gene expression profile (Figure 6b), nor did it affect bacterial colony-forming units (not shown). These findings suggest that CHICORY-EXTRACT does not interfere with the skin's immunological alert state due to *S. epidermidis* settlement or disrupt commensal microbiota.

To assess potential postbiotic effects, *S. epidermidis* cultures were spiked with 1% CHICORY-EXTRACT, and the resulting supernatant was applied to a keratinocyte/neuron co-culture at 0.1% (as such, a 1000fold dilution of the active ingredient). Dopamine release was significantly elevated by 49% in response to the spiked supernatant, whereas non-spiked supernatant had no effect (Figure 7). CHICORY-EXTRACT alone induced a significant increase in dopamine levels by 30% (not shown). Oxytocin levels were significantly elevated by the spiked supernatant by 23%, while *S. epidermidis* supernatant alone showed already a trend to elevated oxytocin release. These results suggest that CHICORY-EXTRACT modulates the microbial metabolism in a manner that promotes neurochemical signalling associated with positive emotional states.

CONCLUSION

The present study demonstrates that CHICORY-EXTRACT significantly improves skin surface smoothness, as evidenced by instrumental, clinical, and perceptual assessments. Emotional responses to the improved skin condition were evaluated using galvanic skin response (GSR) and advanced facial expression and eye tracking system (AFETS) and interpreted through the circumplex model of affect. While both placebo and CHICORY-EXTRACT initially elicited positive emotional valence, only CHICORY-EXTRACT maintained this response throughout the study duration. In contrast, placebo treatment was associated with a shift toward negative emotional valence after repeated application, despite comparable levels of emotional arousal.

The sustained positive emotional response to CHICORY-EXTRACT may be attributed to its rapid skin-smoothing effect, which was perceptible even after short-term application. Furthermore, EEG analysis of

a technician caressing treated skin revealed increased gamma wave activity in the left frontal cortex and suppression of activity in the right frontal cortex demonstrated by significant frontal alpha asymmetry, patterns associated with approach-oriented, socially engaging emotional states. Placebo treatment, by contrast, induced more neutral or distancing neural responses.

To investigate the biochemical underpinnings of these effects, a 3D reconstructed epidermal model was employed. Infection with *Staphylococcus epidermidis*, a dominant skin commensal, induced a gene expression profile consistent with a primed innate immune state [21, 22]. CHICORY-EXTRACT did not alter this expression pattern, nor did it promote bacterial proliferation, suggesting that it supports the skin's microbial equilibrium without disrupting immunological homeostasis. Although CHICORY-EXTRACT contains short-chain inulin-type fructo-oligosaccharides (SCIFOS), which are known to exhibit prebiotic activity [23], the concentration used (0.1%) may have been insufficient to stimulate bacterial growth in situ.

Further investigation using a keratinocyte/neuron co-culture model revealed that *S. epidermidis* spiked with CHICORY-EXTRACT was capable of significantly inducing dopamine release, and to a lesser extent, oxytocin. These findings suggest a growth-independent, prebiotic activation of *S. epidermidis* by CHICORY-EXTRACT, leading to the release of postbiotic factors capable of modulating neurochemical signalling in skin. This phenomenon, which can be referred to as 'activated rest', implies that CHICORY-EXTRACT can stimulate microbial activity without promoting proliferation [24]. The most extensive knowledge of microbiota–host interactions exists in the context of the gut–brain axis. Here, the interaction is well documented through postbiotic substances such as short-chain fatty acids (SCFAs) and the production of neurotransmitters. These postbiotic metabolites are also referred to as psychobiotics [25]. We can assume that *S. epidermidis* releases similar postbiotics with similar activity on skin. A postbiotic activity of *S. epidermidis* metabolites on skin has also been shown to disrupt *S. aureus* biofilm formation [26].

Taken together, these results support the existence of a microbiome–skin–brain axis in which CHICORY-EXTRACT exerts its effects through both direct skin-smoothing actions and indirect modulation of microbial–neural interactions. The extract appears to enhance emotional well-being via tactile and neurochemical pathways, potentially fostering positive social interactions. The observed increase in dopamine and oxytocin, neuropeptides key factors of social bonding and self-esteem [27], further supports this hypothesis.

While these findings provide compelling initial evidence, they represent an early step in elucidating the mechanisms by which cosmetics can influence the microbiome–skin–brain axis. Ethical constraints limit the ability to study these interactions in vivo, and the emotional responses observed in cosmetic contexts are inherently subtle compared to those in more emotionally charged scenarios. Nevertheless, the use of keratinocyte/neuron co-cultures offers a promising model for investigating postbiotic signalling, despite limitations in replicating the complexity of in situ skin–neuron interactions.

Analogous to the well-established microbiota-gut–brain axis, where microbial metabolites and neurotransmitters influence central nervous system function, the microbiota-skin–brain axis may similarly rely on microbiota-derived signals to modulate emotional and physiological states. While first concepts enter the scientific literature [28, 29], evidence-based experimental insights are sparse. A study exploring the link between brain function and the metabolic activity of the skin microbiota, measured via EEG, revealed a mechanistic parallel between the microbiota-gut-brain axis and the emerging concept of a microbiota-skin-brain axis [14].

The data presented here suggest that metabolically activating the healthy skin microbiome and enhancing skin quality through targeted cosmetic interventions such as CHICORY-EXTRACT may contribute to emotional well-being and social connectivity.

Limitations

While statistical significance was achieved for the measured parameters, the size of the examined panel, with a total of 56 study participants, was limited. A larger confirmatory study could further substantiate the data, especially regarding the relatively subtle emotional variations. The use of a keratinocyte/sensory neuron co-culture can illustrate biochemical relationships but does not provide ultimate proof of direct in vivo activity. Studies on neuronal cultures have shown that the choice of culture medium can influence neuronal metabolism [30, 31]. We attempted to mitigate this bias with an untreated control; however, it cannot be completely ruled out that the observed neurotransmitter release was favored by specific artificial culture systems.

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CONFLICT OF INTEREST STATEMENT

Research and development was made by RAHN AG or, on behalf of RAHN AG, by third-party companies. All authors are employed by RAHN AG.

DATA AVAILABILITY STATEMENT

Research data is not shared.

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