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1	Zhang et al., 2024 [3]	Mulberry fruit extract, AGEs, Oxidative stress, Anti-glycation, Anti-skin aging	Mulberry fruit	[Senescence model] HaCaT cells / By fructose, MGO-BSAKM mice / By D-galactose	- Cell viability - MDA activity, SOD activity - Cell apoptosis - Moisture content, 히알루론산, Hydroxyproline(HYP) Content, AGEs - Serum GSH-px, SOD, MDA
2	Lee et al., 2022 [4]	brown seaweeds; sargassum; skin aging; cosmeceutica	Sargassum spp	[Photoaging model] Male HR-1 strain hairless mice	- Average length and depth(of wrinkle decreasing) - Epidermal thickness(inhibit increasing) - collagen bundle formation
3	Yoon et al., 2022 [5]	Cirsium japonicum flower extract; anti-glycation; skin aging; extracellular matrix; skin elasticity; skin wrinkle	Cirsium japonicum flower extract	[Senescence: Glycation model] Human fibroblast cell / By BSA, glucoseFemale subjects	- glucose glycation system (AGEs, CML, Carbonylated protein contents) - The breaking activity on crosslinks of collagen-GEs - MMP-1 expression - collagen lattices - Skin wrinkles, mean, max depth blggest wrinkle(inhibit increasing), total wrinkle area, total wrinkle volume, skin elasticity
4	Brown et al., 2023 [6]	Anti-aging; Bakuchiol; Photoaging; Retinal; Retinaldehyde; Retinoid; Skin aging; Vigna aconitifolia	Vigna aconitifolia, Bakuchiol, potent retinoid retinal	[Photoaging model] (3D) full-thickness in vitro skin model (FT skin)-normal human epidermal keratinocytes and normal humandermal fibroblasts / By UVB irradiation	- mRNA expression of keratinocyte differentiation (i.e., CALML5, CASP14, KRT14, TP63) - mRNA expression of epidermal barrier function (i.e., CDSN, CLDN1, FLG, GRHL3, TGM1, DSG1) - mRNA expression of MMP9 - mRNA expression of Hydration (AQP3) - mRNA expression of immune, inflammation - In vitro skin irritation potentials - Pro-collagen 1, total Collagen level
5	Nutho et al., 2023 [7]	lotus plant; skin-aging enzyme inhibition; molecular docking; molecular dynamics simulation	Nelumbo nucifera Gaertn.	Molecular Docking	- Molecular Docking(collagenase, elastase, tyrosinase) - Enzyme inhibition(collagenase, elastase, tyrosinase)
6	Lee et al., 2020 [8]	caviar extract; DHA; adiponectin; adipocyte differentiation; skin aging; MMP	Caviar Extract,docosahxaenoic acid (DHA)	[Photoaging model] 3T3-L1 cell / By UVB irradiation	- adipocyte differentiation - mRNA expression of PPAR-gamma, SREBP-1 alpha, C/EBP-alpha - mRNA expression of Adiponectin, MMP-1
7	Zheng et al., 2023 [9]	black tea extract, skin aging, anti-aging, biochemical index, tissue structure	black tea extract	[Senescence model] male KM mice / By D-galactose	- Contents of HA, MDA - SOD, CAT, GSH-Px activity - Total skin collagen content - HE staining of aged skin tissue (increasing) - Type 1, 3 collagen (histology) - Moisture, HA content

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8	Shin et al., 2015 [10]	AGE; fibrillin-1; glycation; human skin explants; Akebia quinata fruit extract	Akebia quinata fruit extract	[Senescence: Glycation model] Human fibroblast cell / By glycated BSA Human Skin Explants / by Methylglyoxal (MG)	- AGEs, N-CML, - Intracellular ROS levels - Activity of SA-β-Gal - Antiglycation Activity - fibrillin-1 under the dermal-epidermal junction
9	Shin et al., 2019 [11]	Rosa gallica, Skin aging, Flavonoid Anti oxidative effect	Rosa gallica petal extracts	[Photoaging model] B16F10 melanoma cells, Human dermal fibroblast / By UV irradiation	- mushroom tyrosinase activity - melanin production - protein expression of Tyrosinase
10	Wang et al., 2019 [12]	Skin aging, Cherry blossom extract Antioxidant, Anti-apoptosis, HaCaT cells	Cherry blossom extract	[Photoaging model] HaCaT cells / By UVB irradiation	- Intracellular ROS levels - Activities of SOD, GSH-Px, content of MDA - Amount of CPD and 8-OHdG - Apoptotic cells - Protein, mRNA expression of Bcl-2, Bax, Cytochrome-c, Caspase-3
