Review Article

Global Perspective of Plant-Based Cosmetic Industry and Possible Contribution of Sri Lanka to the Development of Herbal Cosmetics

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Received 8 March 2021; Revised 24 November 2021; Accepted 5 February 2022; Published 4 March 2022

Academic Editor: Khalid Rahman

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The global consumption of plant-based cosmetics has shown spectacular growth in recent years because of rising consumer awareness regarding the long-term health benefits of natural ingredients. As the global demand for herbal cosmetics increases, there are ample opportunities for Sri Lanka as a tropical Asian country to expand its productions and global exports along with its unique biodiversity and inherited traditional knowledge. Therefore, the present review attempts to give an overview of the widely used medicinal plants in the global herbal cosmetic industry and strengths, challenges, and possible solutions for the development of the herbal cosmetic industry of Sri Lanka. Information was collected using electronic search (using Pub Med, Science Direct, Web of Science, Google Scholar, TEEAL, and Scopus) for articles published in peer-reviewed journals, industrial reports, market surveys, and library search for local books on ethnobotany. Important plant-derived ingredients used in the global herbal cosmetic industry are essential oils, colorants, oils, fats, and waxes. The traditional usage of 108 medicinal plant species (belonging to 58 families) in cosmetic treatments was identified from the local books of Sri Lanka. Of these, 49 plant species were reported as new ingredients for the herbal cosmetic industry. However, the lack of ethnobotanical and ethnopharmacological surveys to identify the cosmetic potential plants, insufficient or absence of continuous supply of raw materials for production in line with the existing demand, the lack of quality control of raw materials and finished cosmetic products, improper systematic cultivation systems for medicinal plants, poor postharvest practices, and the lack of innovations are major challenges encountered in Sri Lanka for the development of the herbal cosmetic industry. In conclusion, addressing these vital knowledge gaps is a timely requirement of the country for the sustainable development of the herbal cosmetic industry in Sri Lanka. Furthermore, assembling of the multidisciplinary cooperation of botanists, chemists, toxicologists, researchers, and biologists is crucial to analyze the interesting functional properties, efficacy, and effectiveness of documented medicinal plants with cosmetic potential.

1. Introduction

In today’s world, being presentable and looking great have become necessary for everyone [1]. The growing consumer demand for cosmetics is mainly driven by the aspiring young population who want to invest in grooming while maintaining their health [2]. Nonetheless, most individuals in different age groups use cosmetics in various forms [3]. With its huge profitability, it is a challenge for a manufacturer to provide a good quality product at a low cost that is simultaneously environmentally friendly [4]. Although cosmetic products are not generally associated with serious
2. Methodology

The process of bibliographic research was conducted from January 2020 to August 2020, comprehending works from 1999 to 2019. This review was mainly focused to address the following research questions:

(1) What is the present status of the global herbal cosmetic industry, including market annual growth, leading cosmetic product categories, and the pioneers of the herbal cosmetic industry by geographical zones and countries?

(2) What are the widely used specialty plant materials in global herbal cosmetic production and their functions?

(3) What is the present status of the herbal cosmetic industry of Sri Lanka?

(4) What are the strengths, challenges, and possible solutions for the development of the herbal cosmetic industry of Sri Lanka as a tropical Asian country?

The research was organized in two phases. Data extraction was done by two investigators (D.G.N.D. Gamage and R.M. Dharmadasa) independently at each phase. Any inconsistencies between the investigators were resolved by consensus with a third investigator (D.C. Abeysinghe).

Information was gathered by adopting databases, such as PubMed, Science Direct, Web of Science, Google Scholar, TEEAL, Wiley Online Library (Wiley), and Scopus.

