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A systematic review of randomized controlled trials assessing phytochemicals and natural ingredients for skin and hair care

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ABSTRACT

Cosmetics are marketed and used worldwide for various purposes. Several natural products are used for the development of cosmetic preparations. This paper systematically reviews randomized controlled trials (RCTs) investigating plant extracts, herbal preparations, and isolated plant-derived compounds used particularly for skin and hair care. Two independent electronic searches were conducted through PubMed and EMBASE to identify eligible RCTs. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement was followed. Data extraction was performed independently by four authors based on standardized extraction forms. The risk of bias was assessed using the Cochrane Collaboration's tool for assessing the risk of bias in randomized trials. Sixty-three RCTs were identified; 53 were using natural products for skin care and 10 for hair care. The results were summarized in tables including the population, type of intervention, comparisons with placebo or other natural products, outcomes reported, follow-up period (P: Patient, Population; I: Intervention; C: Comparison (or Control); O: Outcome; T: Time), and country in which the study was conducted. Ten plants were identified to be present in different locations in Jordan by referring to the Royal Botanic Gardens' publication, titled "The Plants of Jordan: An Annotated Checklist." Some plants were found to have promising findings requiring further investigations in bigger RCTs with robust design and adequate reporting.

INTRODUCTION

In the highly visual consumer culture, the appearance of body shape and beauty is gaining more attention from people as it has become an important factor in the individual's sense of identity. The human body is the most visible expression of a person's self (Domzal and Kernan, 1993; Shilling, 2017), and as a result, people have a high desire to be physically attractive (Kim and Seock, 2009). One way to do that is by using cosmetic products.

Cosmetics are globally used to enhance the appearance or body odor (Ashawat *et al*., 2009; Shivanand *et al*., 2010). Cosmetic products are developed in various dosage forms using natural and synthetic ingredients (Ashawat *et al*., 2009). The use of plants and herbs in cosmetics has gained more popularity in recent years (Ashawat *et al*., 2009; Gediya *et al*., 2011; Shivanand *et al*., 2010). The number of products containing natural ingredients is increasing (Antignac *et al*., 2011). These products are commonly used with the misconception that they are always more effective and safer than completely synthetic products (Antignac *et al*., 2011; Ashawat *et al*., 2009).

Several plants and herbs have the potential for the development of cosmetic preparations due to their chemical composition containing compounds like vitamins, minerals, flavonoids, tannins, and amino acids, which have the potential to influence the human body (Fonseca-Santos *et al*., 2015; Yoo *et al*., 2018).

The use of plants and herbs to enhance beauty is well known in the Middle East since around 3000 BC where it was commonly used by ancient Egyptians and Babylonians in Iraq (Sawicka and Noaema, 2015). In the Middle Eastern region, particularly in Jordan, a wide range of plants with medicinal activity are available (Aburjai *et al*., 2007; Afifi and Abu-Irmaileh,

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2000; Alzweiri *et al*., 2011). The use of natural ingredients in cosmetics is gaining more popularity, not only for their health benefits but also due to the higher demand by consumers for ecologically friendly products (Laroche *et al*., 2001; Ribeiro *et al*., 2015).

This study systematically reviewed randomized controlled trials (RCTs) investigating plant extracts, herbal preparations, and isolated plant-derived compounds used for cosmetic purposes focusing on skin and hair care. In addition, it provides a list of the plants/herbs available in Jordan that have been studied in the literature for cosmetic purposes by referring to the Royal Botanic Gardens publication titled "The Plants of Jordan: An Annotated Checklist" (Taifour *et al*., 2017).

MATERIALS AND METHODS

This systematic review (SR) was based on a registered (PROSPERO CRD42020198926) protocol and reported in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher *et al*., 2009).

Data sources and searches

RCTs reporting cosmetic clinical outcomes in adults (≥18 years old) in the English language were included. Exclusion criteria included studies involving trials with interventions requiring medical attention and postprocedural treatment, not listing a clear description of botanical/phytochemical intervention.

Eligible trials were identified by electronic searches in PubMed and EMBASE from the beginning of time on the database until 26/7/2020. A combination of the following medical subject heading (MeSH terms) and free-text terms was used: phytotherapy, herbal medicine, plant extract, volatile oil, cosmetics, and skin care.

Study selection

Two authors independently reviewed the trial inclusion and exclusion criteria. Excluded trials were listed with the reason for exclusion (Supplementary Material). Disagreements were resolved by consulting a third researcher and achieving consensus.

Data extraction and quality assessment

Data extraction was performed independently by four authors based on standardized extraction forms. Each article was independently extracted by two authors. Disagreements were resolved through discussions and the corresponding authors were contacted if any of the pieces of required information were not described in the published manuscripts.

The risk of bias was assessed by separate domains: randomization, allocation concealment, selective reporting, blinding of participants and authors, attrition, and other biases using the Cochrane Collaboration's tool for assessing the risk of bias in randomized trials (Higgins *et al*., 2011). The results of these domains were graded as a "low," "high," or "unclear" risk of bias.

RESULTS

Skin care

The initial search yielded 1,987 abstracts. Removal of duplicates and applying the exclusion criteria identified 63 studies, 53 of which employed natural products for skin care and 10 for hair care. The process of selecting the studies included in this literature review was based on the inclusion and exclusion criteria as illustrated in Figure 1.

The 63 included studies are summarized in Tables 1 and 2 to demonstrate plants, herbs, or isolated compounds tested in the selected RCTs for skin care and hair care, respectively.

The main skin conditions addressed in selected RCTs were acne, hyperpigmentation, wrinkles, hirsutism, inflammation, stretch marks, and scars as well as testing plants and herbs for their moisturizing and skin protection properties. For hair care, the main hair issues addressed in the RCTs were hair thinning and dandruff.

The highest number of RCTs concerning selected skin conditions tested natural products for their skin protection properties (n = 12) and was published between 1997 and 2018. The investigated plants/products included *Polypodium leucotomos* (Gonzalez *et al*., 1997), *Camellia sinensis* (Camouse *et al*., 2009), *Hibiscus abelmoschus* (Rival *et al*., 2009), *Calendula officinalis* (Akhtar *et al*., 2011), *Avena sativa* (Michelle, 2016), *Ribes nigrum* (Ray *et al*., 2016), phenolic veratric acid (Lee *et al*., 2016), and *Cucumis melo* (Egoumenides *et al*., 2018), as a single ingredient within the formulation. Four other RCTs investigated the combination of extracts, including soy and jasmine (Bazin *et al*., 2010), dead sea water and Himalayan extracts (Wineman *et al*., 2012), *Olea europaea* and *Helianthus annuus* (Danby *et al*., 2013), and *Portulaca oleracea* and *Prinsepia utilis* (Wang *et al*., 2018).

The second highest number of selected RCTs addressed antiaging effects (n = 10) and was published between 2000 and 2020. The plants/herbs investigated included *Centella asiatica* (Gonzalez *et al*., 1997), date palm kernel (Bauza *et al*., 2002), *Sanguisorba officinalis* (Kim *et al*., 2008), *Platycarya strobilacea* (Kim *et al*., 2010), *Oryza sativa* (Kanlayavattanakul *et al*., 2016), *Geranium thunbergii* (Yoshida *et al*., 2019), *Psoralea corylifolia* (Goldberg *et al*., 2019), and *Zanthoxylum bungeanum* (Zeng *et al*., 2019) and two used a combination of extracts including *Glycyrrhiza glabra*, *Angelica gigas*, *Prunus persica*, *Ophiopogon japonicus*, *Paeonia suffruticosa*, *Atractylodes japonica*, *Poria cocos*, *Rehmannia chinensis*, *Cimicifuga simplex*, *Asparagus cochinchinensis*, *Scutellaria baicalensis*, *Astragalus membranaceus*, *Carthamus tinctorius* (Roh *et al*., 2019), and *Coptis teeta* with *Trichosanthes rosthornii* (Im *et al*., 2020).

Nine studies published between 2012 and 2020 tested natural products for the treatment of hyperpigmentation. These studies investigated the constituents *Silybum marianum* (Altaei, 2012), *Sophora flavescens* (Shin *et al*., 2013), *Polypodium leucotomos* (White *et al*., 2013), *Rumex occidentalis* (Mendoza *et al*., 2014), *Serratula quinquefolia* (Morag *et al*., 2015), *P. cocos Wolf* (Lee and Cha, 2018), *Vitis vinifera* (Tsuchiya *et al*., 2020), and *O. europaea* (de Toledo Bagatin *et al*., 2020); one study used a combination of *China camellia*, *Sanchi*, *P. utilis*, and *P. oleracea* (Zhang *et al*., 2019).

Next were RCTs investigating natural products, examining their ability to reduce body hair growth (n = 5); these studies were published between 2003 and 2019 and included *Foeniculum vulgare* (Javidnia *et al*., 2003), *Stryphnodendron*