11	Kang et al., 2018 [13]	Antioxidant activity, Marigold methanol extract, MMP-1 mRNA, MMP-2 activity, Skin anti-aging effects, Type I procollagen synthesis	Marigold methanol extract	[Photoaging model] Human dermal fibroblasts / By UVA irradiation	- Mushroom tyrosinase activity - Color difference meter (a value) - Melanin production - Protein expression of TYR, MMP-1
12	Jo et al., 2020 [15]	Vaccinium uliginosum; skin aging; UVB; wrinkles; mitogen-activated protein kinase (MAPK)	Vaccinium uliginosum extract	[Photoaging model] Hairless mice (SKH-1, 4-week-old male) / By UVB irradiation	- Skin water holding capacity, TEWL, erythema value, - Inhibit increasing epidermal thickness - Effects of an anthocyanin-enriched extract from Vaccinium uliginosum on - Total wrinkle area, number of wrinkles, mean wrinkle length, wrinkle depth, mean wrinkle depth (inhibit increasing) - Inhibit increasing epidermal thickness Collagen degradation (histological) - mRNA expression of MMP-2, MMP-3, MMP-9, TIMP1, TIMP2, COL1a1, HYAL, SOD1, CAT, GPx - Protein expression of MAPK pathway - IL-6, IL-12, TNF-alpha
13	Bacqueville et al., 2020 [16]	anti-aging therapy, clinical trial, inflammaging, senescence, skin model	combination containing bakuchiol (BK) and vanilla tahitensis extract (VTE) (serum form)	[Photoaging model] Human dermal fibroblasts / By UVA irradiation Ex vivo human skin / By UVA irradiation	- Cellular Morphology - IL-8, p16 - Dermal density(GAGs) - Efficacy Outcomes (in human) - Illustrative analysis of improvement of ptosis volume(in human) - Results of skin firmness - Full-face macrophotographs of radiance evaluation(in human)

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14	Choi et al., 2017 [18]	Ulmus macrocarpa Hance extracts; human dermal fibroblasts; hairless mice; antioxidant; anti-aging	Ulmus macrocarpa Hance extracts	[Oxidative stress model] HDFs / by H2O2 [Photoaging model] Hairless mice	- ROS generation - SA-β-gal positive cells - Protein expression of SOD, CAT, GPx, GR, MAPK pathway - Inhibit increasing wrinkle length, number, depth, thickness
15	Mao et al., 2021 [19]	Rosemary extract; Human skin fibroblasts; UVA photoaging; ROS; p53 Protein	Rosmarinus officinalis extracts	[Photoaging model] Human dermal fibroblasts / By UVA irradiation	- Proliferation activity - SA-β-gal positive cells - Morphological change - ROS - Protein expression of p53, MMP-1, MMP-3
16	Puglia et al., 2013 [20]	skin, red orange, oral supplementation, anti-aging, solar lentigo	Red orange extracts	[Photoaging model] Subjects (skin types II ~ IV) / By UV irradiation	- Erythema index². Mean values of solar spots, spotless skin sites
17	Yang et al., 2024 [21]	Corydalis heterocarpa; cellular senescence; anti-aging; autophagy; LRSAM1	Corydalis heterocarpa extracts	[Senescence model] HDFs / By replicative senescence (young, old)	- SA-β-gal positive cells - Protein expression of p53, p21, caveolin1 - The cell cycle distribution - Autophagy, protein expression of LC3B, p62 - Lysosomal activation⁶. Protein expression of LRSAM1, AMPK, mTOR, ULK1
18	Upatcha et al., 2023 [22]	Nanoencapsulation; cordyceps extract; antioxidation; autophagy; skin regeneration	Cordyceps extract	[Oxidative stress model] HDFs / by H2O2	- mRNA expression of Collagen and Elastin synthesis - mRNA expression of Antioxidant - ROS generation - mRNA expression of Autophagy - Efficiency of wound healing
19	Chao et al., 2023 [23]	Poria cocos; aging; lanostane triterpenoids; Lipucan®; collagen; hyaluronic acid	P. cocos lanostane triterpenoids extract	[Senescence model] SD rats (10 weeks old) / By D-galactose	- Skin papillary ridge, epidermis thickness, width (inhibit decreasing) - Protein expression of Collagen 1 - Hyaluronic acid level
