Upcycled coffee cherry botanical for follicle longevity

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ABSTRACT

Caffeine is among the best-studied molecules in cosmetic science and is widely used in concepts centred on stimulation and vitality for skin, scalp and hair care. Cascara, the dried outer shell of the coffee cherry, is a byproduct of coffee production that is emerging as a promising new botanical. Its particular strength lies in building on the widely known and well-loved coffee concept, yet introducing a new botanical dimension through cascara. This combination of familiarity, novelty together with its exceptional phytochemical richness makes cascara attractive for cosmetic concepts. This article introduces Cascara Pro (hereafter called the cascara caffeine extract), a propanediol-aqueous extract from organic coffee cherry cascara (*Coffea arabica L.*), enriched with natural caffeine and developed for scalp and hair care. Phytochemically, the cascara caffeine extract brings together the best of two worlds: the well-known stimulating activity of caffeine and the broader protective properties of cascara extract. Comparative phytochemical analysis showed that the cascara caffeine extract provides a broader bioactive profile than pure caffeine alone and a stronger stimulation concept than conventional coffee-based botanical extracts. *In vitro*, the active significantly reduced intracellular free radical formation in human hair follicle cells. *In vivo*, a serum containing 2% cascara caffeine extract improved perceived scalp health, comfort and vitality over 28 days and also produced an immediate sensory impression of scalp activation in a placebo-controlled consumer study. Taken together, these findings position the cascara caffeine extract as a coffee-based cosmetic concept that combines sustainability with proven scalp-care efficacy

For many consumers, coffee is almost synonymous with the bean. Yet the coffee cherry contains more than the bean alone. Its outer layer, known as cascara, is separated during coffee processing as a byproduct and is still largely discarded (Figure 1).

However, cascara has strong cosmetic potential. It retains the familiar stimulation story associated with the well-loved world of coffee, while adding a new botanical dimension. At the same time, it carries a strong upcycling story and aligns well with current interest in natural, sustainable and innovative ingredients.

In addition, cascara offers a rich phytochemical profile with both stimulating and protective bioactives. This combination of coffee association, stimulation, novelty, sustainability and upcycling makes cascara especially attractive for cosmetic applications.[1,2]

Organic, traceable and upcycled: cascara from Brazil

For the cascara caffeine extract, Lipoid Kosmetik sources organic cascara from Brazil through a traceable supply chain linked to responsible coffee farming. The raw material comes from a family business in Pedra Azul, Espírito Santo, that has been committed to sustainable coffee cultivation since the 1960s.

The cascara is harvested manually, gently sun-dried on raised beds and further processed on-site. This controlled handling supports both phytochemical quality and full traceability.

As a result, the cascara caffeine extract combines responsible sourcing with cosmetic functionality, transforming a byproduct of coffee production into a value-added botanical active. It also aligns with current expectations for transparent and sustainability-oriented ingredient sourcing.

Phytochemistry – Coffee energy meets botanical protection

The objective of this study was to compare the phytochemical composition of the cascara caffeine extract with pure caffeine and other coffee-based botanical extracts used in cosmetic hair care, in order to assess its combined potential for scalp vitality and protection.

A comparative phytochemical analysis was performed to characterize the main bioactive compounds present in the cascara caffeine extract. The investigation focused on caffeine, trigonelline, polyphenols, tannins and flavonoids, as these constituents are associated with stimulation, antioxidant protection and overall scalp health (Figure 2).

The results showed that the cascara caffeine extract combines features of both categories. As a cascara-derived botanical extract, it provides a rich profile of trigonelline, polyphenols, tannins and flavonoids, contributing protective and antioxidant-related properties.