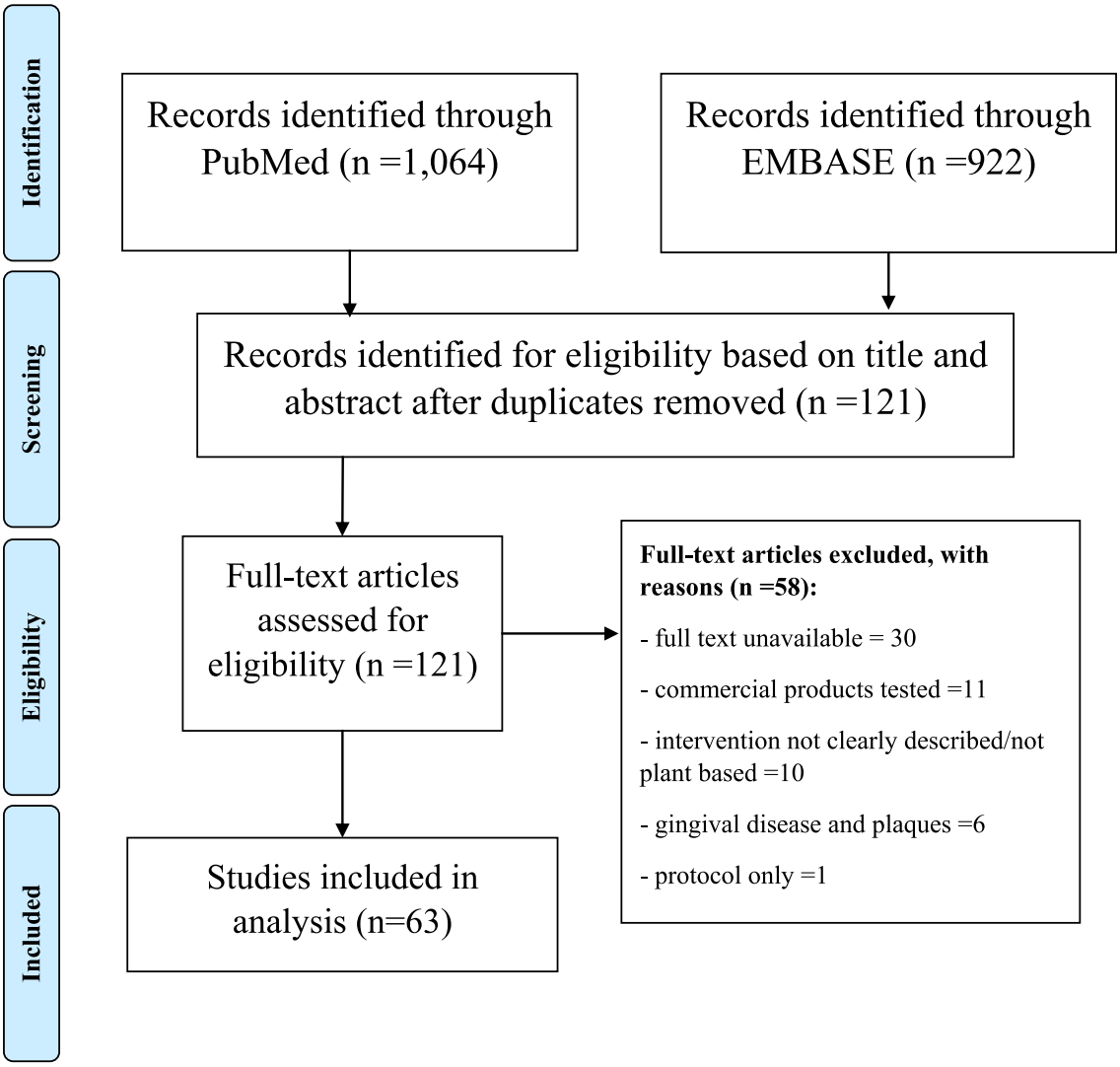

Figure 1. PRISMA flow diagram showing the number of RCTs identified and included in this SR.

adstringens (Vicente *et al*., 2009), *Medicago sativa* (Aali *et al*., 2016), and *Curcuma aeruginosa* (Srivilai *et al*., 2017, 2018).

Studies concerning the moisturizing properties of natural products (n = 4) were published between 2016 and 2019 and included *Rhododendron ferrugineum* (Filipovic *et al*., 2016), *C. asiatica* (Milani and Sparavigna, 2017), *Scaphium scaphigerum* (Kanlayavattanakul *et al*., 2017), and *Curcuma longa* (Asada *et al*., 2019).

The RCTs investigating natural products for their anti-inflammatory properties (n = 3) were published between 2014 and 2019, investigating the constituents *Prunus yedoensis* (Zhang *et al*., 2014) and *Glycyrrhiza inflata* (Boonchai *et al*., 2018) as a single ingredient preparation within the formulation; one related RCT investigated a combination of extracts of *Gentiana lutea*, *G. glabra*, and *Salix daphnoides* (Seiwerth *et al*., 2019).

The RCTs investigating natural products for acne treatment (n = 2) were published between 2011 and 2018 and explored combinations of extracts; the first group of studies explored retinol, rose, and hexamidine diisethionate (Lee *et al*., 2011), while the second group explored coco-glucoside, *Simmondsia chinensis*, *G. lutea*, *Mentha arvensis*, *Humulus lupulus*, *Leptospermum scoparium*, *S. daphnoides*, *H. annuus*, pectin, and xanthan gum (Weber *et al*., 2019).

Two studies, published between 2008 and 2016, tested natural products for foot care. In the former, they used a combination of mango butter and olein fraction fortified with vitamin E (Mandawgade and Patravale, 2008), whereas in the latter study, *Ziziphus mauritiana* (Akhtar *et al*., 2016) was used.

Rosacea was investigated in one study published in 2015 and used a cream containing medical-grade kanuka honey (Braithwaite *et al*., 2015). Stretch marks and scars reduction were investigated in two separate studies published in 2014 and 2010, using *O. europaea* (Soltanipour *et al*., 2014) and *Allium cepa* (Hosnuter *et al*., 2007), respectively.

Finally, three studies published in 2015, 2018, and 2019 tested plants for multiple effects; the first study investigated *Tamarindus indica* for its antisebum and antihyperpigmentation properties (Muhammad *et al*., 2015); the second tested *Prunus serrulata* for its moisturizing, antihyperpigmentation, antiaging, and overall improvement of skin condition and elasticity

Table 1. Summary of RCTs conducted between 1997 and 2020 of plants, herbs, or isolated compounds used for skin care.

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Skin protection										
Gonzalez *et al.*, 1997	Spain	18–46-year-old males and females untreated or treated with oral psoralens (21)	Topical or oral *P. leucotomos* (oral dose = 1,080 mg)	Untreated control	1. Immediate pigment darkening (IPD): ultraviolet (UV) dose significantly increased ($p < 0.01$) 2. Minimal erythema dose (MED): UV dose significantly increased ($p < 0.01$) 3. Minimal melanogenic dose (MMD): no significant difference 4. Minimal phototoxic dose (MPD): UV dose significantly increased ($p < 0.01$) 5. Langerhans cells examination: partial prevention of acute phototoxicity compared with untreated skin	1. IPD 2. MED 3. MMD 4. MPD 5. Langerhans cells examination of psoralen-sensitized volunteers	3 days	*P. eucotornos*	–	Capsules containing 120 mg *P. eucotornos* or lotion containing 10, 25, and 50% *P. eucotornos* extract (*v*/*v*)
Camouse *et al.*, 2009	USA	19–58-year-old males and females (90)	Topical green tea or topical white tea applied minute prior to solar-simulated UV radiation irradiation, as well as immediately after it	Placebo	Contact hypersensitivity (CHS): no significant effect ($p > 0.05$)	CHS evaluated by the total millimetre increase in skin fold thickness	2 days	*C. sinensis*	–	–
Rival *et al.*, 2009	France	Group A: 40–50-year-old females (20) Group B: 50–60-year-old females (40)	Group A: topical product containing 3% *H. abelmoschus* Group B: topical product containing 3% *H. abelmoschus* and topical product containing 3% vitamin C	Placebo	1. Skin elasticity: improved for both groups and both products 2. Skin firmness, texture, and density: improved for both groups and both products Fringe projection: significantly reduced compared to the placebo in group B for both products ($p < 0.05$)	1. Skin elasticity measured on the cheek using a ballistometer 2. A visual and tactile evaluation of skin firmness, texture, and density performed by an expert clinician 3. Depth of the main wrinkle analyzed by fringe projection	6 weeks	*H. abelmoschus*	Seed	–
Bazin *et al.*, 2010	Germany	45–65-year-old Caucasian females (24)	Emulsion containing soy and jasmine applied twice daily	Placebo	Global signals detected in the dermis significantly higher ($p < 0.05$)	Multilayers acquisitions using a multiphoton tomograph with subcellular resolution	12 weeks	–	–	Emulsion
Akhtar *et al.*, 2011	Pakistan	24–35-year-old healthy males and females (21)	W/O emulsions containing 3% *C. officinalis*	Placebo	Hydration and firmness of skin were significantly improved ($p < 0.05$)	Mechanical parameters of the skin using noninvasive suction skin elasticity meter Cutometer 580 MPA	8 weeks	*C. officinalis*	–	Cream

(Continued)

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Wineman *et al.*, 2012	Israel	Antiwrinkles effect: ≥45-year-old females (20) Skin hydration: 19–60-year-old females (10)	A cream containing complex of Dead Sea water and three Himalayan (Tibetan goji berries, moss lichen, and Himalayan raspberry) extracts applied once daily	Untreated control	Antiwrinkles effect: wrinkles depth significantly reduced ($p < 0.05$) Skin hydration: significantly increased ($p < 0.05$)	Antiwrinkles effect: the depth of one single wrinkle in the eye examined before and after application by PRIMOS optical 3D measuring device Skin hydration: electrical capacitance (EC) measured using capacitance meter (Corneometer CM 825)	Antiwrinkles effect: 4 weeks Skin hydration: 12 hours	–	Tibetan goji: berries Himalayan raspberry: root	Cream
Danby *et al.*, 2013	UK	Cohort 1: males and females with an average age of 46 ± 5.7 years with previous atopic dermatitis (AD), no symptoms for 6 months (7) Cohort 2: males and females with an average age of 46 ± 5.7 years with/without previous AD, no symptoms for 6 months (12)	Cohort 1: Six drops of olive oil applied to the forearm twice daily Cohort 2: six drops of olive oil or sunflower oil applied to the forearm twice daily	Untreated control	Cohort 1: 1. Transepidermal water loss (TEWL): significantly increased with tape stripping ($p < 0.001$) 2. Cohesiveness of stratum corneum (SC): significantly decreased in volunteers with a history of AD ($p < 0.05$) 3. SC hydration: no significant effect ($p > 0.05$) 4. Erythema: higher Cohort 2: 1. TEWL: no significant effect 2. Cohesiveness of SC: no significant effect ($p > 0.05$) 3. SC hydration: significantly higher ($p < 0.05$) 4. Erythema: no significant effect ($p > 0.05$)	1. Skin-surface pH measured using pH meter (PH905) 2. SC hydration measured using Corneometer (CM825) 3. Erythema measured using Mexameter (MX 18) 4. TEWL measured using an AquaFlux AF200 5. Protein removed using tape stripping performed in conjunction with TEWL, then the amount of protein that each disc immediately determined using infrared densitometry	Cohort 1:5 weeks Cohort 2:4 weeks	*O. europaea* *H. annuus*	*O. europaea*: fruit *H. annuus*: seed	Oil
Ilnytska *et al.*, 2016	USA	18–65-year-old healthy females with bilateral moderate to severe dry skin on their lower legs (50)	Colloidal lotion containing oatmeal extract applied twice daily	Untreated control	1. Dry skin: significantly improved ($p < 0.05$) 2. Skin barrier integrity and hydration: significantly improved ($p < 0.05$)	1. Dry skin: visual evaluation and using Dermalab 2. Skin barrier integrity and hydration assessed by TEWL measurements and using Skicon 200 EX	5 weeks	*A. sativa*	–	Lotion
Ray *et al.*, 2016	UK	40–68-year-old males (32)	Low-concentration or high concentration blackcurrant juice drink	Placebo	No significant difference ($p > 0.05$)	1. Phototesting using a calibrated irradiation monochromator 2. MED	6 weeks	–	–	Juice
Lee *et al.*, 2016	South Korea	Females with an average age of 47.7 ± 4.8 years (20)	0.5% phenolic veratric acid cream	Placebo	1. Visual evaluation: showed improvement 2. Photometric evaluation: significantly improved ($p < 0.01$) 3. Self-assessment: positive feedback	1. Visual evaluation 2. Photometric evaluation using Skin-Visiometer SV 600 3. Self-assessment	12-weeks	–	–	Cream