20	Lyu et al., 2022 [24]	Chenopodium formosanum; DJulis; ultraviolet radiation; advanced glycation end products; glycation stress; reactive oxygen species	Chenopodium formosanum	[Photoaging model]HDFs / by UVB irradiation	- Antioxidant Activity - ROS generation - Protein expression of Nrf2, Keap1, HO-1 - Nuclear translocation of Nrf2 - Protein expression of MMPs, TIMP, MAPK, pro-collagen 1 - Protein expression of TGF-β, Smad3, RAGE - Collagen contents
21	Klinngam et al., 2022 [25]	Polymethoxyflavone, Kaempferia parviflora, Skin aging, Senescence, Ex vivo	Kaempferia parviflora	[Senescence model] HDFs / By replicative senescence (young, old)Aged ex vivo skin tissues (old subjects)	- SA-β-gal positive cells, activity - Gene expression of cellular senescence-related genes (CDKN1A, TP53, SIRT1..) - ROS level - Protein expression of IL-6, STC-1, MMP1, Tropocollagen - Staining of collagen type I, fibrillin-1, hyaluronic acid, Lamin B1, Lamin 5 - Epidermal thickness (inhibit decreasing, dermal-epidermal stability) - SASP factors (GDF-15, IL-6, IL-8, MMP-1)

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22	Shecori et al., 2024 [26]	hyperpigmentation; grapevine leaf extract; UV radiation; tyrosinase inhibition; sun protection factor (SPF); polyphenols; total phenolic content (TPC); skincare	grapevine leaf extract	no model	- Pytochemical contents - SPF factors - PCA analysis - Tyrosinase Inhibitory Effect
23	Kanlayavattanak u&Lourith, 2018 [27]	cosmeceuticals, hyperpigmentation, kojic acid, natural products, skin-whitening, topical agents	Plants and antioxidants	[Review article]- Photoaging: melanocyte(B16F10 cells)	- TYR, TRP-1, TRP-2, MC1R, MITF, EPK, a-MSH - Melanin contents, antimelanogenesis
24	Shariful Azam et al., 2018 [28]	cAMP, ERK, Hyperpigmentation, MITF, Sargaquinoic acid, Tyrosinase	Sargassum serratifolium	[Photoaging model] B16F10 cells	- Melanin content, TYR activity - Protein expression of TYR, TYR1, TYR2, CREB, MITF, - Protein expression of cAMP, PKA - Molecular docking model (cAMP, PKA) - Protein expression of MAPK
25	Fukunaga et al., 2018 [29]	ceramide, food extract, melanogenesis, tyrosinase, tyrosinase-related protein-1 (TRP1), yeast	ceramides(Yeast, rice, maize)	[Photoaging model] B16F10 cells	- Melanin content, TYR activity - Protein expression of TRP1
26	Kim et al., 2015 [30]	: Gaillardia aristata, Melanogenesis, Melanin, Tyrosinase, Skin-lightening effect	Gaillardia aristata	[Photoaging model] B16F10 cells	- Melanin content, TYR activity - Protein expression of TYR activity, TYR, TRP-1, DCT, MITF - mRNA expression of TYR, TRP-1, DCT, MITF - melanogenesis activity
27	Chan et al., 2018 [31]	Dendrobium tosaense; polyphenol; antioxidation; mushroom tyrosinase; B16F10; melanogenesis	Dendrobium tosaense extracts	[Photoaging model] B16F10 cells	- Antioxidant activity - Mushroom tyrosinase inhibition activity, melanin content
28	Portillo-Esnaola et al., 2021 [34]	cyclobutane pyrimidine dimers; dark cyclobutene pyrimidine dimers; ultraviolet radiation;Polypodium leucotomos; photoprotection; melanocytes; skin cancer	Polypodium leucotomos	[Photoaging model] B16F10 cells / By UVA irradiation	- CPD formation, positive cells - Nitric oxide, Superoxide, Peroxynitrite formation
29	Moreau et al., 2023 [35]	ROS scavenging; plant small RNA technology (PSRTM); aconitase; mitochondrial function	black tea extract	[Photoaging model] Keratinocytes, fibroblasts (From normal human skin sample) / By UVA, UVB irradiation	- Aconitase activity - Basal respiration, ATP synthesis, respiration rate - Mitochondrial ROS - Relative quantification of CPDs - Relative quantification of MLH1 - mRNA expression of MMP1 - Staining of procollagen 1, fibrilin-1

