Journal of the Korean Applied Science and Technology
Vol. 40, No. 6. December, 2023. 1445~1453
ISSN 1225-9098 (Print)
ISSN 2288-1069 (Online)
http://dx.doi.org/10.12925/jkocs.2023.40.6.1445

Research Trends in the Development of Cosmetic Ingredients for Skin Barrier Improvement

Hyung-Bum Park[1] · Jeong-Yeon Park[2,†]

[1]*Ph.D Course, Dept. of Start-up business, Graduate school, Honam University, CEO, Natural Story Inc.*
[2]*Professor, Department of Beauty Design, Wonkwang University*
(Received December 20, 2023; Revised December 27, 2023; Accepted December 28, 2023)

Abstract : In 2022, the domestic production performance of functional cosmetics in South Korea reached 4.6 trillion won, accounting for 33.85% of the total cosmetics production. The number of functional cosmetics reviewed increased by about 7.5% from the previous year, totaling 974 items. Especially with the increasing importance of the skin barrier function due to skin sensitivity caused by various environmental pollutants, domestic cosmetic companies are showing interest in the development of new ingredients and products related to this area. This study aims to analyze academic research trends related to in vitro experiments for the development of cosmetics improving the skin barrier, to provide practical information for the cosmetic industry. The findings are as follows: Academic research mainly focused on the efficacy of natural ingredients in improving the skin barrier, but there is a significant lack of quantitative accumulation of research. For the development of skin barrier-improving cosmetic ingredients, efficacy evaluation indicators were set, including hyaluronic acid production, expression of filaggrin gene, loricrin, formation of cornified envelope (CE), and expression of ceramide synthesis enzyme genes. Moreover, effective cosmetic ingredients for improving the skin barrier included lemongrass and perilla leaf extracts, flavonoids, Lactococcus lactis subsp. lactis, Exosomelike Nanovesicles derived from apple callus, Eleutherococcus sessiliflorus, Acanthopanax sessiliflorus, Eleutherococcus gracilistylus, Acer okamotoanum extracts, Aloe vera adventitious root extract, ethanol extract of Aruncus dioicus, and organic solvent fraction of Dracocephalum argunense.

Keywords : Skin Barrier, Functional Cosmetics, Cosmetic Ingredient Research, Skin Barrier Improvement Cosmetics

†Corresponding author
(E-mail: yp2023@wku.ac.kr)
* Following are results of a study on the "Leaders in INdustry-university Cooperation 3.0" Project, supported by the Ministry of Education and National Research Foundation of Korea.

1. Introduction

Recently, cosmetics have been recognized not just as products for beautification but as essentials for adjunctive skin treatment and improvement[1]. Moreover, the cosmetic industry is showing diverse changes due to the increasing desire for products tailored to individual skin conditions and skin troubles caused by environmental factors such as pollution and mask-wearing[2-3].