During the first phase, information was collected on the global herbal cosmetic industry. Extensive bibliographic research was performed using keywords and syntax, such as “herbal cosmetics,” “global herbal cosmetic industry,” “medicinal plants with cosmetic potential,” “specialty plant materials used for cosmetic production and their functions,” “essential oils,” “plant-based dye and colorants,” “plant oils used in cosmetics,” “fat and waxes for cosmetics,” “herbal cosmetic industry in China,” “herbal cosmetic industry in India,” “medicinal plants used in cosmetics in China,” “Cosmetic treatments and traditional Chinese medicine,” and “medicinal plants used in skin care/hair care/oral care in India.” Furthermore, references listed in relevant journals were also screened. 218 journals were identified using databases, whereas 20 web resources, 13 industrial reports, 01 book, and 03 book chapters were identified using “Google” search. However, 93 journals, 14 web resources, 10 industrial reports, 01 book (International Cosmetic Ingredient Dictionary and Handbook, published by Personal Care Products Council, Washington), and 03 book chapters (The Therapeutic Benefits of Essential Oils, Chinese Topical Herbal Treatments and Essential Oil Protocols and Cosmetics’ Quality Control) were utilized for writing on the global herbal cosmetic industry after excluding repeated records, suspected plagiarisms, non-peer reviewed journals, incomplete data or obvious errors of information (e.g., errors in scientific, vernacular, or English names of medicinal plants), and records in different languages. Materials in the English language alone were chosen during this phase. Furthermore, peer-reviewed journals and books, market analysis done by reputed research organizations (e.g., Future Market Insights/FMI), industry reports developed by governments or recognized non-governmental associations (e.g., Basic Chemicals, Cosmetics and Dyes Export Promotion Council, India/CHEMEXCIL, The Associated Chambers of Commerce and Industry of India/ASSOCHAM), ethnobotanical and ethnopharmacological surveys with minimum sample size and in vitro bioactivity studies of medicinal plants with a minimum number of replications were considered to be eligibility materials for writing in this phase. Moreover, extracted data from the publications on medicinal plants with cosmetic potential in China were compared with the “Inventory of Existing
Cosmetic Ingredients in China (IECIC)-2015” issued by the National Medical Products Administration, China to confirm the usage of identified plant materials in the cosmetic industry. Cross-checking was performed by two investigators (D. G. N. D. Gamage and R. G. S. Wijesekara). However, no inventories or dictionaries of cosmetic ingredients were found for data comparison in India.

During the second phase, information on the herbal cosmetic industry of Sri Lanka, the traditional usage of medicinal plants in cosmetic treatments, strengths, and challenges for the development of the herbal cosmetic industry of Sri Lanka was accumulated. The bibliographic research was performed using keywords and syntax, such as “herbal cosmetics of Sri Lanka,” “herbal cosmetic industry of Sri Lanka,” “medicinal plants used for cosmetic treatments in Sri Lanka,” “medicinal plants and bioactivity studies in Sri Lanka,” and “medicinal plants used in skin care/hair care/oral care in Sri Lanka.” The numbers of records identified using databases and “Google” searching were 95 and 17, respectively. After applying the same inclusion and exclusion criteria, only 14 publications and 2 conference proceedings (Current scenario on the import of plant-based Ayurvedic raw materials in Sri Lanka and Current scenario of herbal medicine in Sri Lanka) were accepted for writing in this phase. Because of the lack of relevant publications available in databases, data extraction was focused by searching local books from the libraries of Industrial Technology Institute, National Science Foundation and Institute of Indigenous Medicine, University of Colombo in Sri Lanka. Therefore, both English and Sinhala languages were considered during the search of libraries. Four Ayurveda authentic books, namely the “Compendium of medicinal plants-Sri Lankan study, volumes I, II, III, and IV,” published by the Ayurveda Department of Sri Lanka and the book called “A collection of medicinal plants in Sri Lanka,” published by Nature’s Beauty Creations Limited, Sri Lanka, were selected to identify potential medicinal plants for cosmetic productions. The current usage of identified medicinal plants with cosmetic potential through books was compared with the survey conducted on identifying medicinal plants used in the herbal cosmetic industry of Sri Lanka [12] to recognize new plant materials for the Sri Lankan herbal cosmetic industry.

In total, 107 peer-reviewed journal articles, 14 web resources, 10 industrial reports, 6 books, 2 conference papers from proceedings, and 3 book chapters were employed for writing this review. Figure 1 illustrates the schematic diagram of the employed methodology. The results were summarized in a narrative manner using tables. The scientific names of documented plants were validated based on the collections listed on the homepages http://www.theplantlist.org and http://www.worldfloraonline.org. In addition, important links have been given where all details cannot be provided.