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30	Makino et al., 2017 [36]	Antioxidant activity, Aesculus hippocastanum, cyclobutane pyrimidine dimers, DNA repair, horse chestnut seed	Aesculus hippocastanum extracts	[Photoaging model] NHDFs / By UVB irradiation	- CPDs level - Antioxidant activity - Cell nuclei stained by 4',6-diamidino-2-phenylindole
31	Vernhes et al., 2012 [37]	Plants, UV radiation, fibroblast, DNA repair	Phyllanthus orbicularis Kunth	[Photoaging model] XP4PA (DNA repair) / By UVB irradiation	- Transmittance against the UV wavelength interval - Cell survival - Apoptosis level - Improved DNA damage (CPD) removal
32	Bolfa et al., 2013 [38]	Romanian propolis; Ultraviolet radiation; Inflammation; Apoptosis; Genotoxic lesions	Romanian propolis	[Photoaging model] Swiss mice (8 weeks old) / By UVB, UVA irradiation	- MDA, 8-oxo-dG, GSH, NO levels and activation of GPx - IL-6, IL-12 levels - Epidermal thickness (inhibit increasing), cell layers, Neutrophil infiltration-ermis - Sun burn cells - Epidermal active caspase-3 - TUNEL-positive cells - CPD formatin
33	Yang et al., 2013 [39]	skin fibroblasts; senescence; growth; cigarette smoke extract; senescence-associated β -galactosidase.	cigarette smoke extract	[Senescence model] HDFs / By cigarette smoke extracts	- Fibroblast growth, proliferation, growth kinetics - SA β-gal activity - Morphological changes - microvilli shedding, nucleolus degeneration, mitochondrial deformity - ROS production, SOD and GSH-Px activities
34	Bellu et al., 2022 [40]	stem cells; nanofibers; skin aging; cell senescence; 4D dynamic model; precision medicine; natural extracts; biophysics; cellular mechanisms	Myrtus communis	[Photoaging model] Human skin stem cells, Human skin fibroblast 1 / By UVB irradiation	- Activity of SA-β-Gal - mRNA expression of p16, p19, Bmi1, TERT (senescence) - mRNA expression of Oct-4, Sox2, Nanog, HAS - Morphological changes
35	Kim et al., 2011 [41]	Centella asiatica –dermal fibroblasts –gene expression –hydrogen peroxide –senescence	Centella asiatica	[Senescence model] HDFs / By H2O2	- SA β-gal activity - Protein expression of p53, p21, pRb, Rb - Expression profile of differentially expressed mRNAs - mRNA expression of FoxM1, E2F2, MCM2, GDF15, BHLHB2 (senescence) - DNA synthesis in UVA in H2O2-induced
36	Huang et al., 2011 [42]	cellular senescence; human placental extract; oxidative stress; dermal fibroblasts	human placental extract	[Senescence model] HDFs / By H2O2	- Cumulative population doubling level, SAβ-gal activity - mRNA expression of p16 - ROS levels - Gene expression of 'extracellular matrix organization', 'antioxidant' - Protein expression of anti-NRF2
37	Wo et al., 2022 [44]	Isatis tinctoria L.; senomorphics; replicative senescence; senescence-associated secretory phenotype (SASP); anti-aging; mTOR pathway	Isatis tinctoria L	[Senescence model] HDFs / By replicative senescence (young, old)	- SA β-gal activity - ROS generation - Protein expression of p53, p21, p16 - SASP expression(ILs, MMP-1) - Protein expression of SIRT1-mTOR-MAPK-NF-κB Signaling - Staining of p65

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38	Ortiz-Espí et al., 2017 [45]	Deschampsia antarctica, human fibroblasts, cellular senescence	Deschampsia antarctica extracts	[Senescence model] HDFs / By replicative senescence (young, pre, old), H2O2	- Cell proliferation and viability - mRNA expression of PCNA - SA β -gal activity 4. Protein expression of Sirt1, LmnA/C, Trx2
39	Gu et al., 2022 [46]	bamboo leaf flavonoids; nanoliposome; biopolymer conjugation; in vitro release; skin permeability; anti-senescence activity	bamboo leaf flavonoids	[Senescence model] C57BL/6J mice HaCaT cells / By AAPH	- In vitro skin penetration of naked - Proliferation and inhibition of proliferation - SAHF formation, positive cells - Protein expression of p16, p21, K9M-H3