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Wang *et al.*, 2018	France	Females with an average age of 37.1 ± 10.6 years with dry and sensitive skin (20)	A cream containing Yunnan *P. oleracea* extract, *P. utilis* oil, beta-glucan, and sodium hyaluronate extracted from mushroom applied to 1 side of the face twice daily	A control cream containing *C. tinctorius* extract and oil	1. Visual evaluation: a significant improvement 2. Self-assessment questionnaire: test cream was significantly favoured ($p < 0.05$) of dryness, erythema, and roughness was observed compared to baseline ($p < 0.05$). For skin desquamation, no significant difference was observed 3. Hydration index: significantly increased ($p < 0.05$) 4. Skin texture parameter: roughness significantly declined, and smoothness significantly increased ($p < 0.05$) 5. Skin barrier function (TEWL), sebum recovery (lipid index), wettability, color, and stinging test: no significant effect ($p > 0.05$)	1. Visual evaluation including dryness, roughness, desquamation, and erythema 2. Self-assessment questionnaire 3. TEWL assessment using Vapometer 4. Skin hydration assessment using Corneometer CM825 5. Lipid index assessment using Sebumeter SM 815 6. Skin texture assessment using Visioscan VC98 7. Skin-surface wettability 8. Skin color using Minolta 400 Chroma Meter 9. Skin sensitivity using a stinging test with 10% lactic acid	4 weeks	*P. oleracea* *P. utilis*	–	Cream
Egoumenides *et al.*, 2018	France	19–50-year-old healthy Caucasian (93)	1. A melon concentrate capsule containing 20 mg superoxide dismutase 2. Cream containing 12 U superoxide dismutase per cm^2 of skin	Placebo	MED: significantly higher for both cream and capsule ($p < 0.05$)	MED using ORIEL solar simulator as a source of radiations	4 weeks	*C. melo* L.	Skin and seeds	1. Hard capsule 2. Cream
Antiaging										
Martelli *et al.*, 2000	Italy	20–25-year-old healthy female (20)	A cream containing boswellic acids, silybin, and *C. asiatica* extracts	Placebo	1.Skin hydration: no significant difference 2. Biomechanical properties: significantly increased ($p < 0.02$) No adverse effects were reported	1. Skin hydration measured by EC by Coneometer 2. Biomechanical properties (extensibility and firmness) of the skin measured using suction device (Dermaflex)	4 weeks	*C. asiatica*		Cream
Bauza *et al.*, 2002	France	46–58-year-old females (10)	Cream with 5% date palm kernel extract on the eye area twice daily	Placebo	1. Skin microrelief evaluation: total surface of wrinkles was significantly reduced ($p < 0.05$) 2. Clinical evaluation: 60% of participants showed improvement 3. Questionnaire: 50% of participants reported improvement	1. Skin microrelief evaluation: silicon replica analysis using a software 2. Clinical evaluation under a magnifying glass 3. Questionnaire	5 weeks	–	Kernel	Cream

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Kim *et al.*, 2008	Korea	35–53-year-old healthy females (20)	0.03% ziyuglycoside I cream	Placebo	1. Visual evaluation: intervention showed a nonsignificant difference between 4 and 8 weeks, significant results were observed after 12 weeks of treatment ($p < 0.05$) 2. Photometric evaluation: mean depth of roughness showed a significant difference in 12 weeks ($p < 0.05$)	1. Visual evaluation using photodamage score 2. Photometric evaluation using Skin-Visiometer SV 600	12-weeks	*S. officinalis*	Root	Cream
Kim *et al.*, 2010	Spain	34-49-year-old healthy females (25)	0.2% *P. strobilacea* extract	Placebo	1. Visual evaluation: intervention showed a nonsignificant difference between 4 and 8 weeks, significant results were observed after 12 weeks of treatment ($p < 0.05$) 2. Photometric evaluation: average difference in roughness showed a significant difference in 12 weeks ($p < 0.05$)	1. Visual evaluation 2. Photometric evaluation 3. Image analysis using Skin-Visiometer SV 600	12-weeks	*P. strobilacea*	Fruit	Cream
Kanlayavattanakul *et al.*, 2016	Thailand	25–50-year-old healthy males and females (24)	Cream containing 0.1% or 0.2% rice panicle extract applied twice daily	Placebo	Skin hydration: significantly improved ($p < 0.05$) Skin lightening: significantly improved ($p < 0.001$) Skin firming: significantly increased ($p < 0.05$) Skin wrinkle: significantly reduced ($p < 0.05$)	Clinical evaluation using Corneometer® CM 825, Cutometer® MPA 580, Mexameter® MX 18 and Visioscan® VC 98	12 weeks	*O. sativa cv. Indica*	Rice panicle	Cream
Yoshida *et al.*, 2019	Japan	34–56-year-old healthy females (21)	A gel containing 20 mg/ml of *G. thunbergii* extract	Placebo	Skin wrinkle scores: significantly reduced ($p < 0.05$) Skin hydration: significantly improved ($p < 0.05$) No side effects reported	1. The antiwrinkle efficacy evaluated by visual scoring by a dermatologist, 3D skin replica images obtained from the eye corner using Silflo® and the 3D image analyzer PRIMOS system. 2. Skin elasticity measured using the Cutometer DUAL MPA580 w	8 weeks	*G. thunbergii*	Leaves	Gel
Roh *et al.*, 2019	Korea	40–50-year-old healthy females (46)	SHYBE extract included: 0.0385% liquorice extract, 0.0765% *A. gigas* extract, 0.0765% peach extract, 0.0765% *O. japonicus* extract, 0.0765% *P. suffruticosa* extract, 0.0765% *A. japonica*	Placebo	1. Skin hydration: significantly increased at week 4 ($p < 0.05$) 2. Skin elasticity: significantly increased at week 4 ($p < 0.05$) 3. Dermal thickness and density: significantly increased at week 4 ($p < 0.05$) 4. Self-assessment: no significant differences	1. Skin hydration evaluation using Corneometer® CM 825 2. Skin elasticity evaluated using Cutometer® MPA580 3. Dermal thickness and density evaluation Dermascan® C	8 weeks	Licorice: *G. glabra*, *A. gigas*, *Peach: P. persica*, *O. japonicus*, *P. suffruticosa*, *A. japonica*, *P. cocos*, *R. chinensis*,	*G. glabra*: root, *A. gigas:* root, *P. persica:* kernel, *O. japonicus:* root, *P. suffruticosa:* root, *A. japonica:* rhizome,	Cream

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
			extract, 0.1290% *P. cocos*, 0.1290%*R. chinensis* extract, 0.0385% *C. simplex* extract, 0.0765% *A. cochinchinensis* extract (0.0765%), 0.0385% safflower extract, 0.0385% *S. baicalensis* extract (0.0385%), and 0.1290% *A. membranaceus* extract		5. Safety assessment: No AEs were reported	4. Self-assessment using a questionnaire 5. Safety assessment by a dermatology specialist		*C. simplex, A. cochinchinensis, S. baicalensis, A. membranaceus, Safflower: C. tinctorius*	*P. cocos:* sclerotium, *R. chinensis:* root, *C. simplex:* root, *A. cochinchinensis:* root, *C. tinctorius:* flower, *S. baicalensis:* root, and *A. membranaceus* root	
Goldberg *et al.*, 2019	USA	Efficacy and tolerability study: 40–65-year-old healthy females (39) Hydration study and transepidermal water loss study: 18–65-year-old males and females (24) Test in oily skin: 30–65-year-old healthy females (31) Noncomedogenic study: 18–55-year-old females with combination or oily facial skin with comeDones (33)	Night facial serum containing melatonin, bakuchiol, and ascorbyl tetraisopalmitate applied daily	Untreated control	Efficacy and tolerability study: 1. Wrinkle roughness: significantly decreases ($p < 0.05$) 2. Skin firmness: skin deformation volume and depth decreased significantly ($p < 0.05$) 3. Pigmintation: Significant decrease in pigmentation in comparison with baseline ($p < 0.05$) Hydration study and TEWL study: 1. Hydration kinetics: significantly improved ($p < 0.05$) 2. TEWL: significantly improved until after 6 hours of application only ($p < 0.01$) Test in oily skin 1. Sebum secretion: significantly decreased ($p < 0.01$) Noncomedogenesis study: 1. 85% of subjects had fewer comeDones after 28 days of treatment	Efficacy and tolerability study: 1. Wrinkles assessment using Dermatop 2. Firmness assessment using Dynaskin 3. Pigmentation assessment using A CM-700d Spectrocolorimeter 4. Subject questionnaire Hydration study and TEWL study: 1. Hydration kinetics using a Corneometer CM825 probe connected to a Cutometer dual MPA 580 2. TEWL using a Tewameter® TM 300 Test in oily skin: 1. Forehead sebaceous secretion measured using the Sebumeter SM 815 2. Subject questionnaire Noncomedogenesis study: 1. Clinical examination 2. Self-assessment	Efficacy and tolerability study: 13 weeks Hydration study and transepidermal water loss study: 12 hours Test in oily skin: 28 days Noncomedogenesis study: 28 days	*P. corylifolia* to obtain bakuchiol	Seeds	Serum
Zeng *et al.*, 2019	China	35–60-year-old females with bilateral visible static crow's feet (20)	Formulation containing 2% *Z. bungeanum* maxim extract	Placebo	1. Skin roughness: no significant difference ($p > 0.05$) 2. Skin hydration: no significant difference ($p > 0.05$)	1. Objective assessments of pictures taken using VISIA®. Crow's feet were measured	4 weeks	*Zanthoxylum bungeanum* maxim	Fruit	–