This has led to the spread of 'scientific evidence-based' awareness regarding cosmetic ingredients and materials. Numerous products with high safety and effectiveness, such as anti-pollution and microbiome-containing cosmetics incorporating new technologies, are continuously being launched[4-5]. The importance of ingredients is expected to establish a new form of consumption, hence the demand for functional cosmetics is expected to increase further. Functional cosmetics, which are conceptually between pharmaceuticals and cosmetics, contain ingredients that help enhance skin physiological activity. They are known to have stronger effects on skin physiological activity compared to general cosmetics but milder compared to pharmaceuticals[6]. According to Article 2.2 of the Cosmetic Act, functional cosmetics are classified as follows: First, products that help in whitening the skin; second, products that help in improving skin wrinkles; third, products that help in refining the skin or protecting it from ultraviolet rays; fourth, products that help in changing or removing hair color, or providing nutrition to the hair; and fifth, products that help in preventing or improving dryness, cracking, hair loss, and keratinization due to the weakening of skin or hair functions[7]. In other words, functional cosmetics are cosmetics whose efficacy and functionality have been enhanced through the application of science and technology[8]. Previous research shows that whitening agents, wrinkle improvers, and sunscreen products have mainly constituted the domestic cosmetics market and related research has been conducted[9]. However, with the amendment of the Cosmetic Act in 2017, the realm of functional cosmetics has expanded, leading to diversification in the cosmetics industry. Particularly, as air pollution and environmental pollution have accelerated, the importance of the skin barrier function has become more recognized due to the increasing sensitization of the skin, and companies are showing great interest in developing related products. The skin barrier prevents excessive moisture loss from the body and blocks harmful substances like chemicals and microorganisms from entering our bodies[10]. The skin barrier is formed through the differentiation process of keratinocytes, and its improvement is regulated by the balance between the differentiation of keratinocytes and the skin's process of shedding these cells[11]. The function of the skin barrier is influenced not only by filaggrin but also by abnormalities in proteins similar to filaggrin, such as hornerin and FLG(filaggrin)2. Changes in the skin barrier function can induce dryness and itching and increase susceptibility to various external stimuli or infections, becoming a significant factor in increasing the risk of contact dermatitis and skin infections[12]. Therefore, developing technologies that can inhibit the decline of the skin barrier function or enhance it is an important part of developing functional cosmetics. Research on the active ingredients commonly used to influence the structural and functional changes of the skin barrier function and its mechanisms should be conducted. In this study, we aim to review and analyze literature and trends related to skin barrier improvement cosmetic technology, a type of functional cosmetic, to examine the cosmetics industry. Based on this, we intend to present practical implications for both the industry and the academic field.

2. Mechanism of skin barrier

The stratum corneum of the epidermis, which is the outermost layer of the skin, makes the human body an external analogy It protects against harmful irritants and prevents the loss of water in the body. It has an important function of preventing[13-14]. Among these, the skin's moisture retention is The water-bearing capacity of keratinocytes and the moisture content of lipids between keratinocytes Relies on the ability to prevent threads[15]. Therefore, various skin diseases When damage to the skin barrier structure is caused by the moisture in the stratum corneum This results in a decrease in content and an increase in water loss[16]. In particular, the stratum corneum constitutes intercellular lipids Natural moisturizing factor (NMF) contains Ceramides, squalene, cholesterol, esters, neutral lipids,There are free fatty acids, which fill in the gaps between keratinocytes[17]. It protects the skin from auxiliary substances and inhibits moisture evaporation.It plays an important role in shaping walls[18].

In healthy skin, keratinocytes and keratinocytes water in which lipids cause itching, such as allergens and irritants prevent the influx of vaginas[19]. However, external environmental factors, inflammatory spots damage to the epidermal barrier occurs due to various causes, such as clots If endogenous inflammatory mediators and external incoming substances are obscured, by activating the C nerve fiber, which is the myriad nerve associated with depression, itching is provoked[20-21]. the transmission route of itch varies greatly depending on the medium and mechanism. it can be divided into staminergic and nonhistaminergic-mediated pathways. salt In the skin in a state of inflammation, histamine freed from mast cells It also stimulates some sensory nerve fibers, but in addition to histamine, Releases various cytokines, protease and neuropeptides Itching is caused by T cells, neutrophils, eosinophils, and keratinocytes[22-23]. It can cause or exacerbate it. Abnormalities in skin barrier function activate proteolytic enzymes that promote the replacement and shedding of the stratum corneum, leading to PAR-2-mediated itching. barrier dysfunction, dryness, itching are atopic skin Skin diseases such as editis, psoriasis, and contact dermatitis, as well as kidney Hypofunction, diabetes, liver disease, cholestasis disease, hematological oncology disease It is also common in a variety of systemic diseases, including, and normal It can also occur as a result of physiological aging[24-25].

3. Research Method

3.1 Research Method and Scope

The data for this study were collected and analyzed using the National Assembly Library, Research Information Service System (RISS), and Google Scholar, focusing on academic materials related to ‘functional cosmetics’, ‘skin barrier’, and ‘skin barrier improvement cosmetics’. The keyword extraction image used a big data analysis solution.(Fig. 1).