40	Woo et al., 2021 [47]	Cellular senescence, SASP, cell cycle arrest, HDFs, Silybum marianum flower	Silybum marianum flower	[Senescence model] HDFs / By replicative senescence (young, old)	- Morphology change - Staining of γ -H2AX - mRNA expression of p16, p21, p53 - SA- β -gal activity - caspase-3/PARP pathway - senescent cells and cell proliferation 7. MMP-1, IL-6, Type-1 procollagen expression
41	Lee et al., 2022 [48]	Selaginella rossii; matrix metalloproteinases; amentoflavone; skin aging; anti-wrinkle	Selaginella rossii	[Senescence model] CCD-986sk fibroblasts, HaCaT / By UVB, AAPH	- MMP-1, 2, 3, 9 expression - type I C-peptide (PIP), mRNA expression of COL1A1, COL1A2 - ROS accumulation - Protein expression of MAPK
42	Hsu et al., 2020 [49]	Ajuga taiwanensis, fibroblasts, senescence	Ajuga taiwanensis	[Senescence model] HDFs / By replicative senescence (young, old)	- Cell aging analysis (Cell cycle phase, SA- β -gal activity, ki-67, morphology) - Protein expression of p53 - cell colony formation - Cell proliferation rate, ROS generation
43	Zhou et al., 2014 [50]	Tetrahydroxystilbene glucoside, dermal layer thickness, collagen fiber, insulin/IGF-1 signal pathway, Ca ²⁺	Tetrahydroxystilbene glucoside	[Senescence model] Male Kunming mice aged 18 months / Old aged	- Thickness of dermal layer (inhibit decreasing) - Collagen fiber content - Elastic fiber content - Levels of insulin, IGF-1, and the receptors of insulin and IGF-1 - Levels of Ca ²⁺ , P, in serum
44	He et al., 2024 [51]	(-)- α -Bisabolol, Cellular senescence, D-Galactose, SASP, Skin aging	(-)- α -bisabolol	[Senescence model] Human skin fibroblasts / by D-Galactose. BALB/c mice	- Aging phenotype (SA- β -gal, SASP, MMPs, p16, p21) - TEWL, skin barrier index - Mean epidermal area, Dermal thickness (inhibit increasing), brown area of dermis - SOD inhibition rate, contents of MDA and HYP - mRNA expression of elastin, collagen III, MMP-2, and MMP-3
45	Hu et al., 2016 [52]	Laminaria polysaccharide, dermal thickness, MAPK, Aging	Laminaria polysaccharide	[Senescence model] female Kunming / By young, old age	- Dermal thickness (inhibit decreasing) - Collagen, HYP content, type I collagen mRNA levels - Protein expression of MMP-1, TIMP-1, MAPK pathway - Antioxidant enzyme expression

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46	Park et al., 2017 [53]	Intrinsic skin aging, Kaempferia parviflora Wall ex. Baker, cellular senescence, mitochondrial dysfunction	Kaempferia parviflora Wall ex. Baker extracts	[Senescence model] Human dermal fibroblasts (Hs68) / By H2O2 female hairless mice / By middle, young age	- cell growth promotion and SA-β activity. - mRNA and protein expression of p53, p21, p16, pRb, E2F1, SIRT1 - Protein expression of PI3K/AKT pathway, mTOR and FoxO3a - mRNA and protein expression of IL-6, IL-8, NF-kb, COX2 - ATP, ROS level - mRNA expression of PGC-1α, ERRα, NRF-1, and Tfam - mtDNA expression - Wrinkle area, number, total length, wrinkle depth (inhibit increasing) - Skinfold thickness (inhibit decreasing) - Collagen content - Gross elasticity
47	Song et al., 2012 [54]	hairless mice; Mangifera indica; skin aging; ultraviolet B	Mangifera indica L	[Photoaging model] HR-1 hairless mice / By UVB irradiation	- Features of the dorsal skin, - Mean length of skin wrinkle - Epidermal thickness (inhibit increasing) - Staining of collagen fiber
48	Chen et al., 2017 [55]	Anti-skin-aging, EGCG, d-galactose, Oxidative stress, EGFR pathway	Epigallocatechin gallate (EGCG)	[Senescence model] male, Kunming mice / by D-Galactose.	- Epidermal, dermal thickness (inhibit decreasing) - Staining of collagenin - H2O2, MDA levels - Activities of SOD, CAT, GSH, GSH-px - Protein expression of p21, EGFR, JAK-2, STAT-5, Bax, Bcl-2