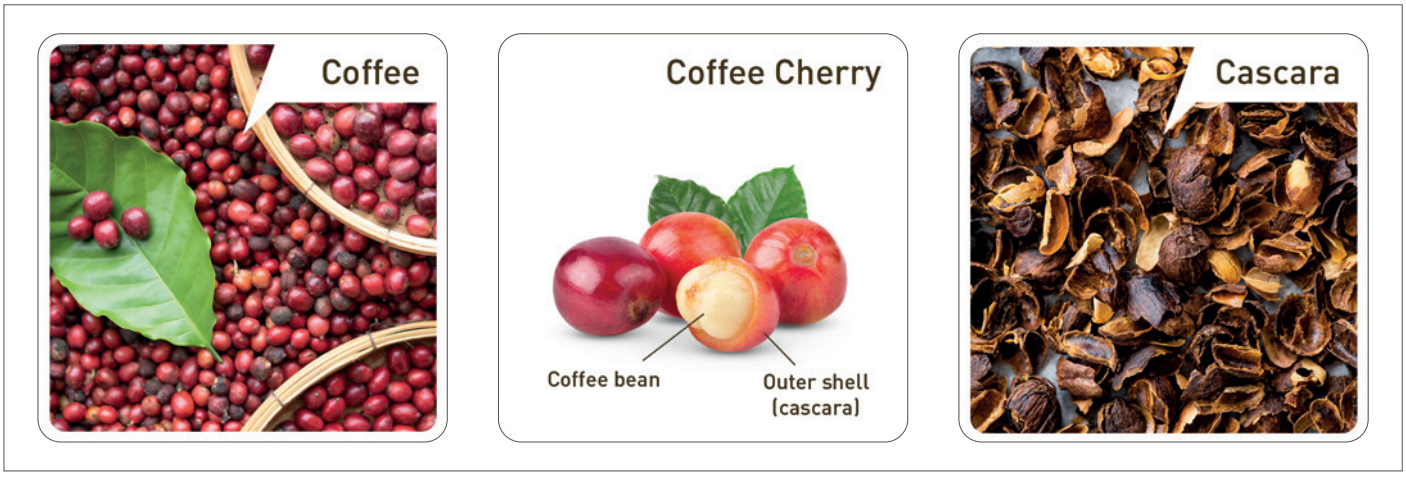

Figure 1: Coffee, coffee cherry and cascara. The coffee cherry consists of an inner bean and an outer shell, known as cascara. During coffee processing, the bean is separated for coffee production, while cascara remains as a byproduct. As a phytochemically rich plant material with cosmetic potential, cascara represents an attractive upcycled botanical resource