Fig. 1. Search key word.

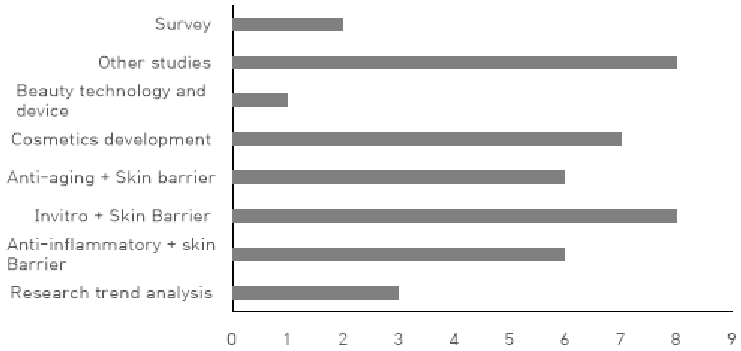

Fig. 2. Research Topic Analysis

Table 1. Academic research analysis

Topic(Year)	Research type
Skin Hydration and Skin Barrier Effects of Cymbopogon citratus and Perilla frutescens Extracts(2019)	Journal
Roles of Fisetin on Skin Barrier Function and Anti-aging in Epidermal Keratinocyte(2020)	Journal
Skin Barrier Improvement Effect of Exosomal Nanovesicles Derived from Lactic Acid Bacteria(2021)	Journal
Study on Reinforcing Skin Barrier and Anti-aging of Exosome-like Nanovesicles Isolated from Malus domestica Fruit Callus(2021)	Journal
Comparison of Anti-inflammatory, Skin Barrier Improvement, and Anti-aging Efficacy of Eleutherococcus divaricatus var. chiisanensis and various Eleutherococcus Genus Extract(2022)	Journal
Efficacy in vitro Antioxidation and in vivo Skin Barrier Recovery of Composition Containing Mineral- cation -phyto DNA Extracted from Aloe vera Adventitious Root(2023)	Journal
Skin barrier and anti-inflammatory effect of petasites japonicus(2023)	Journal
Anti-oxidant Activity and Skin Barrier Function Measured in Different Solvent Fractions Obtained from Agrimoniae Herba(2023)	Journal

4. Results and discussion

4.1. Research Trends in Materials for Skin Barrier-Improving Cosmetics

To examine Within the last 5 years academic research trends within the past five years on materials for developing functional cosmetics for skin barrier improvement, a total of 41 academic papers were found using academic research information services, the National Assembly Library, and Google Scholar (Fig. 2).

Among these, eight papers that conducted in vitro experiments to evaluate the efficacy for the development of cosmetics materials aimed at improving the skin barrier were selected for final analysis (Table 1).