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
					3. Skin elasticity: no significant difference ($p > 0.05$) 4. Subjective assessments: Investigator's global assessment (IGA) score significantly decreased 5. Participants' self-assessment: 90% reported some improvement	by Primospico, a three-dimensional system for measuring skin roughness quantitatively 2. Skin hydration measured using Corneometer® CM825 3. Skin elasticity measured using Cutometer® MPA580 4. Subjective assessments: IGA of the severity of the crow's feet recorded using a scale from 0 to 6 5. Participants' self-assessment of efficacy graded as worse, no improvement, some improvement, moderate improvement, and excellent improvement				
Im *et al.*, 2020	Korea	40–59-year old Soyang- (SY-) type females (21)	Cream including 0.3 % *C. teeta* and *T. rosthornii* extract applied to the area around the eyes twice daily	Placebo	1. Visual assessment of skin wrinkles: skin damage was significantly restored ($p < 0.05$) 2. Evaluation of skin wrinkle parameters using replica images: significantly decreased ($p < 0.05$) 3. Questionnaire evaluation by participants: no significant difference ($p > 0.05$) 4. Skin safety evaluation: no adverse dermatological events were observed	1. Visual assessment of skin wrinkles under specific lighting conditions 2. Evaluation of skin wrinkle parameters using replica images analyzed using Visioline VL650 3. Questionnaire evaluation by participants 4. Skin safety evaluation performed by assessing skin irritation through an interview and by medical examination	12 weeks	*C. teeta* *T. rosthorn*ii	*C. teeta*: rhizome *T. rosthornii*: seed	Cream
Melasma/hyperpigmentation treatment and skin whitening										
Altaei, 2012	Iraq	28–55-year-old males and females with melasma (96)	A cream containing 0.1% or 0.2% silymarin applied twice daily	No treatment and Placebo	1. Skin pigment evaluation melasma area and severity index (MASI): significantly improved ($p < 0.05$) 2. Physician global assessment (PGA): significantly improved ($p < 0.05$) 3. Assessment of overall treatment: significantly satisfied ($p < 0.05$)	1. Skin pigment evaluation by MASI 2. PGA 3. Assessment of overall treatment using a scale from 0 to 10	4 weeks	*S. marianum*	–	Cream

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Shin *et al.*, 2013	Korea	21–53-year-old participants (25)	Lotion with 0.05% *S. flavescens* extract applied twice daily	Placebo	Significantly whitening by device and visual assessment ($p < 0.05$)	1. Visual assessment by dermatologists 2. Whitening effects measured using a chromameter CR-400	8 weeks	*S. flavescens*	root	Lotion
White *et al.*, 2013	USA	Hispanic females with moderate-to-severe facial melasma (40)	Oral *P. leucotomos* extract three times daily	Placebo	1. MASI: No significant difference ($p = 0.14$) 2. Assessment of melasma-related quality of life (MelasQOL): No significant difference ($p = 0.62$)	1. MASI 2. Assessment of MelasQOL	12 weeks	*P. leucotomos*	–`	–
Mendoza *et al.*, 2014	Philip-pines	18–60-year-old males and females with epidermal and mixed melasma (45)	3% *R. occidentalis* cream applied twice daily	4% hydroquinone cream and placebo	1. MASI: significantly improved compared with baseline ($p < 0.05$) 2. Skin pigmentation and Mexameter MX18 readings: significantly improved compared with baseline ($p < 0.05$)	1. MASI 2. Skin pigmentation: using Mexameter MX18	8 weeks	*R. occidentalis*	–	Cream
Morag *et al.*, 2015	Poland	26–55-year-old females with melasma and lentigo solaris (102)	A cream with the aqueous extract from leaf of five-leaf serratula containing 2.51% of arbutin applied twice daily	Placebo	Average level of melanin: significantly improved for patients with melasma ($p < 0.05$)	1. Skin discoloration and measuring the average level of melanin: video dermatoscope DermoGenius (LINOS) and a probe Mexameter MX18 2. Dermatoscopic examination: probe Mexameter MX18	8 weeks	*S. quinquefolia*	Leaves	Cream with aqueous extract
Lee and Cha, 2018	Korea	20–30-year-old females (40)	A cream with 2% (wt %) *P. cocos* Wolf extracts applied once daily in the morning	Placebo	Skin brightness increased significantly ($p < 0.05$)	Visual evaluation 2. Skin tone improvement measured using a Spectrophotometer CR 2600D	4 weeks	*P. cocos* Wolf	–	Cream
Zhang *et al.*, 2019	China	25–50-year-old males and females with melasma (90)	A cream containing herbal mixture [*C. camellia* (1%), *Sanchi* (0.5%), *P. utilis* oil (0.5%), and *P. oleracea* (1%)]	Arbutin cream and placebo	1. MASI score: significantly improved after 12 weeks ($p < 0.05$) 2. Melanin index (MI): significantly decreased after 12 weeks ($p < 0.05$) 3. Erythema index (EI): significantly decreased after 12 weeks ($p < 0.05$) 4. The density of inflammatory cells: significantly decreased after 12 weeks ($p < 0.05$) 5. The subjective satisfaction scores: "very satisfied" increased from 13.3% at week 4%–33.3% at week 12	1. MASI score, MI, EI, using Mexameter and photographed using VISIA 2. Assessment of density of inflammatory cells using a reflectance confocal microscopy 3. The subjective satisfaction scores: The volunteers evaluated their satisfaction with the following criteria: 0 = not satisfied, 1 = partially satisfied, 2 = satisfied, or 3 = very satisfied	12 weeks	*C. camellia, Sanchi, P. utilis*, and *P. oleracea*	–	Cream

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Tsuchiya *et al.*, 2020	Japan	30–59-years-old females (100)	200 ml beverage containing 200 mg of red wine oligomeric procyanidins once daily	Placebo	1. Sunspot scores: significantly reduced ($p < 0.05$) 2. MI value: significantly reduced ($p < 0.05$) 3. Water content of the SC: significantly increased ($p < 0.05$) 4. Skin viscoelasticity: no significant difference ($p > 0.05$) 5. Wrinkle depth, and visual analog scale (VAS) questionnaire: no significant difference ($p > 0.05$)	1. Sunspot score diagnosed by a dermatologist 2. MI value in sunspots, and skin color using a CIE 1976 lightness 3.Water content of the SC 4. Skin viscoelasticity 5. Wrinkle depth, and VAS questionnaire	12 weeks	*V. vinifera*	Fruit	Beverage
de Toledo Bagatin *et al.*, 2020	Brazil	32–49-year-old females with center-facial melasma (42)	Topical formulation containing the olive extract and oral placebo or Topical vehicle formulation and oral capsule containing the olive extract	Placebo	1. Modified melasma area and severity index (mMASI): no significant difference ($p > 0.05$) 2. MI: no significant difference ($p > 0.05$)	1. mMASI score (20) evaluated based on high resolution images and luminosity using VisioFace 1000D equipment 2. MI evaluated using a spectrophotometer Mexameter	12 weeks	*O. europaea*	Fruit	Topical: - Oral: capsule
Antihirsutism										
Javidnia *et al.*, 2003	Iran	16–53-year-old females with mild-to-moderate forms of idiopathic hirsutism localized to the face (45)	Creams containing 1% or 2% of Fennel extract applied twice daily	Placebo	Hair diameter from the facial area: significantly reduced using fennel extract ($p < 0.05$)	Hair diameter measurement from the facial area	12 weeks	*F. vulgare*	Seeds	Cream
Vicente *et al.*, 2009	Brazil	>18-year-old females with excess terminal hair (54)	A cream containing 6.0% of *S. adstringens* extract	Placebo	Significant improvement ($p < 0.05$)	Clinical examination	26 weeks	*S. adstringens*	Bark	Cream
Sargazi *et al.* 2016	Iran	18–24-year-old females (60)	Eucerin as a basal cream mixed with 1%, 2%, and 5% of alfalfa extract applied twice daily	Placebo	Hair growth length and hair diameters; significantly reduced ($p < 0.05$)	Hair growth length and hair diameters measured using a caliper with 0.02-micrometer sensitivity	12 weeks	*M. sativa* L.	Leaves	Cream
Srivilai *et al.*, 2017	Thailand	18–23-year-old females (60)	A lotion containing 1 or 5% w/w essential oil of *C. aeruginosa*	Placebo	1. Safety pretesting (hydration, irritation, etc.): There was very little erythema and no edema 2. Hair growth: significantly diminished ($p < 0.05$) 3. Hair density: insignificant effect ($p > 0.05$)	1. TEWL assessment using a Tewameter®TM300 2. Skin hydration assessment using a Corneometer®CM825	12 weeks	*C. aeruginosa*	Rhizomes	Lotion