49	Lee et al., 2023 [56]	food; inner beauty; panax; skin aging; ultraviolet rays	ginseng sprouts	[Photoaging model] hairless mice / By UVB irradiation	- Epidermal thickness (inhibit increasing), dermal collagen density - Skin barrier (TEWL, Moisture, Roughness) - Skin elasticity, content of procollagen type 1 C-peptide (PIP)
50	Goto et al., 2012 [57]	Proteoglycans, glycosaminoglycan (GAG), UVB, skin aging, salmon nasal cartilage	salmon nasal cartilage extracts	[Photoaging model] hairless mice / By UVB irradiation	- Erythema values, TEWL - Hydration levels - Skin sections of dorsal skin - Epidermal and dermal thickness (inhibit increasing) - TNF-α, IL-1β, IL-6
51	Gu et al., 2023 [58]	skin aging, photoaging, ultraviolet B, Schizonepeta tenuifolia, mitogen-activated protein kinase (MAPK), advanced glycation end products (AGEs)	Schizonepeta tenuifolia	[Photoaging model] HR-1 hairless mice / By UVB irradiation	- Body weight and liver toxicity serum biomarkers - Wrinkle area, total wrinkle length, wrinkle depth (inhibit increasing) - Skin, epidermal thickness (inhibit increasing) - Protein expression of MMP1, MMP3, MMP9, pro-COL1A1, TIMP1 - Protein expression of HAS1,2,3, Filaggrin, collagen-1, HYAL-1,2 - Skin moisture, hyaluronan - Protein expression of MAPKs and nuclear factor-kappa - AGEs accumulations, Protein expression of AGE, RAGE
52	Carpenter et al., 2023 [59]	glucosinolate, isothiocyanate, nitrile, UVB, photoprotective, chemopreventive, 3D skin equivalent, MMPs (Min. 5-ax. 8)	(Limnanthes alba) glucosinolate derivatives	[Photoaging model] keratinocytes (HPEKs) and 3D human skin / By UVB irradiation	- Staining of human skin equivalent sections - Epidermal sunburned cell counts, epidermal thickness (inhibit increasing) - Epidermal of CPDs + cells - Protein expression of p-H2A.X, epidermal PCNA+ cells - Protein expression of MMP-1, MMP-3

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53	Calvo-Castro et al., 2013 [60]	Blackberry juice, NHEK cell, Apoptosis, Caspases 9	Ultrafiltered blackberry juice	[Photoaging model] NHEK cell / By UVB irradiation	- Apoptosis level(PARP, caspases 3, 6, 8 and 9) - Protein expression of 8-oxodG, p53, p-p53 (Ser15) - CPD
54	Mary Britto et al., 2017 [62]	UV radiation, Apigenin, DNA damage, Apoptosis, Cyclobutane pyrimidine dimer	Apigenin	[Photoaging model] HDFa cell / By UVB irradiation	- Sun protection factor - CPDs formaton - mRNA expression of XPC, TFIIH, ERCC1 - Protein expression of XPC, XPB, XPG, XPF, Bcl-2, Bax, Caspase-3 - Apoptosis rate
55	Shin et al., 2013 [64]	veratric acid, photoprotection, anti-inflammation	veratric acid (VA, 3,4-dimethoxybenzoic acid)	[Photoaging model] HaCaT Cell / By UVB irradiation	- DNA damage, CPD positive cell number - p-p53, γ-H2AX positive cell - Percentage of cells in the subG1, G1, S, G2/M phase - Apoptosis rate - PARP, capase-3, 8, 9, Bcl-xL - Protein expression of COX-2, PGE2, IL-6 - Induction percentage of eythema
56	Katiyar et al., 2010 [65]	Green tea polyphenols, contact hypersensitivity,nucleotide excision repair	Green tea polyphenols	[Photoaging model] Human fibroblasts / By XPA-deficient, UVB irradiationC3H/HeN mice / XPA-deficient	- Ear skin thickness (inhibit increasing) - CPD positive cells - mRNA expression of XPA, XPC, RPA1, DDB1, DDB2 - Genomic DNA of XPA+/+, XPA—
57	Minoretti et al., 2023 [66]	protein carbonylation, cyclobutane pyrimidine dimers, dna, ultraviolet radiation, actinic keratosis	Fotoker, Eryfotona AK NMSC Fluid, Heliocare 360 MD AK 100+, Actixicam, KeràK1, KeràK2, Vehicle	[Photoaging model] Subjects of Fitzpatrick skin types II—II / By UVB irradiation	- Actinic keratosis (CPDs) - Protein carbonylation