4.2. Efficacy Evaluation Indicators for Skin Barrier-Improving Cosmetic Materials

This is an analysis of efficacy evaluation indicators for the development of cosmetics materials related to skin barrier improvement (Fig. 3). The studies by Soyang Kang et al. (2019) on lemongrass and perilla leaf extracts[26] and Han Ji Won et al. (2022) on extracts from Jirisan acanthopanax, spiny acanthopanax, acanthopanax trees, and ogan trees[27] measured the expression of genes related to hyaluronic acid production and skin moisturization, HAS1, HAS2, HAS3, AQP3 mRNA, and genes related to the skin barrier like filaggrin, loricrin, and involucrin mRNA as indicators. Wang Hyesoo et al. (2021)[28] used FN1 (fibronectin) and FLG (Filaggrin) gene expression as evaluation indicators to investigate the effects of exosome-like nanovesicles derived from lactobacillus on skin barrier improvement. Kim Dongmyeong et al. (2023)[29] in their study on the skin barrier improvement with a cationic and mineral complex containing phyto DNA extracted from Aloe vera adventitious roots, measured filaggrin and loricrin as efficacy evaluation indicators. Additionally, Kim Chaehyeon et al. (2023)[30] examined the expression of mRNA for filagrin and aquaporin-3 in their study on the skin barrier effects of ethanol extracts of Angelica keiskei. Meanwhile, Seo Yuri et al. (2021)[31] used the ability to form a cornified envelope (CE) of keratinocytes as an evaluation indicator to ascertain the impact of Exosome-like Nanovesicles derived from apple callus on skin barrier improvement. In Lee Kyeongha et al.'s (2020)[32] study on the skin barrier function improvement effects of Fisetin, a type of flavonol, the expression of proteins and enzymes FLG, KRT1, IVL, DSP, TGM1, and the major genes involved in the synthesis of epidermal ceramides, CerS3 and CerS4, were used as evaluation indicators. Also, in Han Jegun et al.'s (2023)[33] study on the skin barrier improvement effects of an organic solvent fraction of 龍芽草, the expression of ceramide synthesis enzymes CERS3 and CERS4 mRNA genes was measured.

4.3. Skin Barrier-Improving Cosmetic Material

In the research for the development of skin barrier-improving cosmetic materials, the materials under efficacy validation were derived from natural sources. the skin barrier-Improving cosmetic material extract image used a big data analysis solution(Fig. 4). The main active ingredients can be summarized as follows. In the study by So Yang Kang et al. (2019) on lemongrass and perilla leaf extracts, chlorogenic acid and p-coumaric acid, the main components of lemongrass, were identified as the key efficacy ingredients for skin barrier improvement. Lee Kyung Ha et al. (2020) confirmed the skin barrier improvement effects of flavonoids, a type of polyphenol, in their study on Fisetin. Wang Hye Soo et al. (2021) reported on the skin barrier improvement effects of Lactococcus lactis subsp. lactis, a type of probiotic. Seo Yu Ri et

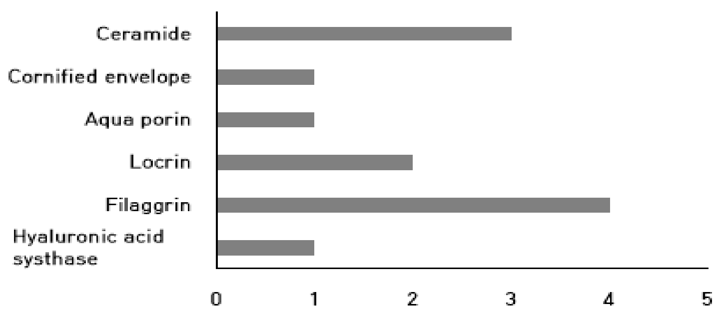

Fig. 3. Efficacy Evaluation Indicators for Skin Barrier-Improving Cosmetic Materials.

al. (2021) verified the skin barrier effects of Exosome-like Nanovesicles derived from apple callus. Han Ji Won et al. (2022) stated that eleutheroside E, chlorogenic acid, and caffeic acid contained in the extracts of Eleutherococcus sessiliflorus, Acanthopanax sessiliflorus, Eleutherococcus gracilistylus, and Acer okamotoanum positively influenced skin barrier improvement. Furthermore, Kim Dong Myeong et al. (2023) reported that purine and pyrimidine, plant-based bases, acted as the main components in the skin barrier improvement effects of the Aloe vera adventitious root extract. Kim Chae Hyun et al. (2023) reported that fukinolic acid, cafeic acid, sequi-terpenoid, ermopetasidone, and phenolic compounds like petasiphenoe and ermophilenoid, acted in the skin barrier effects of the ethanol extract of Aruncus dioicus. Han Je Geun et al. (2023) reported that catechin, quercitrin, rutin, hyperoside, and quercetin, types of flavonoids, were the main active components in the skin barrier improvement effects of the organic solvent fraction of Dracocephalum argunense.