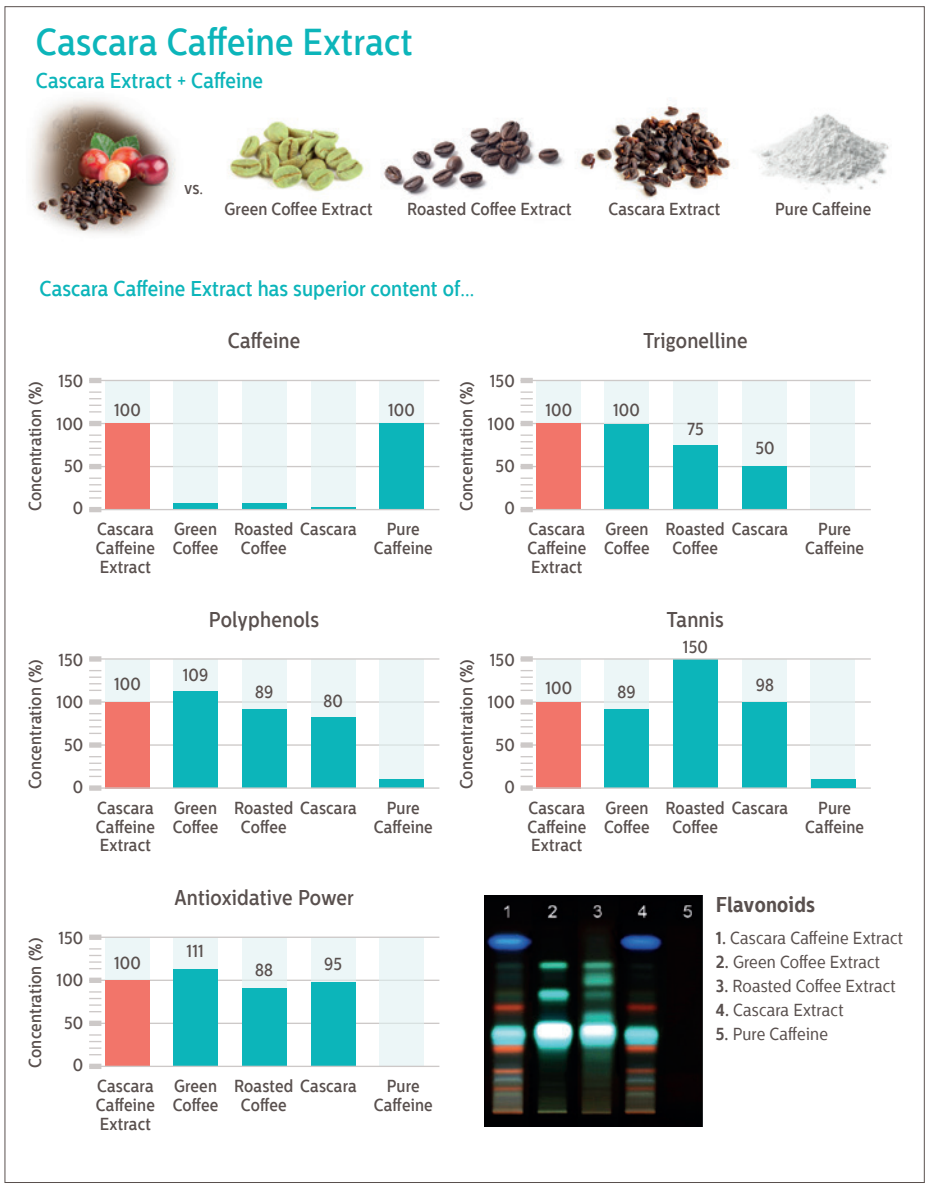

Figure 2: Comparative phytochemical profile of the cascara caffeine extract, pure caffeine and coffee-based botanical extracts. Reference extracts were prepared in propanediol/water and extracted for 48 hours. A caffeine reference solution was prepared at 1.5% in propanediol/water. Caffeine and trigonelline were quantified by HPLC, total polyphenols by the Folin-Ciocalteu assay, tannins by $FeCl_3$ colorimetry, flavonoids by HPTLC and antioxidant activity by the DPPH radical-scavenging assay

Through caffeine enrichment, it also delivers enhanced stimulating activity associated with scalp vitality. Compared with pure caffeine, the cascara caffeine extract offers a broader phytochemical profile and additional protective botanical constituents.

Compared with conventional coffee-based extracts, it provides more stimulating activity through its enriched caffeine content. In this way, the cascara caffeine extract combines the phytochemical richness of cascara with the well-established activity of caffeine, resulting in a higher-performance concept for scalp and hair care (Figure 3).

A protective shield for hair follicle cells

The objective of this study was to determine whether the cascara caffeine extract can protect primary human hair follicle cells from intracellular free radicals and thereby support follicle longevity.

To assess this, an *in vitro* LUCS (Light-Up Cell System) assay was performed.[13] This live-cell method measures intracellular free radical formation in cultured primary hair follicle cells by means of a light-activated, photo-responsive biosensor, allowing antioxidant effects to be quantified by fluorescence.

Primary human hair follicle dermal papilla cells (HFDPC) from Caucasian female donors were cultivated and exposed to serial dilutions of the cascara caffeine extract. After preincubation for one hour, the cells were subjected to light-induced oxidative stress, and intracellular free radical formation was monitored over repeated LED excitation cycles.

The cascara caffeine extract showed strong antioxidant protection, even at low concentrations. The calculated effective concentrations demonstrated that the extract reduced intracellular free radicals by 90% at 1% and by 50% at 0.37% (Figure 4).

These findings indicate that the cascara caffeine extract effectively protects hair follicle cells against oxidative stress, a key factor in follicle aging and senescence. By significantly reducing intracellular free radicals, the extract may help

preserve cellular vitality and support the long-term resilience of hair follicle cells.

Consumers feel the difference: healthier scalp, greater vitality

The objective of this study was to evaluate the consumer experience of a hair serum containing the cascara caffeine extract, with particular focus on perceived effects on scalp health, scalp comfort and sensory scalp activation.

A double-blind, placebo-controlled, randomized *in vivo* study was carried out in 32 women aged 18–59 years with sensitive scalp. Volunteers applied either a leave-on serum containing 2% cascara caffeine extract or a placebo serum to the scalp twice daily for 28 days. Self-assessment of scalp condition and product performance was recorded at baseline, day 14 and day 28.

The results showed clear improvements in perceived scalp condition with the active serum. After 28 days, positive ratings versus baseline reached 56.3% for overall scalp health, 50% for scalp comfort, 62.5% for reduced irritation, 50% for reduced dryness, 37.5% for hair vitality and 50% for protection from daily stress. Representative scalp images also indicated a visible improvement in scalp appearance over the course of treatment (Figure 5).

In addition to these longer-term benefits, the cascara caffeine extract also provided an immediate sensory effect. After product application, 75% of users reported an immediate sense of scalp activation, and 75% reported an immediate boost of vitality, compared with lower values for placebo (Figure 6).