3. Results and Discussion

3.1. Global Perspective of the Plant-Based Cosmetic Industry

3.1.1. Specialty Plant Materials for Herbal Cosmetic Production. In line with the U.S. Food and Drug Administration (FDA), the law defines cosmetics as “articles intended to be rubbed, poured, sprinkled, sprayed on, introduced into, or otherwise applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance” [3]. However, products that are formulated using various permissible cosmetic ingredients to form the base in which one or more herbal ingredients are used to provide defined cosmetic benefits, e.g., influencing the functions of the skin and providing nutrients necessary for healthy skin or healthy hair, can be described as “herbal cosmetics” [13, 14]. Free-radical scavenging, anti-inflammatory, antiaging, sun protection, the reduction of hyperpigmentation, and antimicrobial effects are some of the functional benefits [15]. In the formulation of herbal cosmetics, plants are used in three ways: a total extract, a single molecule obtained from the purification of extracts, or a selective extract [16]. Some important plant-derived ingredients used in cosmetics are oils, fats, waxes, essential oils, plant extracts, and colorants. These ingredients have numerous roles in the final cosmetic products, such as coloring, scenting, moisturizing, thickening, and stabilizing [15]. The usage amount of these specialty plant materials or their extracts in herbal cosmetic products is varied according to the product category, plant materials used, national, regional (e.g., EU cosmetics regulations), and international (e.g., The International Organization for Standardization (ISO), Food and Drug Administration (FDA)) rules and regulations. For instance, the allowable level of Citrus bergamia Risso (Bergamot oil) in cosmetics is 0.1 ppm in Austria. Furthermore, in line with the EU Cosmetics Regulation, the permissible concentration of essential oil in shower gels and baths (rinse-off products) is 0.01%, while the permissible concentration of essential oil in body oils, massage oils, and creams is 0.001% [17]. However, information on the acceptable concentrations of these individual specialty plant materials in cosmetics is scarce.

1) Essential Oils. People have been using aromatic plants and oils for thousands of years in incense, perfumes, cosmetics, medicinal, and culinary applications [15]. Essential oils are highly concentrated, volatile, hydrophobic mixtures of chemicals extracted from plants. It is estimated that more than 3000 essential oils are of commercial importance and are used in flavor and cosmetic industries [18]. The largest consumer of essential oils is the United States of America, followed by western European countries, namely France, Germany, and the United Kingdom. At present, the United States and developing countries are dominant in the production of the most important essential oils. Essential oils are primarily used for their fragrance properties in cosmetic products. However, certain essential oils possess other interesting properties, such as antibacterial or antifungal, conditioning hair, and improving skin elasticity. Because of the unique functional properties and fragrances of plant-derived essential oils, the cosmetic industry uses them profoundly in a wide range of cosmetic products [11]. Table 1 lists the examples of plant-derived essential oils used in cosmetic products.

2) Dye and Colorants. Currently, the market for natural colors in cosmetics continues to grow throughout the world. Manufacturers seek natural plant-based coloring materials...
that offer health benefits, such as antioxidant, antimicrobial, anti-inflammatory, anti-aging, and UV protection properties, beyond their coloring properties alone [22–25]. At present, the main exporting countries of natural dyes are China, Peru, and India [11]. Plant colorants and pigments are used in a whole range of cosmetic products, such as creams, soaps, lotions, hair dyes, and make-up products [15, 26]. Table 2 lists various plant origin colorants and dyes used in the cosmetic industry.

(3) Oils. Oils are rich sources of fatty acids. Plant-derived oils from edible vegetables, fruits, seeds, plant seedlings, ground-nuts, and trees have been safely consumed by humans for millennia. Various oils have been used on the skin since ancient times for cosmetic purposes. Oils are used as the base in a wide variety of cosmetic products, such as creams, emulsions, cosmetic milk, creams, ointments, hair conditioners, brilliantine, cosmetic masks, protective lipstick, bath fluids, nail varnish, and nail cleaners, along with their conditioning, occlusive, emollient, and moisturizing properties [28, 29]. As highlighted by Lubbe and Verpoorte [11], Zielinska and Nowak [29], and Athar and Nasir [30], Table 3 summarizes some commonly used plant-derived oils in cosmetic products.