5. Conclusion

This study was conducted to analyze academic research on skin barrier-improving cosmetics in the context of the growth of the cosmetic industry and the diversification of functional cosmetics, and to provide practical data for research and development in this field. The results are as follows:

Firstly, although 204 academic studies were found in the recent five years under the keywords 'functional cosmetics,' 'skin barrier,' and 'skin barrier-improving cosmetics,' only eight were in vitro experiments for basic research, indicating a dire need for more quantitative academic buildup.

Secondly, for the development of skin barrier-improving cosmetic materials, efficacy evaluation indicators such as hyaluronic acid production capability, expression of the filaggrin gene, loricrin, formation capability of the cornified envelope (CE), and expression of ceramide synthesis enzyme genes were used.

Thirdly, effective cosmetic materials for improving the skin barrier included lemongrass and perilla leaf extracts, flavonoids, Lactococcus lactis subsp. lactis, Exosome-like Nanovesicles derived from apple callus, Eleutherococcus sessiliflorus, Acanthopanax sessiliflorus, Eleutherococcus gracilistylus, Acer okamotoanum extracts, Aloe vera adventitious root extract, ethanol extract of Aruncus dioicus, and the organic solvent fraction of Dracocephalum argunense.

These results highlight the considerable lack of quantitative accumulation in the fundamental research of skin barrier-improving functional cosmetics. Additionally, the study academically derived skin evaluation factors and the

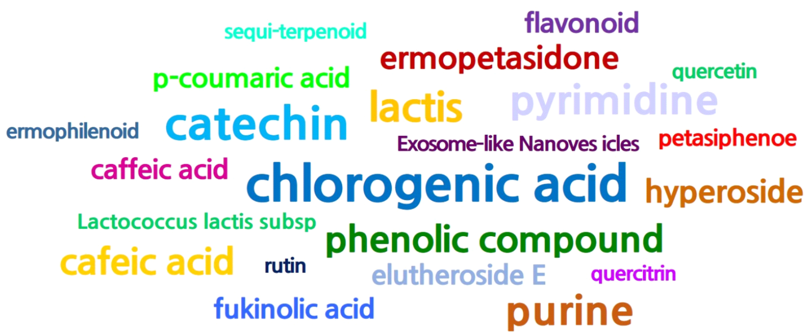

Fig. 4. Skin Barrier-Improving Cosmetic Materials.

mechanism of barrier formation related to the skin barrier, and identified effective cosmetic materials and their main components for skin barrier improvement.

Therefore, vigorous and multifaceted research for the efficacy validation and development of materials for skin barrier-improving functional cosmetics should be actively conducted.

This study is significant for analyzing and forecasting the academic research trends in a situation where the cosmetic industry is evolving and the demand for skin barrier-improving cosmetics is increasing. However, the insufficient accumulation of related research remains a concern, and it is hoped that future academic research will address this gap for both qualitative and quantitative advancements in the field.

