Development of a Hair Care Product Series, “ASTALIFT SCALP FOCUS”


Abstract

We have launched a series of new hair care products, "ASTALIFT SCALP FOCUS," which improve the elasticity and reduce the firmness of hair. Glycyrrhetinic acid, known as an active ingredient for hair growth, is insoluble both in water and in oil; therefore, this compound has been conventionally formulated with higher concentration of ethanol. However, continuous usages of high concentration of ethanol may cause dehydration and inflammation of the scalp. With our proprietary emulsifying technology, we have prepared nanosized (80 nm) glycyrrhetinic acid emulsion, which has high permeability into the scalp without an aid of ethanol. Furthermore, we have developed "nano dispersion of human hair ceramide" using our original emulsifying technology to nanosize (20 nm) "human hair ceramide," which is demonstrated to permeate in human hair and to contribute to improve the firmness and the elasticity of hair.

1. Introduction

FUJIFILM has developed the functional skincare products by applying our photographic expertise to the creation of beautiful skin. In September, 2007, we released the ASTALIFT skincare series based on the blending astaxanthin and three types of collagen. Subsequently, on September 24, 2014, we launched onto the market a new member of the series, "ASTALIFT SCALP FOCUS," that tones up hair to healthy condition by adding to hair bounce, resilience and volume that tend to be decreased with aging (Fig. 1).

In recent years, the need for anti-aging hair care products has been increasing for many women who have hair problems due to aging. The decreases of bounce, resilience and volume of hair are typical problems, which derive from age-related scalp disorders, including dehydration and inflammation. Therefore, it is necessary to improve the scalp condition and to apply appropriate treatment to damaged hair by infusing sufficient amounts of essential active ingredients into scalp and hair.

This paper reports the details of two active ingredients, blended into the ASTALIFT SCALP FOCUS: the glycyrrhetinic acid to improve the scalp condition and the human hair ceramide to enhance bounce and resilience of hair, both of which are blended as nano-emulsion.

2. Nano emulsion of glycyrrhetinic acid

2.1 Features of glycyrrhetinic acid

Glycyrrhetinic acid is a licorice-derived, natural triterpenoid and has anti-inflammatory effect, and is known to inhibit the activation of hormone hair loss (5α-reductase inhibitor). Therefore, this ingredient has been blended into many hair growth formulas. However when blending glycyrrhetinic acid into conventional hair growth formulas, it is usually necessary to dissolve it in high-concentration, approximately 50% of aqueous ethanol solution because this reagent easily...
crystallizes and is not easily dissolved both in water and in oil. There has been concern that the continuous use of high-concentration ethanol containing hair care products would cause inflammation, which induce itching and/or stinging, and would worsen the scalp condition. To address this concern, we analyzed the effect of ethanol on the scalp cells and verified that high-concentration ethanol impairs hair papilla cells and increases the production of the cytokine IL-6, which is known to inhibit hair growth.

2.2 Development of nano-emulsion of glycyrrhetinic acid

We therefore started to develop the methods to blend glycyrrhetinic acid into the hair care product without using high-concentration ethanol. This formula should be designed to make glycyrrhetinic acid permeate the scalp deeply through the pores. We discovered the special oil that can dissolve glycyrrhetinic acid and then develop the nano-shell technology that enables the formation of an emulsion membrane (shell) to stably emulsify the oil and this glycyrrhetinic acid. Using these technologies, we could succeed the preparation of the nano-emulsion of glycyrrhetinic acid in which a diameter of 80 nm glycyrrhetinic acid emulsions are stably dispersed in water at high density, without using ethanol (Fig. 2). Fig. 3 shows the comparison of an ordinary glycyrrhetinic acid with nano-emulsion of glycyrrhetinic acid both of which being added in water at the same concentration. It is clear that the latter can be dispersed stably and evenly in water, and is transparent.

2.3 Permeability of glycyrrhetinic acid nano-emulsion into the epidermis

We expect the nano-emulsion of glycyrrhetinic acid we developed is effectively permeate to the scalp cells. We therefore analyzed the permeability of nano-emulsion into epidermis, using 3D cultured epidermis models. The epidermis permeability of nano-emulsion of glycyrrhetinic acid was 1.7 times larger than that of the glycyrrhetinic acid dissolved in 50% ethanol the latter is usually used in ordinary hair growth formulas (Fig. 4). In general, ethanol is used as a permeation enhancer for hair care formulas. However, in this experiment where the actual concentration of glycyrrhetinic acid in the products used, the ethanol evaporated quickly just after being applied. This could condense the glycyrrhetinic acid in ethanol solution and promoted the crystallization.

In contrast, the nano-suspension of glycyrrhetinic acid could keep the permeation steadily because it did not aggregate and maintained its particle size. It is thus concluded that the permeability of nano-emulsion of glycyrrhetinic acid is superior to that of ordinary glycyrrhetinic acid.