(4) Fat and Waxes. Fats and waxes form an important group of ingredients for the manufacture of personal care products and decorative cosmetics. These are harder substances and very resistant to moisture, oxidation, and microbial attack. Waxes are widely used in a large variety of cosmetic products, such as creams, lotions, balms, ointments,
| Vernacular name | Scientific name | Functional property/properties | Reference(s) |
|-----------------|-----------------|--------------------------------|--------------|
| Basil           | Ocimum basilicum L. | Fragrance | [11] |
| Bay             | Laurus nobilis L. | Antimicrobial properties | [11] |
| Bergamot oil    | Citrus bergamia Risso | Fragrance | [19] |
| Calamus         | Acorus calamus L. | Use in aromatherapy | [11] |
| Caraway         | Carum carvi L. | Fragrance flavouring agent (mouthwashes, toothpastes) | [11] |
| Cardamom        | Elettaria cardamomum (L.) Maton | Use in aromatherapy | [11] |
| Carrot seed     | Daucus carota L. | Use in aromatherapy | [11] |
| Citron          | Citrus medica L. | Antimicrobial properties | [11] |
| Citronella oil  | Cymbopogon winterianus L. | Fragrance | [11, 19] |
| Clary sage      | Salvia sclarea L. | Fragrance | [11] |
| Garden sage     | Salvia officinalis L. | | |
| Spanish sage    | Salvia lavandulifolia Vahl | | |
| Clove           | Syzygium aromaticum (L.) Merr. & L.M.Perry | Antimicrobial properties | [11, 20] |
| German chamomile| Matricaria chamomilla L. | Herbaceous odour | [17, 20] |
| Immortelle      | Helichrysum italicum (Roth) G. Don | Stimulates blood circulation in the skin and regenerates the skin | [17] |
| Jasmine oil     | Jasminum officinale L. | Flowery fragrance | [19] |
| Lavender        | Lavandula angustifolia Mill. | Anti-inflammatory, carminative, and sedative | [11, 17, 20, 21] |
| Lemon           | Citrus limon (L.) Osbeck | Antimicrobial properties | [11, 20] |
| Mint oil        | Mentha × piperita L. | Fragrance | [11, 19, 20] |
| Neroli          | Citrus × aurantium L. | Antiseptic properties | [11, 17] |
| Patchouli oil   | Pogostemon cablin (Blanco) Benth. | Fragrance | [11, 19] |
| Rose oil        | Rosa × damascena Herrm. | Antimicrobial, anti-inflammatory, and antioxidant properties, and moisturizing dry skin | [17, 19] |
| Rosemary oil    | Rosmarinus officinalis L. | Promotes hair growth | [17, 19] |
| Sandal oil      | Santalum album L. | Antidandruff properties | [17, 19] |
| Spike lavender  | Lavandula latifolia Medik. | Prevents hair loss | [17, 19] |
| Sri Lanka cinnamon | Cinnamomum zeylanicum Blume | Fragrance | [11] |
| Star anise      | Illicium verum Hook.f. | Antimicrobial properties | [11] |
| Sweet orange    | Citrus sinensis (L.) Osbeck | Antiseptic properties | [11, 20] |
| Melaleuca alternifolia (Maiden & Betche) Cheel | Carminative | | |
| Tea tree oil    | Melaleuca linariifolia Sm. | Antifungal properties | [17, 20] |
| Vetiver oil     | Chrysopogon zizanioides (L.) Roberty | Fragrance | [11, 19] |
Cosmetics. As CHEMEXCIL (Basic Chemicals, Cosmetics, 3.1.2. China and India as Premier Exporters of Herbal waxes used in cosmetic industry [11, 30, 55].

Herbal drugs utilized in TCM belong to the two categories called “antiaging products” and “moisturizer products.” Herbal skincare therapies have been popularly used in TCM. Most cosmetic products and TCM compounds in the production of cosmetic products is very much derived from the medicinal and pharmaceutical applications of TCM [57]. TCM uses approximately 5000 plant species in a wide variety of herbal products [58]. Table 4 indicates some commonly used medicinal plants in TCM for cosmetic treatments [104].

However, Angelica dahurica Fisch.ex Hoffm., Asarum sieboldii Miq., Asarum heterotropoides F.Schmidt, Astragalus propinquus Schischkin, Evodia rutaecarpa (A.Juss.) Hook.f. & Thomson, Hippophae rhamnoides L., Saccharina japonica (J.E.Areschoug) C.E.Lane, C.Mayes, Druehl & G.W.Saunders, Lavandula angustifolia L., Ligusticum striatum DC. (Benth. & Hook.fil.) Franch., Matricaria recutita L., and Pinus tabuliformis Carrière, which were listed in Table 4, are no longer considered cosmetic ingredients according to the IECIC 2015.