Overall, these findings show that the cascara caffeine extract supports scalp health and vitality both through perceived long-term improvement and through immediate sensory activation, making it well suited for modern scalp care concepts.

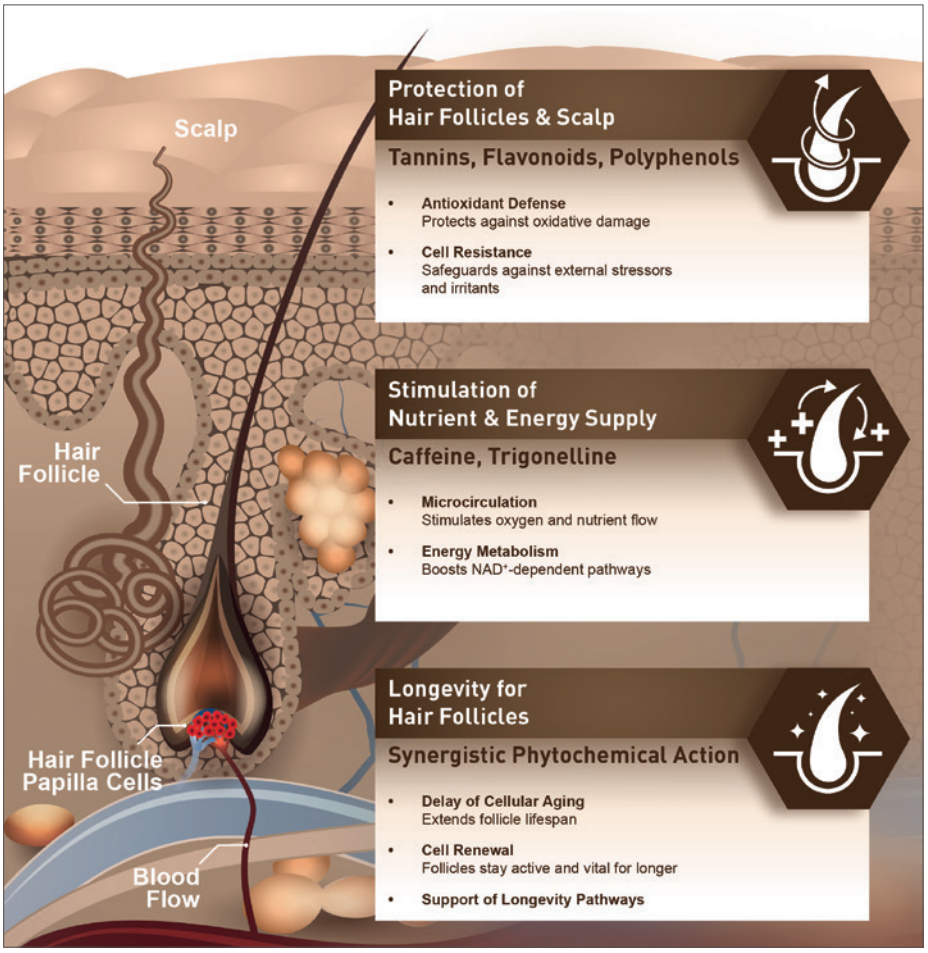

Figure 3: The mode of action can be understood as a three-part concept linking protection, stimulation and longevity support. It combines the phytochemical richness of cascara with the well-established activity of caffeine to support scalp and follicle function in a broader way than a simple energizing concept. Polyphenols, tannins and flavonoids contribute protective effects by helping defend scalp and follicle structures against oxidative and environmental stress, thereby supporting scalp comfort and resilience. Caffeine and trigonelline add a stimulating dimension associated with microcirculation, metabolic activity, dermal papilla support and scalp vitality. Together, these protective and stimulating effects support follicular longevity by helping maintain cellular activity, vitality and resilience over time[3-12]

Conclusion

The cascara caffeine extract illustrates how a byproduct of coffee production can be transformed into a relevant and substantiated cosmetic active for modern scalp care. By combining organic cascara with natural caffeine, the ingredient unites two complementary dimensions: the familiar stimulation concept associated with coffee and caffeine, and the broader protective phytochemical richness of cascara. This gives rise to a more balanced activity profile that goes beyond a caffeine-only approach and also differs from conventional coffee-based botanical extracts.

This positioning is supported by several layers of evidence. Comparative phytochemical analysis showed that the cascara caffeine extract combines caffeine with trigonelline, polyphenols, tannins and flavonoids, supporting both stimulating and protective properties.