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
					4. Skin brightening: insignificant effect ($p > 0.05$) 5. Participant questionnaire: generally positive	3. Hair growth and hair density: images recorded by a video imager, hair lengths, and numbers were measured using a computer software 4. Melanin measurement using a Mexameter®MX18 5. Skin irritation and skin flaking, or scaling assessed by a practicing dermatologist 6. Participant questionnaire				
Srivilai *et al.*, 2018	Thailand	20–52-year-old females (30)	A lotion containing 5% sesquiterpene-Enriched Extract of *C. aeruginosa* applied twice daily	Placebo	1. Hair growth: delayed response, retarded hair growth was observed after week 7 2. 2. Participant questionnaire: overall satisfaction ($p < 0.05$)	1. Hair growth and length: images recorded by a video imager, hair lengths, and numbers were measured using a computer software 2. Participant questionnaire	13 weeks	*C. aeruginosa*	Rhizomes	–
Moisturizer										
Filipovic *et al.*, 2016	Serbia	Healthy females (76) 1. Phase I: average age = 21.15 ± 2.05 (52) 2. Phase II: on sodium lauryl sulfate- (SLS-) irritated skin, average age = 29.9 ± 8.9 (24)	Alpine Rose stem cells (ARSC), olive oil squalene, and a natural alkyl polyglucoside cream: Formula 1: 0.4% of ARSC Formula 2: 1% of squalene Formula 3: Commercially available with 0.4% of ARSC Formula 4: 1% of squalene + 0.4% of ARSC Formula 5: 6% of squalene + 0.4% of ARSC Formula 6: Placebo	Untreated control on the forearm	Phase I: 1. EC: significant change with formula 2 and 3 ($p < 0.05$) 2. TEWL: significantly decreased with formula 2 ($p < 0.05$) Phase II: 1. EC: significantly increased with formula 1, 2, and 5 ($p < 0.05$) 2. TEWL: significantly decreased with all tested creams ($p < 0.05$) 3. EI: significantly increased with formula 1, 4, and 5 ($p < 0.05$)	1. EC using Corneometer® CM825 2. TEWL using Tewameter® TM210 3. EI using Mexameter® MX18 4. Skin elasticity using Cutometer® MPA580	Phase I: 21 days Phase II: 6 days	*R. ferrugineum*	Stem cells	Cream
Milani and Sparavigna, 2017	Italy	Healthy females with an average age of 40 years (20)	A fluid containing *C. asiatica* meristem cell culture	Untreated control	1. Skin hydration: significantly increased ($p < 0.05$) 2. TEWL assessed: significantly decreased ($p < 0.05$)	1. Skin hydration evaluated using a Corneometer 2. TEWL evaluated using a Vapometer device	1 day	*C. asiatica*	Leaves	Fluid

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Kanlayavattanakul *et al.*, 2017	Thailand	23–39-year-old healthy males and females (24)	A gel containing 0.5% Malva nut polysaccharide (0.5%) or a formulation containing 0.2% polysaccharides, tamarind, and algae	Placebo	1. Safety assessment: no irritation observed 2. Skin hydration: Malva nut gel was shown to hydrate the skin more effectively than tamarind and base gels ($p < 0.05$)	1. Safety assessment by a single application closed patch test 2. Skin hydration monitored by using Corneometer®CM 825	75–180 minutes	*S. scaphigerum*	Seeds	Gel
Asada *et al.*, 2019	Japan	21–54-year-old males and females (47)	A hot water extract of *C. longa* taken daily or a hot water extract + curcumin	Placebo tablets contained safflower color and kaoliang color to match the color of the other tablets	1. Water content of the skin surface: significantly increased ($p > 0.05$) 2. TEWL: no significant difference ($p > 0.05$) 3. MED: no significant difference ($p > 0.05$)	1. Water content of the skin surface measured with a Skicon-200EX 2. TEWL measured using a Vapo Scan ASVT100RS 3. MED performed using a solar simulator 601-300 2.5 UV Multiport	8-weeks	*C. longa*	Rhizomes	Tablets
Anti-inflammatory										
Zhang *et al*, 2014	China	18–65-year-old males and females (40)	A cream containing 3% cherry blossom extract applied twice daily to forearm with induced irritation using occlusive application of 3% SLS for 24 hours	Placebo	1. Visual erythema scores: significantly decreased from the third day ($p < 0.05$) 2. Erythema value: significantly decreased from the fifth day ($p < 0.05$)	1. Visual erythema scores were evaluated by dermatologist 2. Erythema value measurement using Mexameter MX18	9 days	*P. yedoensis*	Flowers	Cream
Boonchai *et al.*, 2018	Thailand	15–72-year-old males and females with mild-to-moderate facial dermatitis (80)	A cream containing 4-t-butylcyclohexanol and licochalcone applied twice daily	0.02% triamcinolone	1. Physician's assessment: significantly improved ($p < 0.05$) 2. Skin hydration: significantly increased ($p < 0.05$) 3. Patients evaluation of sensory symptoms: significantly decreased ($p < 0.05$)	1. Physician's assessment and redness score using a Eucerin redness rating card 2. Skin hydration and TEWL measured using a Corneometer CM825 and a Tewameter TM300 3. Patients evaluation of sensory symptoms for itching, pain, burning sensation, tingling, and redness using 10 cm VAS	4 weeks	*G. inflate*	–	Cream
Seiwerth *et al.*, 2019	Germany	Healthy males and females (42)	Cream with gentian, liquorice, and willow extract	1% hydrocortisone acetate	UV-erythema test: significantly reduced compared with vehicle only ($p < 0.05$)	UV-erythema test using a Mexameter	48 hours	Gentian: *G. lutea* liquorice: *G. glabra* Willow: *S. daphnoides*	*G. lutea*: root *G. glabra*: root *S. daphnoides*: bark	Cream
Acne treatment										
Lee *et al.*, 2011	South Korea	15–41-year-old males and females with mild-to-moderate	APDDR-0901 (0.03% retinol, 0.7% rose extract, and 0.05% hexamidine	0.1% adapalene gel	1. Median percent change in lesion count: significantly improved from baseline ($p < 0.05$)	1. Median percent change in lesion count 2. Acne grade	12 weeks	–	–	–

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
		acne (97)	diisethionate), daily in the evening		2. Acne grade: significantly improved from baseline ($p < 0.05$) 3. Physician-assessed global improvement: 84% achieved a significant response 4. Patient self-assessment: 77% reported improvement -Adverse effects including pricking were reported	3. Physician-assessed global improvement 4. Patient self-assessment				
Weber *et al.*, 2019	Germany	21–49-year-old males and females with oily skin (21)	A cleanser containing coco-Glucoside, *S. chinensis* oil, *G. lutea* extract, *M. arvensis* oil, *H. lupulus* extract, *L. scoparium* oil, *S. daphnoides* extract, *H. annuus* oil, Pectin, Xanthan gum	Face cleanser with sodium laureth sulfate	1. Skin sebum: significantly reduced only on day 17 after the application 2. Good skin tolerability 3. Self-assessment: participants reported pleasant skin sensation	1. Skin sebum measurement using Sebumeter 2. Skin erythema measurement using a Mexameter 3. Self-assessment	8 weeks	*S. chinensis* *G. lutea* *M. arvensis* *H. lupulus* *L. scoparium* *S. daphnoides* *H. annuus*	*S. chinensis:* seed *G. lutea*: roots *L. scoparium*: branch/leaf *S. daphnoides*: bark *H. annuus*: seed	–
Foot care										
Mandawgade and Patravale, 2008	India	Healthy males and females suffering from different foot ailments (6)	A cream containing mango butter and olein fraction, fortified with vitamin E acetate (1%*w/w*)	Untreated control	1. Assessment of functional attributes: complete repair of cracked skin in all the volunteers. Antiseptic, healing, soothing, and cooling actions were predominant in most of the clinical subjects 2. Assessment of esthetic attributes: Excellent emolliency, rebuilt protective skin barrier and replenished moisture, and improve smoothness. Had good appearance, spreadability, skin feel, smoothness, and absorption ($p < 0.05$)	1. Assessment of functional attributes: reduction in amplitude of cracked heels, pain, and bleeding through the cracks, degree of healing, skin reconstruction, soothing, skin rehydration, and antiseptic against the growth of resident microorganisms 2. Assessment of aesthetic attributes: appearance, spreadability, skin feel, smoothness, and absorption	8 weeks	–	Fruit kernels	Cream
Akhtar *et al.*, 2016	Pakistan	25–35-year-old healthy males (13)	An emulsion containing 4 % *Z. mauritiana* extract	Placebo	Erythema: significantly decreased in both groups ($p < 0.05$) Melanin content: significantly decreased ($p < 0.05$) Skin moisture: significantly increased ($p > 0.05$) Skin elasticity: significantly increased ($p < 0.05$) Sebum content: significantly increased ($p < 0.05$)	Melanin content, skin erythema, skin elasticity, sebum content, and skin moisture were evaluated using Mexameter, Corneometer, Visioscan, and Sebumeter MPA 5	8 weeks	*Z. mauritiana*	Leaves	Emulsion
Rosacea										
Braithwaite *et al.*, 2015	New Zealand	Males and females aged 16 or over with a	Cream containing medical-grade Kanuka honey with 10%	Cetomacrogol cream	1. Baseline assessments (the IGA-RSS): significantly improved ($p < 0.05$)	1. Baseline assessments (the IGA-RSS)	8 weeks	–	–	Cream

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
		doctor's diagnosis of rosacea on the face (138)	glycerine applied twice daily		2. Participant-rated rosacea severity visual analog score (VAS-S) on a 100 mm scale: significantly improved (p < 0.001) 3. Participant-rated dermatology quality of life index (DLQI): no significant difference (p > 0.05)	2. Participant-rated rosacea severity visual analog score (VAS-S) on a 100 mm scale 3. Participant-rated DLQI				
Stretch marks prevention										
Soltanipour, 2014	Iran	20–30-year-old nulliparous females with gestational age of 18–20 weeks (150)	1 cm^3 of olive oil applied twice daily on the skin of abdomen gently without massage	Saj cream (a commercial product containing lanolin, stearin, triethanolamine, almond oil, and bizovax glycerin amidine) Control (no intervention)	Striae severity: no significant effects on development and severity of striae gravidarum (p = 0.43)	Striae severity assessed using the Davey method	The subjects were followed until gestational week of 38–40	*O. europaea*	Fruit	Oil
Scars reduction										
Hosnuter *et al.*, 2007	Turkey	Males and females with hypertrophic and keloid scars and an average age of 40.3 ± 9.6 (72)	Group 1: topical onion extract only Group 2: silicone gel sheet only Group 3 (n =20): combined onion extract and silicone gel sheet	Groups compared with each other	1. Clinical evaluation: (A) A significant difference in the color parameter between groups 1 and 2 and in the height parameter between the groups 1 and 3 (p < 0.01 and p < 0.05 respectively) (B) A significant reduction in scar erythema in group 1 compared with group 2 (p < 0.05) (C) TA significant reduction in scar height in group 3 compared with group 1 (p < 0.05) 2. Patient assessment: (A) No significant difference in hardness, itching, and pain between all groups (p > 0.05) (B) A significant improvement in scar color, hardness, and pain in group 1, and a significant improvement scar color, hardness, height, and itching groups 2 and 3 3. Evaluation of the therapeutic index (TI): The total TI of group 3 was better than the others	1. Clinical evaluation by one plastic surgeon 2. Patients' assessment of scar color, scar height, scar hardness, itching, and pain 3. A global assessment of the clinical course of scar development evaluated using a TI	25 weeks	*A. cepa*	–	Gel
Multiple effects										
Muhammad *et al.*, 2015	Pakistan	25–35-year-old males (11)	W/O emulsion containing 4% *w/w* tamarind extract	Placebo	1. Skin sebum contents: significantly decreased with respect to time ($p \leq 0.05$)	1. Skin sebum contents using a Sebumeter MPA5	12 weeks	*Tamarindus indica*	Seeds	Emulsion