IECIC 2015 was the latest version issued by the China Food and Drug Administration (CFDA) in 2015. It is a list of existing cosmetic ingredients that have already been used in cosmetics in China. According to IECIC [105], 8783 cosmetic ingredients are allowed to be used in China. Approximately, one-third of these ingredients are classified as

Table 2: Plants containing natural dye/colorant compounds used in the cosmetic industry.

| English name      | Source plant                        | Chemical class          | Color                  | Reference(s) |
|-------------------|-------------------------------------|-------------------------|------------------------|--------------|
| Alkanet           | Alkanna tinctoria (L.) Tausch       | Alkanin                 | Red/purple             | [24, 25]     |
| Annatto           | Bixa orellana L.                    | Norbixin, bixin         | Orange/red             | [11, 22, 27] |
| Butterfly pea     | Clitoria ternatea L.                | Delphinidin             | Purple/blue            | [24, 25]     |
| Calendula         | Calendula officinalis L.            | Flavoanxthin            | Orange                 | [24, 25]     |
| Carrot            | Daucus carota L.                    | Beta-carotene           | Orange                 | [27]         |
| Catechu           | Senegalia catechu (L.) F.J.H. Hurter & Mabb. | Catechin               | Red                    | [25]         |
| Chamomile         | Matricaria recutita L.              | Chamazulene             | Blue                   | [24, 25]     |
| Dyer’s woad       | Isatis tinctoria L.                 | Alkaloid                | Blue (indigo)          | [11]         |
| European barberry | Berberis vulgaris L.                | Alkaloid                | Yellow-brown           | [11]         |
| French marigold   | Tagetes patula L.                   | Flavonoids              | Yellow                 | [11, 22, 27] |
| Grape vine        | Vitis vinifera L.                   | Anthocyanin             | Red/blue               | [11]         |
| Henna             | Lawsonia inermis L.                 | Naphthoquinone          | Red                    | [11, 22, 27] |
| Hibiscus          | Hibiscus rosa-sinensis L.           | Cyanidin-3-sophoroside, cyanidin-3-sambubioside, delphinidin-3-sambubioside | Red/pink | [27] |
| Indigo            | Indigofera tinctoria L.             | Indigotin               | Blue                   | [22]         |
| Iris              | Iris × germanica L.                 | Mangiferin, delphinidin | Purple/blue/green      | [24, 25]     |
| Madder            | Rubia tinctorum L.                  | Alizarin, purpurin      | Red/purple             | [11, 27]     |
| Paprika           | Capsicum annuum L.                  | Carotenoids             | Orange/red             | [11, 22]     |
| Persian walnut    | Juglans regia L.                    | Naphthoquinone          | Brown                  | [11]         |
| Pomegranate       | Punica granatum L.                  | Punicalagin             | Red/purple             | [22]         |
| Red beet          | Beta vulgaris L.                    | Betanin                 | Pink/red               | [11]         |
| Red cabbage       | Brassica oleracea L.                | Cyanidin-3-glucoside and delphinidin-3-glucoside | Pink/purple | [25] |
| Red sandalwood    | Pterocarpus santalimum L.f.         | Santalin                | Red                    | [22]         |
| Rosehip           | Rosa canina L.                      | Lycopene, beta-carotene | Red/orange             | [11, 22]     |
| Safflower         | Carthamus tinctorius L.             | Flavonoid               | Yellow/red             | [11, 22]     |
| Saffron           | Crocus sativus L.                   | Crocin, crocetin, picrocrocin, riboflavin | Yellow                | [22, 27]     |
| Sappanwood        | Caesalpinia sappan L.               | Anthocyanin             | Red                    | [24, 25]     |
| Spinach           | Spinacia oleracea L.                | Chlorophyll             | Green                  | [25]         |
| Tomato            | Solanum lycopersicum L.             | Lycopene                | Red/orange             | [22]         |
| Turmeric          | Curcuma longa L.                    | Polyphenol              | Bright yellow          | [11, 22, 27] |