References

1. M. A. Jang, J. M. Lee, S. H. Bae, "A Study of Consumer Choice Behavior Determination Applying the Theory of Planned Behavior (TPB) of Functional Cosmetics", *Asian J Beauty Cosmetology*, Vol.20, No.1, pp. 95-110, (2022).
2. H. R. Cho, M. KIm, "Analysis of the Advertising System to Enhance the Competitiveness of Functional Cosmetics", *Journal of Communication Design*, Vol. 78, pp. 334-344, (2020).
3. M. C. Yoo, J. H. Kim, "The Influence of Online Consumers' Consumption Orientation on Product Attribute Consideration and Repurchase Intention", *Journal of Consumption Culture*, Vol.25, No.4, pp. 113-127, (2022).
4. I. S. Shim, K. J. Kim, "Analysis of Consumer Misconception in Cosmeceutical Advertisements", *Asian Journal of Beauty and Cosmetology*, Vol.18, No.2, pp. 195-207, (2020).
5. S. Y. Nam, M. Y. Yun, H. J. Choi, "Study on Recognition of Functional Cosmetics between Subjects of Major in Beauty and Non-beauty", *Journal of Korean Beauty Society*, Vol.27, No.2, pp. 506-512, (2021).
6. H. Yige, J. A Lee, "Evaluation of Rhodiola rosea Root Fraction as a Functional Cosmetic Ingredient", *Journal of the Korean Society of Cosmetology*, Vol.29, No. 3, pp. 574-581, (2023).
7. https://www.law.go.kr/LSW/lsInfoP.do?efYd=2022 0218&lsiSeq=234911#0000 (acce ssed Oct., 01, 2023)
8. S. Y. An, J. S. Park, Y. M. Chung, "Current Applications of Biomolecules as Cosmetics Ingredients", *Journal of the Korea Academia-Indus trial cooperation Society*, Vol.24, No.2, pp. 21-31, (2023).
9. M. H. Kim, C. S. Hwang, "The difference of the satisfaction level according to the shopping orientation of cosmeceuticals: focusing on whitening, sun screen, anti-aging cosmetics", *Asian Journal of Beauty and Cosmetology*, Vol.9, No.4, pp. 1-14, (2011).
10. J. M. Brandner, S. Kief, C. Grund, M. Rendl, P. Houdek, C. Kuhn, E. E. Tschachler, W. W. Franke, and I. Moll, "Organization and formation of the tight junction system in human epidermis and cultured keratinocytes", *European Journal of Cell Biology*, Vol.81, No. 5, pp. 253-263 (2002).
11. E. Fuchs, "Epidermal differentiation: the bare essentials", *The Journal of Cell Biology*, Vol.111, No.6, pp. 2807-2814, (1990).
12. R. L. Eckert, J. F. Crish, and N. A. Robinson, "The epidermal keratinocytes as a model for the study of gene regulation and cell differentiation", *Physiological. Reviews*, Vol.77, No.2, pp. 397-424. (1997).
13. Jacobi OT. "About the mechanisms of moisture regulation in the horny layer of the skin". *Pro Sci Sect Good Assoc*, Vol. 3, No.1, pp. 22-24, (1959).