Skin care (n = 53)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
			applied twice daily		2. Skin melanin contents: significant regular decline in skin melanin values with respect to time ($p \leq 0.05$)	2. Skin melanin contents using a Mexameter MPA5				
Matsuyama *et al.*, 2018	Japan	35–59-year-old females with mild skin problems (20)	A capsule containing 150 mg Sakura Extract-P (cherry blossom) taken once daily	Placebo	1. Advanced glycation end products (AGEs) and skin parameters: significantly decreased 2. Skin moisture: significantly decreased in both groups ($p < 0.01$) 3. TEWL: significantly increased 4. VISIA and skin replica parameters: the number of facial spots and reddish areas decreased significantly. Skin texture and the number of pores did not change significantly. UV-reactive spots increased significantly. The other parameters showed no changes. 5. Questionnaire results: no significant differences	1. AGEs measured using an AGE reader 2. Skin moisture measured using a Corneometer 3. TEWL measured using a Tewameter 4. Skin elasticity measured using a Cutometer 5. Skin replica analyzed using a reflective 3-dimensional replica analysis system 6. Facial condition assessed by a face image analyzer (VISIA Evolution) 7. Evaluation of spots, wrinkles, texture, pores, UV reactive spots, brown spots, reddish areas, and porphyrin using an image captured with a VISIA Evolution 8. Questionnaires regarding skin condition	8 weeks	*P. serrulata*	Flowers	Capsule
Ahmad *et al.*, 2020	Pakistan	Healthy males (13)	An emulsion containing *S. indicus* extract applied twice daily	Placebo	1. Assessment of skin erythema and melanin level: significant decrease in EI and melanin level ($p \leq 0.05$) 2. Assessment of skin hydration level: significantly increased ($p \leq 0.05$) 3. Assessment of skin elasticity: significantly increased ($p \leq 0.05$) 4. Assessment of skin sebum level: significantly decreased ($p \leq 0.05$) 5. Surface evaluation of living skin: significant decrease of both large and small pores ($p \leq 0.05$)	1. Assessment of skin erythema and melanin level measured using Mexameter® 2. Assessment of skin hydration level using Corneometer® 3. Assessment of skin elasticity using Elastometer® 4. Assessment of skin sebum level using Sebumeter® 5. Surface evaluation of living skin assessed using VisioFace® and investigation of the number of large and small pores, area of skin spots, and wrinkles using images	12 weeks	*S. indicus*	Flowers	Emulsion

Table 2. Summary of RCTs conducted between 1998 and 2018 of plants, herbs, or isolated compounds used for hair care.

Hair care (n = 10)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Baldness										
Hay, 1998	Aberdeen, Scotland	Alopecia areata patients (86)	Massaging aromatherapy oils into scalp for at least 2 minutes, then wrapping warm towel around head every night	Placebo of carrier oil without essential oils	1. Equal distribution of patients by 4-point scale 2. Statistically significant improvement ($p < 0.05$) in photographic assessment in the intervention group 3. Measurement of traced alopecia areas was reduced significantly ($p = 0.05$) in the intervention group	1. Four-point severity scale to ensure equal baseline characteristics in both groups 2. Photographic assessment by 2 independent dermatologists (primary outcome) 3. Calculated area of alopecia (secondary outcome)	7 months	*T. vulgaris*, *Lavandula agustifolia*, *Rosmarius officinalis*, *C. atlantica* (in jojoba and grapeseed carrier)	–	Aromatherapy oils
Kamimura *et al.*, 2000	Japan	30–57-year-old healthy males (29) with male pattern baldness	1%(*w/w*) procyanidin B-2 tonic preparation Directions for use: For 6 months, 1.8 ml of the test agent was applied to the subjects' affected area of the head twice a day, resulting in a daily dose of 30 mg of procyanidin B-2. No use of other hair care products except shampoos and rinses were permitted during the clinical trial.	Placebo	1. Change in hair density: the increase in hair density in the procynadin B-2 group after 6 months was statistically significant compared to placebo ($p < 0.005$) 2. Terminal hair formation: the increase in the number of terminal hairs in the procynadin B-2 group after 6 months was statistically significant compared to placebo ($p < 0.02$)	1. Determination of change in hair density from a predetermined site photographed by a camera fitted with macrolens 2. Determination of terminal hair formation was measured using a micrograph-equipped microscope at a magnification of × 300	26 weeks	*M. pumila* Miller var. domestica Schneider	Fruit juice	Tonic
Sasmaz and Arican, 2005	Turkey	Subjects with patchy alopecia areata (31)	20% azelaic acid Direction for use: applied twice daily on the affected area for 12 weeks	0.5% anthralin (dithranol) Direction of use: applied in sparing applications for a short contact time (15 minutes) for 2 weeks and then, if tolerated, to be continued for 10 weeks with 30 minutes contact time	1. At week 20 the RGS was 1.27 ± 0.9 in the azelaic acid group versus 1.37 ± 0.8 in the anthralin group ($p > 0.05$). A complete response was observed in (8 of 15) 53.3% of cases in the azelaic acid group compared with (9 of 16) 56.2% in the anthralin group ($p > 0.05$) 2. No serious AEs were observed in either group	1. Terminal hair regrowth score (RGS) with a scale ranging from 0 (inadequate response) to 2 (complete response) at week 20	12 weeks then 8 weeks of follow-up without cream use	–	–	Cream
Choi *et al.*, 2015	Korea	28–68-year-old males and females suffering from alopecia areata (50)	0.5 % Rice bran supercritical CO_2 extract (RB-SCE) tonic product Directions for use: treat the scalp with 4 ml of solution once	Placebo	1. Phototrichography: hair density did not differ significantly in 8 weeks (active *vs.* placebo group) but significantly increased after 16 weeks in the active group ($p < 0.034$) in males only 2. Hair diameter: in the active group, hair diameter was significantly increased	1. Phototrichography (hair density, haircount, and diameter by Folliscope) 2. Expert Panel Assessment of Global Photograph	16 weeks	*O. sativa* L. var. *japonica*	Supercritical CO_2 extract	Tonic product

(Continued)

Hair care (n = 10)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
			or twice a day at approximately 12-hours intervals (total daily dose of 8 ml)		from week 8 to week 16 ($p < 0.05$) compared to the placebo group in both males and females 3. Expert panel assessment of Global Photographs: at 16 weeks, the experts observed improved hair growth in the RB-SCE group compared to placebo ($p < 0.05$) in males. However, outcome was insignificant at 16 weeks in the females group 4. Patient satisfaction questionnaire: the overall satisfaction of the RB-SCE group was significantly higher than that of the placebo group at 16 weeks ($p = 0.005$) 3. Skin Tolerance and Safety Evaluation: in all 43 subjects, no adverse reactions (i.e., itching, prickling, burning, stinging, stiffness, tightness, burning of the eyes, weeping, erythema, edema, scaling, papule, or any other RB-SCE-related reactions) were noted	3. The patient questionnaire assessment 4. Skin tolerance and safety evaluations by clinical observation				
Pekmezci *et al.*, 2018	Turkey	20–55-year-old adult suffering from telogen effluvium or androgenic alopecia (120)	Group A: herbal shampoo, Group B: herbal solution, Group C: herbal shampoo + placebo solution, Group D: placebo shampoo + placebo solution Directions for use: Shampoo: Every other day, three times a week, apply 5 ml on wet hair, wait for 3–4 minutes after foaming, and then rinse well. Solution: Every day in the morning and in the evening, apply 3 ml on dry hair and massage all over the scalp. Let it stand for at least 4–6 hours.	Placebo	1. Pull test: statistical analyses revealed significant improvement in all groups for all months compared to baseline. It is noted that group C (active shampoo + solution) had the best clinical outcomes ($p < 0.000001$) 2. Phototricogram: compared to baseline, the number of total hairs in groups A, B, and C (active groups) increased significantly in the 4th and 6th months. The decrease in telogen hairs and increase in anagen hairs were also significant in groups A, B, and C ($p < 0.001$). The (%) changes in telogen and anagen hairs in group D were not significant ($p > 0.05$) 3. Dermatological evaluation: results not reported 4. Self-assessment score: all questions showed statistically significant results based on the difference from placebo (group D) Group C had the best clinical outcomes ($p < 0.000001$) The products were well tolerated, and no side effects were recorded	1. Pull test 2. Phototricogram 3. Dermatological evaluation 4. Self-assessment score	26 weeks	*M. chamomilla, A. millefolium, C. siliqua, E. arvense, U. urens,* and *U. dioica.*	*M. chamomilla:* Flower extract *A. millefolium:* Aerial part extract *C. siliqua:* Fruit extract *E. arvense:* Leaf extract *U. urens:* Leaf extract *U. dioica:* Root extract	Shampoo or/ and solution
FAAD, 2018	US, New York	21–65-year-old healthy women with Fitzpatrick skin types I to IV and self-perceived thinning hair (40)	Oral nutraceutical supplement. Direction for use: 4 capsules daily with a meal or immediately after a meal at the same time each day	Placebo	1. Significant increase in the number of terminals, vellus, and total hair counts ($p < 0.005$) in the intervention group compared to placebo 2. Significant and progressive improvement in investigator global hair assessments (IGHA) and quality scales in the active group compared to placebo ($p < 0.05$). no significant changes in terminal hair diameter	1. Determination of increase in terminal, vellus, and total hair counts using phototrichograms 2. Assessment of hair growth and quality, changes in terminal hair diameter, and bundle	6 months	Standardized extracts of *Ashwagandha*, curcumin, *Saw palmitto*, tocotrienol-rich tocotrienol/ tocopherol complex, piperine, and capsaicin, hydrolyzed marine	–	Capsules