In vitro, the extract significantly reduced intracellular free radical formation in primary human hair follicle dermal papilla cells, highlighting its antioxidant potential and its

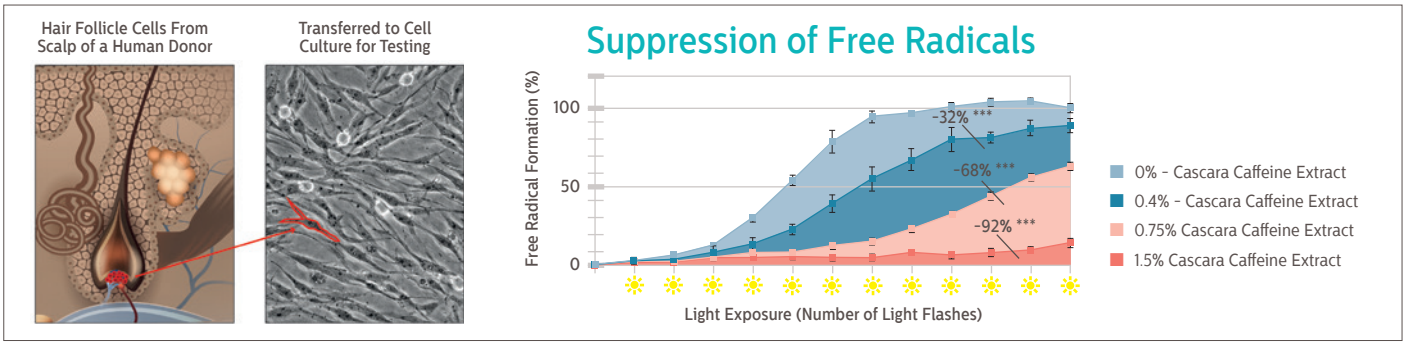

Figure 4: The cascara caffeine extract provides antioxidant protection in primary human hair follicle cells. Real-time intracellular free radical formation under light-induced stress was measured after preincubation with increasing concentrations of the cascara caffeine extract for one hour and loading with a fluorescent biosensor. Fluorescence was monitored over 24 LED excitation cycles. Data are shown as mean ± SD from three independent experiments. Student's t-test versus untreated; *** $p < 0.001$

relevance for follicle vitality.

In vivo, a serum containing 2% cascara caffeine extract improved perceived scalp health, comfort and vitality over 28 days and additionally provided an immediate sensory impression of scalp activation.

Beyond efficacy, the cascara caffeine extract also responds to current expectations for cosmetic ingredients. Its upcycled origin, traceable sourcing and sustainability story fit well with growing market interest in natural, innovative and responsible ingredients. In addition, its 100% natural origin, COSMOS and NATRUE certification, suitability for vegan formulations and preservative-free profile further support its relevance for modern cosmetic concepts.

Taken together, the cascara caffeine extract offers a distinctive platform for modern scalp-care concepts. It combines stimulation, protection and vitality support in one ingredient, while also connecting performance with sustainability. This makes it an attractive option for product concepts aimed at healthier-looking, more resilient and vital scalp and hair. **PCM**