58	Delinasios et al., 2017 [67]	vitamin E, UVAI, keratinocytes, ultraviolet radiation	Vitamin E	[Photoaging model] keratinocytes / By UVAI irradiation	- Intracellular of GSH - DNA damage (% tail DNA) (Oxidised purines, CPD) - Production of oxidising species - Emission spectrum of the "UVA spot" - Pectoradiometric distribution of the emission spectrum
59	Sugimoto et al., 2009 [68]	ultraviolet, ascorbic acid-2-O-phosphate, p53, pyrimidine dimer, (6-4)photoproducts	Ascorbic acid (Asc), Asc2-O-phosphate (Asc2P), Dehydro-Asc, Asc-2-O-α-glucoside (Asc2G).	[Photoaging model] keratinocyte, Human skin fibroblasts cell / By UVA irradiation	- Formation of CPD, 6-4PP - DNA damage (6-4PP) - Gene expression of p53, MDM2

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60	Song et al., 2019 [69]	Grape skin; UV irradiation, NHEK cells; cyclobutane pyrimidine dimers; pyrimidine (6-4) pyrimidine photoproduct	Grape skin extract	[Photoaging model] NHEK cells / By UV irradiation	- Amounts of CPDs, 6-4 PP - Protein expression of Bax, Bcl-2, Cytochrome c - polyphenol content
61	Wang et al., 2017 [70]	Skin aging Cherry blossom extract Antioxidant Anti-apoptosis HaCaT cells	Cherry blossom extract (Prunus Yedoensis)	[Photoaging model] Keratinocyte / By UVB irradiation	- Activites of SOD, GSH-Px, MDA - Amounts of CPD, 8-OHdG - Apoptosis cells - Protein, mRNA expression of Bcl-2, Bax, cytochrome-c, caspase-3
62	Padmaja Divya et al., 2015 [71]	Blackberry extract; Ultraviolet radiation; Inflammation; COX-2; NF-κB	Blackberry extract	[Photoaging model] hairless mice / By UVB irradiation	- Skin thickness (inhibit increasing) - Intracellular ROS - 8-oxodG, CPD - Protein expression of COX-2, TNF-α, IL-6 - Protein expression of ERK1/2, p38, JNK, MKK4
63	Uchino et al., 2020 [72]	Erlotinib · Dry skin · Stratum corneum · Cholesterol sulfate · Ceramide · Hydroxy free fatty acid	Erlotinib	Human stratum corneum	- Intercellular lipid analysis (Ceramide, Free fatty acid) - Chages in Skin rash, dry skin grades - Composition of stratum corneum lipid - Ratio of CER, FFA (protein concentration) - Level of CS (cholesterol sulfate)
64	kim et al., 2013 [73]	Curdrania tricuspidata, antioxidant, photoaging, MMPs, wrinkle	Curdrania tricuspidata leave extract	[Photoaging model] hairless mice / By UVB irradiation	- Wrinkle formation on the back - Histological observation of Skin tissue - Activites of SOD, GPx - mRNA expression of MMP-1, 3, 9
65	Kim et al., 2012 [74]	Lespedeza cuneata, skin aging, antioxidant activity, hairless mouse	Lespedeza cuneata extract	[Photoaging model] hairless mice / By UVB irradiation	- Erythema index, lipid capacity, moisture capacity - xanthine oxidas (XO), SOD 및 CA - GSH, TBARS
66	Park et al., 2018 [75]	mugwort (Artemisia vulgaris), ascorbic acid, antiwrinkle, UVB, skin aging	mugwort (Artemisia vulgaris)	[Photoaging model] hairless mouse / By UVB irradiation	- Skin thickness (inhibit increasing) - Ra (arithmetic average roughness), Rt (skin roughness) - Rq (root mean square roughness), Rz (average roughness) - collagen formation - MMP-1
67	Lee el al., 2019 [76]	photoaging, fibroblast, collagen, Acanthopanax cortex shoots	Acanthopanacis cortex extract	[Photoaging model] Hs68 cell / By UVB irradiation	- ROS generation - MMP-1, MMP-3, collagen production
68	Park et al., 2024 [77]	Perilla frutescens, Galactose, Cellular senescence	Perilla Leaf Extract	[Senescence model] C2C12 / By D-Galactose.	- Protein expression of PCNA - Apotosis cells - Activities of CAT, GSH-Px, T-AOC, SOD, MDA - ROS generation / mitochondrial dysfunction - Loss of MMP - γH2AX, SA-β-gal activity - Protein expression of IL-6, IL-18, p16, p53, p21 - Protein expression of NF-κB and IκBα, Lamin B

번호	참고 논문	핵심 키워드	시험 대상	실험 모델	주요 바이오마커