Hair care (n = 10)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
					3. self-assessment questionnaire (SAQ): there was a significant improvement in hair breakage and anxiety levels in the active group compared to the placebo group ($p < 0.05$). Number of subjects who rate themselves as "improved" in the active group compared to placebo group was significantly higher changes in terminal hair diameter and bundle measurements ($p < 0.05$) Ease of use: 84.6% of the active subjects found it easy to add capsules to their daily routine, 88.5% of patients preferred oral capsules instead of topical application, and 73.1% would recommend the treatment to their friends 4. No treatment-related AEs were reported during the study	measurements using the blinded IGHA 3. Responses in the subject self-assessment questionnaire SAQ, Ease of use, and QoL 4. Safety: changes in physical exam and potential AEs		collagen, hyaluronic acid, and organic kelp		
Antidandruff										
Satchell *et al.*, 2002	Australia	14 and older male and female patients suffering from mild-moderate dandruff (126)	5% tea tree oil shampoo Directions for use: Patients were asked to wash their hair daily, leaving the shampoo in for 3 minutes before rinsing, and were free to use a conditioner	Placebo	Tea tree oil shampoo showed significance improvement in terms of: 1. whole scalp lesion score ($p < 0.001$) 2. total area of involvement score ($p < 0.001$) 3. total severity score ($p < 0.001$) 4. the itchiness and greasiness components of the patients' self-assessment compared to placebo ($p < 0.05$)	1. Whole scalp lesion score 2. Area of involvement 3. Severity score 4. Subjective assessment of scaliness, itchiness, and greasiness using linear analog scale	4 weeks	*M. alternifolia*	Leaves extract (oil)	Shampoo
Herrera-Arellano *et al.*, 2004	Mexico	15–45-year-old participants with pityriasis capitis who are affiliated with Mexican Institute of Social Security (103)	*S. chrysotrichum* extract (12.5%) mixed with neuter shampoo Direction for use: apply directly on damp scalp, rub until obtaining abundant lather, letting the shampoo act for 5 minutes, then rinse with clean water. to be repeated every third day for 4 weeks	Ketoconazole (2%) mixed with neuter shampoo	1. Clinical effectiveness was similar between both groups at the end of the follow-up period (92.16% *vs.* 86.54%; $p = 0.35$) 2. Percentage of mycological effectiveness was higher in ketoconazol group after 2 weeks of treatment ($p < 0.05$), but the effect was reduced at the end of the treatment period, resulting in no statistical significance between both groups ($p > 0.23$) 3. Both treatments were satisfactorily tolerated (tolerability percentage was 100% in both groups) 4. Rates of therapeutic effectiveness was similar between both groups at 2 and 4 weeks of treatment ($p > 0.14$) 5. Given all of the above, therapeutic success was identical in both groups	1. Clinical effectiveness (signs and symptoms that were detected at basal condition) 2. Mycological effectiveness (direct examination and culture) 3. Tolerability (local and systemic side effects) 4. Therapeutic success (by meeting all of the above)	4 weeks	*S. chrysotrichum*	Leaves	Shampoo

Hair care (n = 10)										
Author, year	**Country**	**Population (n)**	**Intervention (dose/method of application)**	**Comparison(s)**	**Outcome(s), p value**	**Method of testing**	**Duration**	**Scientific name of plant used**	**Part used**	**Dosage form**
Salmanpoor *et al.*, 2012	Iran	14–17-year-old males and females with dandruff (203)	Group A: Liquorice 7% shampoo Direction for use: wash their hair twice weekly with the given shampoo (after discontinuing other topical products 2 weeks prior and during the study)	Group B: Selenium-sulfide 1% shampoo Group C: Placebo shampoo	1. The three shampoos significantly decreased DSS with the best result for selenium-sulfide 1% ($p < 0.05$). 2. None of the shampoos significantly decreased scalp inflammation ($p > 0.05$) 3. Pruritis decreased more in the selenium-sulfide 1% group (60%) compared to liquorice 7% group (37.5), but both treatments significantly reduced pruritis compared to placebo 4. Around 33.8% of subjects who used liquorice reported less hair loss compared to selenium-sulfide (18.2%) and placebo (16.7%) 5. Liquorice shampoo caused the most eye irritation compared to selenium-sulfide and placebo ($p < 0.05$) 6. There was no significant decrease in Pityrosporum ovale in all three groups ($p > 0.05$)	–	4 weeks	*G. glabra*	–	Shampoo
Chaijan *et al.*, 2018	Iran	18–60-year-old males and females with dandruff (90)	1. *M. communis* and vinegar solution 2. Placebo shampoo 3. Daily shampoo Directions for use: The patients were instructed to use the solution and shampoo once every 3-4 days. They used them 3 times before the second visit and 5 times between their 2nd and 3rd visits. Also, they were asked to massage the antidandruff solutions on the scalp 3–5 minutes before going for a shower and then to wash their hair with the antidandruff shampoo. In addition, they were instructed to allow the shampoo foam to stay on their scalp for 5 minutes and after that to rinse it	1. Ketoconazole 2% shampoo 2. Placebo shampoo 3. Daily shampoo	All dandruff indices improved from the baseline in both treatment arms by the end of the follow-up period ($p < 0.001$) No significant difference was observed between treatment arms' efficacy, satisfaction rate, and side effects ($p > 0.05$)	1. Dandruff Indices: a. Itching b. excoriation pruritis grading c. adherent scalp flaking score d. Redness of scalp skin e. Grading of scalp skin involvement 2. The patients' satisfaction and acceptance were evaluated using a VAS	1 month	*M. communis* L.	Leaves	Solution

Table 3. Risk of bias assessment of the RCTs included in this SR.

Selection bias		Reporting bias	Other biases	Performance bias	Detection bias	Attrition bias	
Random sequence generation	Allocation concealment	Selective reporting	Other sources of bias	Blinding (participants and personnel)	Blinding (outcome assessment)	Incomplete outcome data	
			Skin care RCTs				
X	X	L	H	X	X	L	Gonzalez *et al*., 1997
X	X	L	L	L	L	X	Martelli *et al*., 2000
L	X	L	L	L	L	L	Bauza *et al*., 2002
L	X	L	L	L	L	L	Javidnia *et al*., 2003
L	X	L	L	L	L	L	Javidnia *et al*., 2003
H	X	L	L	X	H	L	Hosnuter *et al*., 2007
X	X	L	L	L	L	L	Camouse *et al*., 2009
X	X	L	L	L	L	L	Kim *et al*., 2008
X	X	L	X	X	X	X	Mandawgade and Patravale, 2008
L	X	L	L	L	L	X	Rival *et al*., 2009
X	L	L	L	L	L	H	Vicente *et al*., 2009
L	X	L	L	L	X	L	Bazin *et al*., 2010
X	X	L	L	L	L	L	Kim *et al*., 2010
X	X	L	L	L	H	X	Akhtar *et al*., 2011
L	L	L	L	L	L	H	Lee *et al*., 2011
X	X	L	L	L	L	L	Altaei, 2012
H	H	L	L	H	H	L	Wineman *et al*., 2012
X	X	L	L	H	L	L	Danby *et al*., 2013
X	X	L	L	L	L	L	Shin *et al*., 2013
X	X	L	L	L	L	L	White *et al*., 2013
L	X	L	L	L	L	L	Mendoza *et al*., 2014
L	X	L	L	L	H	L	Soltanipoura *et al*., 2014
X	X	L	L	H	L	L	Zhang *et al*., 2014
L	L	L	H	H	L	L	Braithwaite *et al*., 2015
H	X	L	L	L	L	L	Morag *et al*., 2015
X	X	L	L	H	L	L	Muhammad *et al*., 2015
X	X	L	X	X	X	X	Akhtar *et al*., 2016
X	X	L	L	L	L	L	Filipovic *et al*., 2016
X	X	L	L	H	L	L	Ilnytska *et al*., 2016
X	X	L	L	L	L	L	Kanlayavattanakul *et al*., 2016
X	X	L	L	L	L	L	Lee *et al*., 2016
L	L	L	L	L	L	L	Ray *et al*., 2016
L	L	L	L	L	L	L	Srivilai *et al*., 2017
L	X	L	L	H	L	L	Boonchai *et al*., 2018
X	X	L	L	L	X	L	Kanlayavattanakul *et al*., 2017
X	X	L	L	H	L	L	Milani and Sparavigna, 2017
L	L	L	L	L	L	L	Srivilai *et al*., 2017
X	X	L	L	L	L	L	Wang *et al*., 2018
X	X	L	H	L	L	L	Egoumenides *et al*., 2018
X	X	L	L	H	H	L	Goldberg *et al*., 2019
X	X	L	L	L	L	X	Lee and Cha, 2018
L	L	L	L	L	L	L	Matsuyama *et al*., 2018
L	X	X	L	L	X	L	Weber *et al*., 2019
X	X	L	L	L	L	L	Yoshida *et al*., 2019
X	L	L	H	L	L	L	Asada *et al*., 2019
L	L	L	L	L	L	L	Roh *et al*., 2019

(Continued)

Selection bias		Reporting bias	Other biases	Performance bias	Detection bias	Attrition bias	
Random sequence generation	Allocation concealment	Selective reporting	Other sources of bias	Blinding (participants and personnel)	Blinding (outcome assessment)	Incomplete outcome data	
X	X	L	L	L	L	L	Zeng *et al*., 2019
L	X	L	L	L	L	L	Zhang *et al*., 2019
X	X	L	L	L	H	X	Ahmad *et al*., 2020
L	X	L	L	L	L	L	de Toledo Bagatin *et al*., 2020
X	X	L	L	L	L	L	Im *et al*., 2020
			Skin care RCTs				
X	X	L	L	L	L	H	Hay, 1998
L	X	L	X	L	L	L	Kamimura *et al*., 2000
X	X	L	X	H	L	L	Satchell *et al*., 2002
X	X	L	X	L	L	L	Herrera-Arellano *et al*., 2004
X	X	L	L	H	H	L	Sasmaz and Arican, 2005
X	X	H	X	H	H	X	Salmanpoor *et al*., 2012
L	X	L	L	L	L	L	Choi *et al*., 2015
X	X	L	X	L	L	L	FAAD, 2018
L	L	L	L	L	L	X	Chaijan *et al*., 2018
L	X	L	L	L	H	L	Pekmezci *et al*., 2018

L = Low risk; H = High risk; X = Unclear risk.

