Development of the Renewed Functional Skin Care Product "ASTALIFT JELLY AQUARYSTA"


Abstract

We have developed the renewal product of "ASTALIFT JELLY AQUARYSTA", which contains our unique nanoscale dispersion called "human-type nano-acylceramide". Acylceramides are essential components of the long periodicity phase (LPP) lamellar structures of intercellular lipids localized in the stratum corneum. These molecules are important for skin permeability barrier maintenance. The amount of skin acylceramides gradually decreases with aging, which may contribute to age-associated skin drying. Here we developed 20 nm diameter "human-type nano-acylceramide" and confirmed that this dispersion both accelerates the restoration of surfactant-damaged LPP lamellar structures and improves skin barrier functions. Finally, we demonstrated that the application of "ASTALIFT JELLY AQUARYSTA" makes skin appearance like "Attractive Elegant skin".

1. Introduction

We have applied our technologies that we have developed in the photography fields such as collagen research, antioxidation technology, nano technology, to the development of functional skin care products. In 2010, we launched the ASTALIFT series "JELLY AQUARYSTA" as a special care item for radically improving dry skin, which triggers various skin problems. This product contains "human-type nano-ceramide" produced by our original emulsification technology. In September 2015, we pursued further moisture retention and barrier function and launched the renewed "JELLY AQUARYSTA" making the most of the "advanced ceramide technology." (Fig. 1)

This paper reports the studies of effectiveness of the nanosized dispersion of human-type acylceramide, "human-type nano-acylceramide" added to the renewed "JELLY AQUARYSTA".

2. Barrier function of skin and ceramide

2.1 Structure of stratum corneum and ceramide

The skin has a barrier function. It blocks out external stimuli and foreign substances and prevents body water from evaporating. The stratum corneum, the outermost layer of the skin, plays a major role in the function. The stratum corneum consists of cornocytes and intercellular lipid. The intercellular lipid contains about 50 wt% ceramide as the main component. Some researchers report that the amount of ceramide directly correlates with the barrier function. That suggests that ceramide is a critical component to the barrier function.

2.2 Long periodicity phase lamellar structure and acylceramide

To achieve the barrier function for which ceramide plays an important role, the structure is important as well as the...
amount of ceramide. It is the long periodicity phase (LPP) lamellar structure. The LPP structure has intercellular lipids regularly arranged about 13 nm. Acylceramide is said to be an essential component of the LPP structure in the intercellular lipids (Fig. 2) 31-40.

Ceramide consists of fatty acid amide-linked with sphingoid base. Acylceramide has the end of fatty acid hydroxylated and it is ester-linked with fatty acid (Fig. 3).

When the skin is suffering from atopic dermatitis, ichthyosis, psoriasis or any other skin disease with barrier function failure, the amount of acylceramide is reduced and the LPP structure is reduced. That was reported 20 years ago 41. Even if the skin is healthy, it has been also reported, the amount of acylceramide can be reduced because of aging or change of the seasons 42-48 and the LPP structure is reduced with the reduction 49-50. If acylceramide is effectively supplied to the stratum corneum, the LPP structure and the barrier function are expected to be repaired. That has not been confirmed by any reports, yet.

To beef up the skin’s barrier function and radically improve dry skin, we have started to develop a formula of acylceramide drug for external use that will penetrate into the stratum corneum and restore the LPP structure between corneocytes.

3. Development of high-penetration “human-type nano-acylceramide” that restores the long periodicity phase lamellar structure

3.1 Preparation of “human-type nano-acylceramide”

In the steric structure of ceramide, the sphingoid base has at least two asymmetric carbons (Fig. 3). Theoretically four stereoisomeric forms can exist 51. But, only one form of steric configuration of ceramide (2S, 3R) exists in human body. No other stereoisomeric forms are detected 52. For cosmetic materials in addition to ceramide having the same structure as the one in human body (hereinafter referred to as human-type ceramide), its glycoside and ceramide-like substances are used. Researchers have compared the barrier functions of ceramide-like substances, racemic form and human-type ceramide using a model of stratum corneum lipid and found that the barrier functions of ceramides except human-type ceramide can decline 53. The report indicates that the steric structure of ceramide is important for ceramide to contribute to the barrier function as a component of the intercellular lipid. We have therefore chosen the “human-type nano-acylceramide.”

![Diagram of skin structure and ceramide](image)

**Fig. 2** Localization and structure of long periodicity phase (LPP) lamellar consists of acylceramides

![Diagram of molecular structure](image)

**Fig. 3** Molecular structure of human-type of acylceramide

*; Asymmetric carbon
To enhance the permeability of human-type nano-acylceramide to the stratum corneum, we have decided to prepare a water-based nano-dispersed liquid by uniform nanoscale dispersion. Human-type acylceramide had longer acyl chains than human-type ceramide and thus low in solubility and high in crystallization. It was difficult to add to a water-based fluid. Using our original nano dispersion technology, we have succeeded in preparing a water-based nano-dispersed liquid. Compared with the conventional human-type acylceramide dispersed liquid (particle diameter of several μm), this liquid was transparent and uniform with a mean particle diameter of about 20 nm (Fig. 4).