14. Purnamawati S, Indrastuti N, Danarti R, Saefudin T. "The role of moisturizers in addressing various kinds of dermatiㆆtis: a review", *Clinical Medicine & Research,* Vol.15, No.3-4, pp. 75-87, (2017).
15. Cork MJ, "The importance of skin barrier function", *Journal of Dermatological Treatment*, Vol.8, No.1, pp. 7-13, (1997).
16. Potenzieri C, Undem BJ. "Basic mechanisms of itch", *Clinical & Experimental Allergy*, Vol.42, No.1, pp. 8-19, (2011).
17. Kremer AE, Feramisco J, Reeh PW, Beuers U, Oude Elferink RP. "Receptors, cells and circuits involved in pruriㆆtus of systemic disorders", *Biochim Biophys Acta*, Vol.1842, No.7, pp. 869-892, (2014).
18. Choi JK, Oh HM, Lee S, Park JW, Khang D, Lee SW, et al. "Oleanolic acid acetate inhibits atopic dermatitis and alㆆlergic contact dermatitis in a murine model", *Toxicol Appl Pharmacol,* Vol.269, No.1, pp. 72-80, (2013).
19. Grewe M, Bruijnzeel-Koomen CA, Schöpf E, Thepen T, Langeveld-Wildschut AG, Ruzicka T, et al. "A role for Th1 and Th2 cells in the immunopathogenesis of atopic dermatitis", *Immunol Today*, Vol.19, No.8, pp. 359-361, (1998).
20. Rincón M, Anguita J, Nakamura T, Fikrig E, Flavell RA. "Interleukin (IL)-6 directs the differentiation of IL-4-proㆆducing CD4+ T cells, *J Exp Med*, Vol.185, No.3, pp. 461-470, (1997).
21. Elias PM, Schmuth M, Uchida Y, Rice RH, Behne M, Crumrine D, Pharm D. "Basis for the permeability barrier abnormality in lamellar ichthyosis", *Experimental Dermatology*, Vol.11, No.3, pp. 248-256, (2002).
22. Finlay AY, Nicholls S, King CS, Marks R. The "dry non-eczematous skin associated with atopic eczema", *British Journal of Dermatology*, Vol.101, No.3, pp. 249-256, (1980).
23. Ganemo A, Virtanen M, Vahlquist A. "Improved topical treatment of lamellar ichthyosis: a double blind study of four different cream formulations", *British Journal of Dermatology*, Vol.141, No.6, pp. 1027-1032, (1999).
24. Garg A, Chren MM, Sands LP, Matsui MS, Marenus KD, Feingold KR, Elias PM. "Psychological stress perturbs epidermal permeability barrier homeostasis: implications for the pathogenesis of stress-associated skin disorders", *Arch. Dermatol.*, Vol.137, No.1, pp. 53-59, (2001).
25. Ghadially R, Brown BE, Sequeira-Martin SM, Feingold KR, Elias PM. "The aged epidermal permeability barrier: structural, functional, and lipid biochemical abnormalities in humans and a senescent murine model", *The Journal of clinical investigation*, Vol.95, No.5, pp. 2281-2290, (1995).
26. Y. K. So, J. Y. Hwang, H. W. Kim, H. N. Jo, T. B. Lee, "Skin Hydration and Skin Barrier Effects of Cymbopogon citratus and Perilla frutescens Extracts", *Journal of the Society of Cosmetic Scientists of Korea*, Vol.45, No.3, pp. 225-235, (2019).
27. J. W. Han, B. M. Nam, B. S. Lee, seok, J. A. Ko, J. Y. Hwang, "Comparison of Anti-inflammatory, Skin Barrier Improvement, and Anti-aging Efficacy of Eleutherococcus divaricatus var. chiisanensis and various Eleutherococcus Genus Extract", *Journal of the Society of Cosmetic Scientists of Korea*, Vol.48, No.4, pp. 373-383, (2022).
28. H. S. Wang, K. S. Lee, Y. W. Kang, "Skin Barrier Improvement Effect of Exosomal Nanovesicles Derived from Lactic Acid Bacteria", *Journal of the Society of Cosmetic Scientists of Korea*, Vol.47, No.2, pp. 171-178, (2021).
29. D. M. Kim, W. J. Kim, H. K. Lee, Y. S. Kwon, Y. M. Choi, "Efficacy in vitro Antioxidation and in vivo Skin Barrier Recovery of Composition Containing

Mineral-cation-phyto DNA Extracted from Aloe vera Adventitious Root", *Asian Journal of Beauty and Cosmetology*, Vol.21, No.2, pp. 231-246. (2023).
30. C. H. Kim, W. S. Moon, Y. A. Jang, "Skin barrier and anti-inflammatory effect of petasites japonicus", *Journal of the Korean Applied Science and Technology*, Vol.40, No.2, pp. 258-267, (2023).
31. Y. R. Seo, K. S. Lee, Y. W. Kang, "Study on Reinforcing Skin Barrier and Anti-aging of Exosome-like Nanovesicles Isolated from Malus domestica Fruit Callus", *Journal of the Society of Cosmetic Scientists of Korea*, Vol.47, No.2, pp. 139-145. (2021).
32. K.. H. Lee, W. Kim, "Roles of Fisetin on Skin Barrier Function and Anti-aging in Epidermal Keratinocyte", *Journal of the Society of Cosmetic Scientists of Korea*, Vol.46 No.4, pp. 391-401, (2020).
33. J. G. Han, M. J. Kim, H. J. Park, K. H. Lee, S. S. Roh, "Anti-oxidant Activity and Skin Barrier Function Measured in Different Solvent Fractions Obtained from Agrimoniae Herba", *The Korea Journal of Herbology*, Vol.38 No.3, pp. 19-26, (2023).