Table 4. Plants and/or herbs found effective in the identified RCTs and available in Jordan.

Plant/herbs available in Jordan	[a]Availability in Jordan based on the city
A. sativa	Irbid
C. siliqua	Petra and Tal Al-Rumman
F. vulgare	Madaba and Tal Al-Rumman
G. glabra	Jordan bridge
M. sativa	Al-Mafraq and Ain Al Beida
M. communis	Karak Governorate and Alkaser
Olea europaea	Amman, Tal Al-Rumman and Wadi Orjan
P. oleracea	Al-Mafraq, Ajloun, Amman, Aqaba, and Moab
S. marianum	Irbid and outskirt of Irbid
U. urens	Tal Al-Rumman

[a]Availability in Jordan as listed in "The Plants of Jordan: An Annotated Checklist."

(Matsuyama *et al*., 2018); and the third study tested *Sphaeranthus indicus* for its moisturizing, antihyperpigmentation, antisebum, elasticity properties, and overall improvement of the skin condition (Ahmad *et al*., 2020).

Hair care

Ten RCTs concerned with hair care were identified for reducing hair loss and baldness, six of which were published between 1998 and 2018. The studies used *O. sativa* (Choi *et al*., 2015), *Malus pumila* (Kamimura *et al*., 2000), and anthralin (Sasmaz and Arican, 2005), and three used a combination of natural products. Of those combinations, one study used *Thymus vulgaris*, *Lavandula angustifolia*, *Rosmarinus officinalis*, and *Cedrus atlantica* (Hay, 1998); another study used *Matricaria chamomilla*, *Achillea millefolium*, *Ceratonia siliqua*, *Equisetum arvense*, *Urtica urens*, and *Urtica dioica* (Pekmezci *et al*., 2018), whereas the third one used *Ashwagandha*, curcumin, *Saw palmetto*, tocotrienol/tocopherol complex, piperine, capsaicin, hydrolyzed marine collagen, hyaluronic acid, and organic kelp (FAAD, 2018).

Four studies published between 2002 and 2018 tested natural products and compounds for their antidandruff activity; they used *Melaleuca alternifolia* (Satchell *et al*., 2002), *Solanum chrysotrichum* (Herrera-Arellano *et al*., 2004), *G. glabra* (Salmanpoor *et al*., 2012), and *Myrtus communis* (Chaijan *et al*., 2018).

Risk of Bias of the Included Studies

The risk of bias of the included studies in this review was conducted by the researchers, with the bias assessment for all the studies included in detail in Table 3.

Skin care

Eighteen studies were at low risk of randomization bias, as they were randomized using either sequence generation or block randomization. On the other hand, 3 studies were at a high risk due to inadequate randomization. The rest did not provide sufficient information regarding the randomization method; thus, the risk was considered unclear (n = 32). Most studies (n = 42) did not describe the allocation concealment process, so the risk of bias was noted as unclear, whereas 10 studies were considered of low risk as proper concealment techniques were described. Only one study was considered high risk regarding the allocation concealment, as the participants were unblinded. Fifty-two other studies were considered of low-risk selective reporting bias while only one was considered unclear, as the p values were not reported in the results section (Weber *et al*., 2019). Many studies (n = 39) were double-blinded and therefore at a low risk of performance and detection biases. The participants were not blinded in 9 studies, so these were considered at a high risk of performance bias. Additionally, the assessors were not blinded in 6 studies, so these were at a high risk of detection bias. If it was unclear whether

the participants and/or assessors were blinded, the studies were considered to be at an unclear risk of performance/detection bias. For the attrition bias, attrition rates above 20% were considered of high risk; 2 studies were found to have high dropout rates and were at a high risk of attrition bias, 43 were stated as low risk, and 8 were of unclear risk because it was unclear whether the data of all participants were considered or if any failed to complete the study. Many studies (n = 43) were stated as low risk in the domain of other biases, six were stated as high risk as the researchers were funded from the same companies providing the test products, and eight were considered unclear because the conflict of interest was not declared in these studies.

Hair care

Four studies were at low risk of randomization bias, while six were considered of unclear risk, because the randomization methods were not mentioned. One study was considered at low risk of allocation bias, and nine were considered of unclear risk. In the reporting bias domain, nine were considered low risk and one was of unclear risk. Some studies (n = 7) were double-blinded, so they were at low risk of both performance and detection biases, while the remaining three studies followed an open-label strategy and thus were at a high risk for both performance and detection biases. In the attrition bias domain, seven studies were at low risk, two were at an unclear risk, and one was stated high risk. Regarding other biases, five studies were considered low risk, and the other five were stated as unclear risk.

Outcomes

Skin care

Thirty-six RCTs compared natural product(s) or derived compound(s) with a placebo; 29 preparations were found effective. Nine RCTs compared natural product(s) or derived compound(s) with another treatment; eight preparations were found effective. Eight RCTs compared natural product(s) or derived compound(s) with untreated controls, all of which yielded statistically significant results. One RCT compared silymarin cream with untreated control and placebo was found effective in both cases. The results of the remaining studies were statistically insignificant.

Hair care

Six RCTs compared natural product(s) or derived compound(s) to placebo, and all were found to have statistically significant outcomes. Four RCTs compared natural product(s) or derived compound(s) with active treatments, and the efficacy outcomes were found to be statistically insignificant.

The tested natural product(s) or derived compound(s) showed good tolerability in most studies, but adverse events (AEs) including dryness, scaling, erythema, edema, itching, and pricking were reported with a formulation containing retinol and rose extract (Lee *et al*., 2011).

Plants present in Jordan

From the above discussed studies, ten plants were identified to be present in different locations in Jordan, as illustrated in Table 4. The plants that are found in Jordan and can be used for skin and hair care were as follows: *A. sativa*, which was investigated in a study conducted in the United States of America (USA), was found effective in improving skin barrier integrity and increasing its hydration (Garay, 2016). *Portulaca oleracea* was reported to be useful in the treatment of melasma in China (Zhang *et al*., 2019). In addition, it was found to improve skin health and reduce sensitization when used in combination with other plants (Wang *et al*., 2018). *Silybum marianum* was also reported to be useful for melasma as was found in an Iraqi study (Altaei, 2012). *Foeniculum vulgare* and *M. sativa* were effective in reducing facial hair in two studies, both conducted in Iran (Javidnia *et al*., 2003; Sargazi *et al*., 2016). *Glycyrrhiza glabra* was used in combination with other plants to improve the overall skin condition (Roh *et al*., 2019; Seiwerth *et al*., 2019) and in a hair shampoo as an antidandruff agent (Salmanpoor *et al*., 2012). *Myrtus communis* was also found useful for the treatment of dandruff when mixed with vinegar in a study conducted in Iran (Chaijan *et al*., 2018). *Ceratonia siliqua* and *U. urens* were used in a combination used to improve hair growth and strength with other plants in a study conducted in Turkey (Pekmezci *et al*., 2018).

DISCUSSION

The worldwide growth of the cosmetic sector is partially driven by the input of natural products (Cervellon and Carey, 2011). The global market value for natural cosmetics is expecting a positive increase with the upcoming years (Shahbandeh, 2020). This SR is unique as it explored plant extracts, herbal preparations, and isolated plant-derived compounds used for cosmetic purposes, particularly for skin and hair care. Fifty-three RCTs exploring natural products used for skin care were identified. Most of the RCTs were published between the years 2013 and 2019 (n = 34). Thirty-seven RCTs used natural products as a single ingredient (around 70% of the RCTs), while 16 RCTs used them in combinations (around 30% of the RCTs). Creams were the most frequently used dosage form (49% of the topical preparations). Other tested dosage forms were lotions, serums, gels, emulsions, beverages, oils, tablets, and capsules. Ten RCTs were designed to test natural products for hair care, seven of which used natural products as a single ingredient (70% of the RCTs), while the other three used them in combinations (30% of the RCTs). Shampoos were the most common form used (40%); aromatic oils, creams, solutions, capsules, and hair tonics were also used. The population included in this review added up to 3,439 subjects, and about 50% of the studies included females exclusively. The smallest number of participants was 3 and the highest was 203. The most common duration of the RCTs was 12 weeks (around 27% of the RCTs). The shortest duration was 75 minutes (0.0074 weeks), and the longest duration was 7 months (30.42 weeks). Around 87.3% of the reviewed RCTs found the tested natural products to have statistically significant efficacy outcomes. In addition, several treatment preparations were described, highlighting the diverse possibilities for incorporating botanicals into cosmetics. However, these reported outcomes should be interpreted cautiously for several reasons. Firstly, the majority of RCTs did not include power calculations indicating whether the number of participants is representative of the population or not. Secondly, participants were usually from a certain background, and thus the findings might not be applicable to all people of diverse ethnicities, lacking external generalizability.

Thirdly, statistical significance may not necessarily indicate clinical significance, as the outcomes of interest are sometimes surrogate markers. It is important to explore local plants for their cosmetic potential, which may add to the diversity of the local market. In our case, plants that are present in Jordan are of particular interest, as these can be used in developing cosmetics locally and can be marketed internationally to help the country's economy flourish (Workman, 2020). This discussion sheds light on each of these plants to provide needed information for policy makers and investors in the country.

CONCLUSION

Cosmetics are marketed and used worldwide for various purposes, which makes them a subject for academic and market research (Infante *et al*., 2016). This SR provided a summary of the plants/herbs in the literature which were clinically tested in RCTs from 1997 until 2020 for their cosmetic purposes, particularly skin and hair care. Such information can be helpful for policy makers and investors to make informed decisions regarding the production of cosmetics that can be of benefit locally and internationally. Additionally, this SR provided a list of plants/herbs found in Jordan which evidently showed cosmetic potential. In order to provide clear and comparative results, plants with promising findings are worth further investigations in robust RCTs.

AUTHORS' CONTRIBUTION

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be accountable for all aspects of the work.

ETHICAL APPROVAL

Not applicable.

CONFLICT OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

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