69	Kim et al., 2004 [78]	skin, parsley extract, collagen, aging, PGE2	Parsley extract	[Senescence model] hairless mouse / By replicative senescence (Old-40 weeks) Fibroblast cell [Photoaging model] HaCaT cell / By UVB irradiation	[Senescence model] - Production of total collagen, type 1 procollagen - Skin thickness (inhibit decrease) [Photoaging model] - type I procollagen , MMP-1 - Inhibition of PGE2 - Inhibition of TNF- α , IL-1 α ,
70	Lee et al., 2017 [79]	Mori Folium, wrinkle formation, collagen, Advanced glycation end product	Mori Folium	[Glycation model] Sprague-Dawley (SD) rat / By streptozotocin	- Contents of AGEs in serum, skin tissue - Protein expression of RAGE, CML, CEL - Protein expression of MMP-1, COL1A2, IL-6
71	Lee et al., 2006 [80]	NOS, SOD, Old-rat, testosterone, erectile dysfunction	KH-304	[Senescence model] Rat / By replicative senescence (Old- 21 months)	- Protein expression of eNOS, nNOS, Caveolin1,3, SOD/Mn - blood testosterone - SOD activity
72	Berkers et al., 2018 [skin lipid 1]	Ceramides . lipid organization . skin barrierrepair . topical formulation	Ceramides	[Skin moisture] ex vivo / Human stratum corneum cultured	- Epidermer thickness - CER, CER EOS, CER NS, FAm TG(Triglyceride) - TEWL
73	Berkers et al., 2019 [skin lipid 2]	Fourier-transform infrared spectroscopy, skin barrier repair, inflammatory	-	[Skin moisture] in vivo (Healthy subjects male 18~29 years), ex vivo / Human stratum corneum	- CER subclass - MCL (Mean chain length) - C34 CER, MuCER (Mono-unsaturated CERs) - CH2 symmetric stretching vibrations
74	Mack Correa et al., 2013 [skin lipid 3]	oleic acid, skin barrier, skin lipids, stratum corneum	Oleic acid, Glyceryl trioleate (GT)	[Skin moisture] ex vivo / Human stratum corneum (surgical abdominal)	- Skin depth - TEWL - SC region - Interactions of OA or GT with model SC lipids in monolayers - Δ Gex - CD2 stretching region demonstrating OA-d penetration into skin
75	Røpke et al., 2017 [skin lipid 4]	Skin lipids, Stratum corneum, Glucocorticoids, Skin atrophy, Skin barrier	clobetasol proprionate (CP), betamethasone dipropionate (BDP)	[Skin moisture] in vivo / Human stratum corneum	- Epidermal thickness by OCT - stratum corneum thickness by CSLM - Full skin thickness by ultrasound - TEWL - CER (ceramides), TAG (triacylglycerols), Cho (cholesterols), SFA (saturated fatty acids) UFA(unsaturated fatty acids) - TG level - Levels of saturated and unsaturated fatty acids - Levels of CER subclass

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76	ip et al., 2024 [skin lipid 5]	barrier repair, ex vivo skin, fatty acid-containing formulations, intercellular lipid lamellae, lamellar bodies, repair, skin barrier	-	[Skin moisture] ex vivo / Human stratum corneum	- Ki-67 potsitivel cells - Epidermal area and image - Number of Stratum Corneum layers - intercellular lipid lamellae length - Number of intact Lamellar Bodies (iLB) - Lamellar bodies (LB) extrusion process
77	Rissmann et al., 2009 [skin lipid 6]	Lipid organization , Skin barrier perturbation, Murine model	Acetone	[Skin moisture] in vivo / hairless mouse	- TEWL - Photomicrographs, number of SC layers - lipid composition and organization
78	Wang et al., 2023	Vanilla pompona, Orchidaceae, Vanilloideae, bioactivecompounds, cosmeceutical, senescence, skin fibroblasts	Vanilla pompona leaves	[Senescence model] NHDF-d(Normal Human Dermal Fibroblasts), / By replicative senescence (young, old) [photoaging model] NHDF-d(Normal Human Dermal Fibroblasts), HaCaT cell (Keratinocyte) / By UVB, UVA	- Inhibiton of Elastase - Protein production (Collagen, HA, Elastin) - lipid composition and organization - SA-β activity and image - Cell viability - mRNA expression of TGF-βR1-2, Smad2-3-7, Elastin, FBN1-2, LOX, LOXL, MMP-1, TIMP-1