Glycyrrhetinic acid was dissolved in a special solvent oil and stabilized by being wrapped in a membrane (shell) that separated the constituent particles completely from water so they would not combine each other (nano-shell technology).

Fig. 2 Image of “nano glycyrrhetinic acid”

Glycyrrhetinic acid is separated from water (left). Glycyrrhetinic acid dissolved in 50% ethanol as usual (center). Nano glycyrrhetinic acid can disperse in water without ethanol (right).

Fig. 3 Comparison of glycyrrhetinic acid in water (left), in 50% aqueous ethanol (middle), and water-diluted “nano glycyrrhetinic acid” (right)

Fig. 4 Skin permeability of glycyrrhetinic acid
2.4 Permeability of glycyrrhetinic acid nano-emulsion to hair follicles

Because there is no 3D cultured epidermis model which contain hair follicles, the evaluation of ingredient permeability through hair follicles is impossible with the 3D cultured epidermis model. We therefore considered the establishment of a new assay system that enables the localized glycyrrhetinic acid molecules to be directly visualized using excisional human scalp skin. In conventional visualization methods, the target chemical compounds are observed by tracking fluorescence or pigment markers by labeling them. However, the labeling itself influences the properties of the chemical compounds, which may prevent accurate assessment. We therefore selected and introduced Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) used for the surface analysis of thin layers of functional film, etc. TOF-SIMS can directly detect the molecular weight of chemical compounds and map them without requiring any labeling. Using this method, the locations of chemical compounds in skin can be identified. In the same way as the assessment of epidermis permeability, we applied glycyrrhetinic acid nano-emulsion to extracted human scalp skin followed by the cryopexy. We then prepared thin-layer skin slice samples and analyzed them by TOF-SIMS. Fig. 5 shows the images of the slice to map the intensity and the location of glycyrrhetinic acid (the molecule exists in colored regions). This result indicated that the glycyrrhetinic acid could reach to scalp pores.

3. Hair ceramide nano-dispersion

3.1 Hair structure and the functions of the cell membrane complex (CMC)

The hair shaft consists of three layers: the medulla at the center, the cortex that surrounds the medulla and the cuticle that covers the surface (Fig. 6). The cell membrane complex (CMC) that binds those three layers together has the functions, such as, the retention of moisture inside the hair and the prevention of hair components from leaking them outside by forming the cuticle on the surface.3 The mass of CMC decreases with aging and this is considered to be one of the causes of the decrease of the bounce and the resilience of hair. To improve these hair conditions, we focused on and aimed to blend the human hair ceramide that constitutes the CMC in the hair care products.

3.2 Development of nano-dispersion of human hair ceramide

The solubility of human hair ceramides is low both in water and in oil. These ceramamides easily crystallize in solvvent. Therefore, it is usually dissolved with a large amount of oil and then dispersed with solvent such as water. So the concentration of human hair ceramide is low and its diameter is large, approximately 1 μm. To overcome these defects, we prepared the human hair ceramide nano-particle using the company’s nano technology and succeeded in stably dispersing high-concentration human hair ceramide in water which average particle diameter is 20 nm (Fig. 7).
and compared the structure before and after immersing the hairs in the ceramide dispersion. The results confirmed that nano human hair ceramide can permeate the inside of hair via immersion and fill the void of the CMC (Fig. 8). Moreover, compared with the condition before immersion, the amount of human hair ceramide in the immersed hair doubled (Fig. 9).

For the confirmation of the effect on the surface of hair, we observed the cuticle with a scanning electron microscope (SEM) and visualized the adsorbed ceramide with TOF-SIMS. The results of SEM observation confirmed that the cuticle opened because of damage was rebonded after immersion into nano human hair ceramide. The results of TOF-SIMS revealed that human hair ceramide was homogeneously distributed on the surface of the hair (Fig. 10).

Furthermore, the measurement of the bounce and resilience of hair with and without undergoing immersion in nano human hair ceramide indicated that immersing it can increase those properties of hair to 1.4 times (Fig. 11).

4. Product evidence

We selected 16 Japanese women with ages from 40 to 64 whose hair scores ranging from 2 to 4 according to the hair loss severity scores for the Japanese. For 24 weeks, they used the nano human hair ceramide-blended shampoo and conditioner once a day and the nano glycyrrhetinic acid-blended scalp essence twice a day (in the morning and at night after shampooing or before hair styling). Hair loss severity scoring and imaging of the crown of the head were performed by a dermatologist before use and after 12 weeks and 24 weeks of use. As a result, the average severity score decreased from 2.53 before use to 2.30 after 24 weeks of use (Fig. 12) and improvements were observed in 12 subjects out of 16. Fig. 13 shows the photo images of the crowns of two subjects as improvement examples.
5. Conclusion

ASTALIFT SCALP FOCUS described in this paper is a functional hair care product that only FUJIFILM could develop by applying the company’s unique technologies. We will keep improving these technologies and will engage in the development of the functional cosmetics that provide new customer values.

References


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