3.2 Evaluation of permeability of human-type nano-acylceramide to stratum corneum

We have examined whether the prepared "human-type nano-acylceramide" permeates the stratum corneum as designed. We have applied the "human-type nano-acylceramide" and the conventional human-type acylceramide dispersed liquid to human skin specimens, left them covered for six hours, collected the second to sixth layers of the stratum corneum by tape stripping, and measured with LC-MS. In every layer, the permeation of "human-type nano-acylceramide" was significantly larger. Specifically, the permeation was improved six times in total (Fig. 5).

3.3 LPP structure repairing effect of "human-type nano-acylceramide"

We have examined whether the "human-type nano-acylceramide" in the stratum corneum would restore the LPP structure. We have added 1% sodium dodecyl sulfate (SDS) solution to the stratum corneum of a cultured epidermis
model for 15 minutes to produce a damaged skin model. We have then added the "human-type nano-acylceramide" or water (control) to the stratum corneum of a damaged skin model and continued culturing for two days. We have peeled stratum corneum specimens by trypsin treatment. We have left them at 22°C and 50% RH for 24 hours. Using the small-angle X-ray diffraction (SAXS), we worked out the amount of LPP from the diffraction peak area equivalent to the LPP structure (Fig. 6). We have found that the LPP structure reduced by the SDS treatment is restored by application of the "human-type nano-acylceramide."

It is known that the LPP structure, when dyed with osmium tetroxide or ruthenium tetroxide, is seen as black and white stripes in a cycle of about 13 nm\(^1\). Using this method, we have conducted TEM observation of samples prepared under the same conditions as those for SAXS measurement. A sample without SDS treatment (left in Fig. 7a) shows distinctive stripes. An SDS-treated sample shows no stripes (center in Fig. 7a). The model treated with the "human-type nano-acylceramide" shows regular stripes restored (right in Fig. 7a). We have analyzed the luminance distribution of the regular stripes and confirmed that they were a repeated structure in a cycle of about 13 nm (Fig. 7c).

Fig. 7b shows schematic diagrams of the molecular structure changes.

The observation has confirmed the LPP structure repairing effect of "human-type nano-acylceramide" visually. The result matched the quantitative result of SAXS measurement.

The LPP structure repairing effect of acylceramide externally applied to a model had never been confirmed before. We have developed a formula of "human-type nano-acylceramide" for external use that will repair the LPP structure, the first of its kind.
3.4 Barrier function effect of “human-type nano-acylceramide”

We have added 1% conventional “human-type nano-ceramide” and 0.1% newly developed “human-type nano-acylceramide” to the stratum corneum of a cultured epidermis model and cultured it for two days. We have removed a residual solution from the stratum corneum and measured the barrier function using the transepithelial electrical resistance (TER) value. Compared with the model with only 1% “human-type nano-ceramide” added, the model with 0.1% “human-type nano-acylceramide” also added had better barrier function. It was 2.3 times that of the control (water was added) (Fig. 8).

4. Effect of “JELLY AQUARYSTA” formula

With the product concept of “advanced ceramide technology changes the visual quality,” we explored the skin’s barrier function, added the “human-type nano-acylceramide” in addition to the conventional component “human-type nano-ceramide” and we have come up with the renewed “JELLY AQUARYSTA.”

To verify the effects of “JELLY AQUARYSTA” on human skin, we have conducted testing on 45 Japanese women aged 40 to 54. The subjects used the product twice a day in the morning and at night for 28 consecutive days. Before and after the continuous use of the product, we measured the water content of the skin, skin firmness, texture smoothness and other conditions. Compared with those conditions before the continuous use, water content and firmness significantly improved. Especially, marked improvement was observed with the nine subjects of the dry skin group (the water content before the continuous use was 50 or less) (Fig. 9a and b). The volume fraction of the replica of grit that represents the texture smoothness also significantly improved (Fig. 9c). The continuous use of “JELLY AQUARYSTA” for 28 days moisturized the skin, enhanced the firmness and smoothed the texture. Fig. 9d and e show the grit replica images of cheeks and the appearance of cheeks as examples of improved skin. The texture before the continuous use had unclear grain in one direction. After the use, the texture had clear grain in various directions. The visual quality has improved. The replica image has shown many small triangles that characterize smooth-textured skin (Fig. 9d). The cheeks have been brightened up on the whole, the gloss has increased and the skin looked firmer. (Fig. 9e.)
5. Conclusion

In renewal of "JELLY AQUARYSTA," we have aimed at radical improvement of dry skin. We have further explored the barrier function good skin has. As a result, we have for the first time succeeded in repairing the LPP structure of the stratum corneum using "human-type nano-acylceramide" produced by applying the nano-dispersion technology we have developed from our photography technology. It provides reliable skincare effects. It not only improves the skin functions but also makes distinct changes in the look.

We would like to continue the development of functional cosmetics that provide customers with unprecedented and appreciable effects, making the most of FUJIFILM’s original technologies.

References


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