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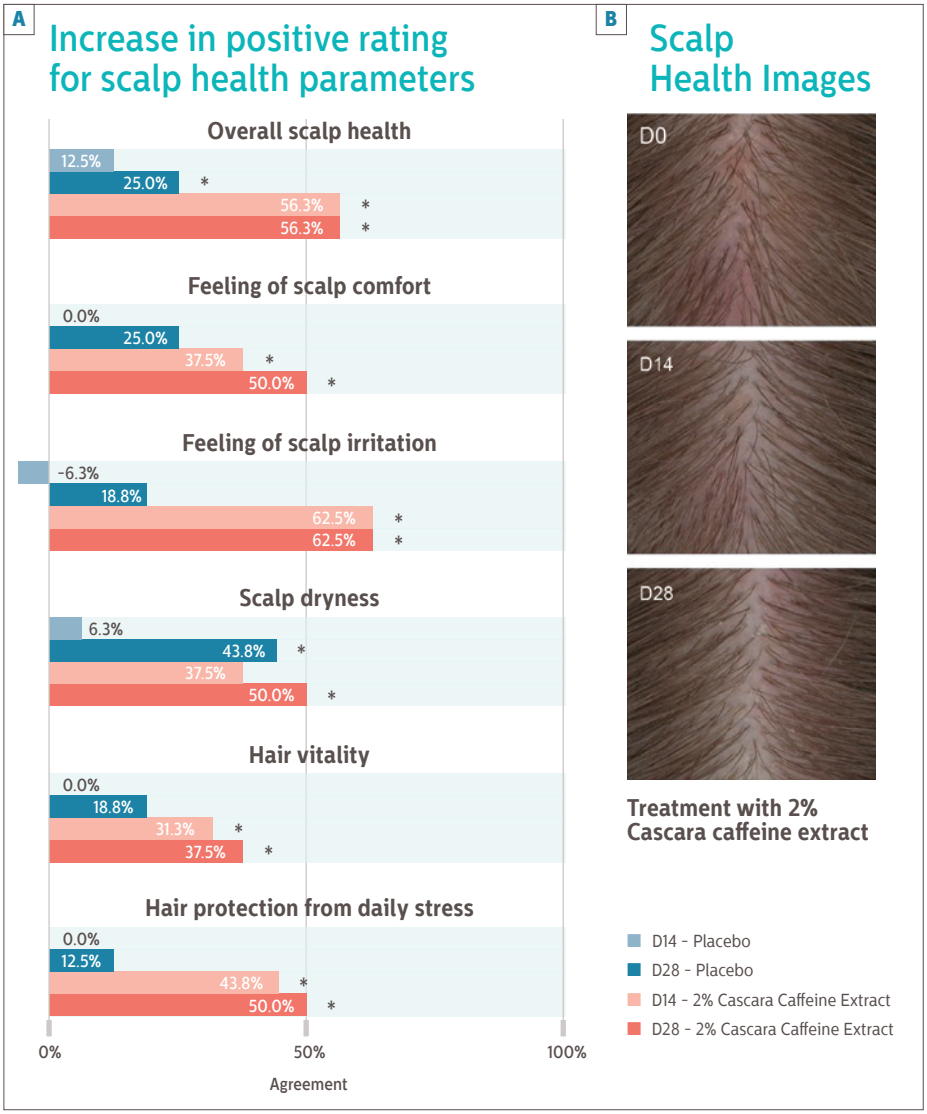

Figure 5: The cascara caffeine extract improves perceived scalp health and vitality. In a double-blind, placebo-controlled, randomized study, 32 women applied a serum containing 2% cascara caffeine extract or placebo to the scalp twice daily for 28 days. At baseline, day 14 and day 28, participants rated scalp-related parameters on a scale from 1 (poor condition) to 10 (good condition). Panel A shows the increase in positive ratings (scores 6–10) expressed as % change versus baseline. Panel B shows representative scalp images obtained at baseline, day 14 and day 28 after treatment with 2% cascara caffeine extract. N = 16 per group. Statistical significance between positive and negative responses was assessed using the sign and binomial tests; * $p < 0.05$

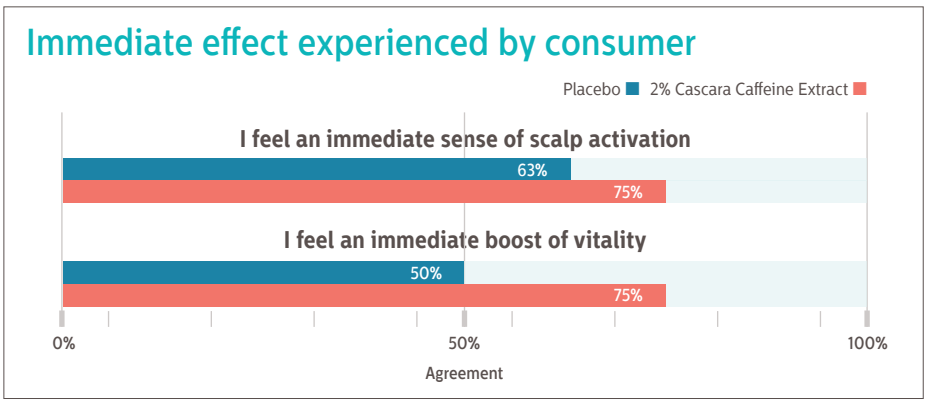

Figure 6: Cascara caffeine extract provides an immediate sensory impression of scalp activation and vitality. After completing the 28-day study, volunteers were asked whether they experienced an immediate sense of scalp activation or an immediate boost of vitality after product applications. Responses were rated on a four-point scale from strongly disagree to strongly agree. Bars show the percentage of positive responses (ratings 3–4), normalized to 100%