lipsticks, mascara, foundations, and eye shadows for their emollient, moisturizing, thickening, and emulsifying properties. Kokum butter (Garcinia indica (Thouars) Choisy), Sal butter (Shorea robusta Gaertn.), Ilife butter (Shorea stenoptera Burck), avocado butter (Persea americana Mill.), cocoa butter (Theobroma cacao L.), carnauba wax (Copernicia prunifera (Mill.) H.E.Moore), candelilla wax (Euphorbia spp.), berry wax (Rhus verniciflua Stokes), sunflower wax (Helianthus annuus L.), and rice bran wax (Oryza sativa L.) are the most commonly used plant-derived fats and waxes used in cosmetic industry [11, 30, 55].

3.1.2. China and India as Premier Exporters of Herbal Cosmetics. As CHEMEXCIL (Basic Chemicals, Cosmetics, and Dyes Export Promotion Council), set up by the Ministry of Commerce and Industry, Government of India, and Singh [56] highlight, China is the largest exporter of herbal cosmetics. Traditional Chinese medicine (TCM) has a deep history of herbal cosmetics production. There are plentiful instances where herbal skincare therapies have been popularly used in TCM. Most cosmetic products belong to the two categories called “antiaging products” and “moisturizer products.” Herbal drugs utilized in TCMs for medicinal purposes are used in cosmetics and personal care products. Therefore, the use of TCM compounds in the production of cosmetic products is very much derived from the medicinal and pharmaceutical applications of TCM [57]. TCM uses approximately 5000 plant species in a wide variety of herbal products [58]. Table 4 indicates some commonly used medicinal plants in TCM for cosmetic treatments [104].
Table 3: Some commonly used plant-derived oils in cosmetic products.

| Oil                  | Source plant               | Properties                                                                 | Reference(s) |
|----------------------|----------------------------|---------------------------------------------------------------------------|--------------|
| Almond oil           | *Prunus dulcis* (Mill.) D.A.Webb | Reduces hypertrophic scarring, smoothing, rejuvenating, emollient, improving complexion and skin tone, anti-inflammatory, immunity-boosting | [31, 32]     |
| Apricot kernel oil   | *Prunus armeniaca* L.      | Nourishing, revitalizing, emollient                                       | [33]         |
| Avocado oil          | *Persea americana* Mill.   | Hydrating, regenerating, antiaging, antiwrinkle, stimulating hair growth, having extraordinary transdermal penetration capacity | [34]         |
| Brazil nut oil       | *Bertholletia excelsa* Bonpl. | Antioxidative                                                             | [35]         |
| Camellia oil         | *Camellia sinensis* (L.) Kuntze | Antimicrobial, antioxidative, antiallergic, antiviral, skin healing properties, antiwrinkle | [36]         |
| Carrot oil           | *Daucus carota* L.         | Antiaging, antioxidative, suntan accelerator, photo protection, hair colour protection, emollient | [37]         |
| Cashew nut oil       | *Anacardium occidentale* L. | Antiaging, restoring moisture, smoothing                                 | [38]         |
| Castor oil           | *Ricinus communis* L.      | Emollient, lubricant, nourishing                                         | [39, 40]     |
| Coconut oil          | *Cocos nucifera* L.        | Emollient, hydrating, lubricating, cooling, soothing                      | [32]         |
| Corn oil             | *Zea mays* L.              | Antioxidative, nourishing, antiaging, regenerating damaged cell membranes |             |
| Cotton seed oil      | *Gossypium hirsutum* L.    | Emollient, cleansing, antioxidative, anti-inflammatory, soothing          | [41]         |
| Jojoba oil           | *Simmondsia chinensis* (Link) C.K. Schneid. | Emollient, anti-inflammatory                                             | [42]         |
| Linseed oil          | *Linum usitatissimum* L.   | Soothing, healing, immune booster, antiacne, antibacterial               | [32]         |
| Marula oil           | *Sclerocarya birrea* (A.Rich.) Hochst. | Antiseptic, astringent                                                  | [43]         |
| Neem oil             | *Azadirachta indica* A.Juss. | Moisturizing, occlusive                                                  | [44]         |
| Peanut oil           | *Arachis hypogaea* L.      | Emollient, anti-inflammatory                                             | [32, 46]     |
| Pine nut oil         | *Pinus pinea* L.           | Nourishing, curative, antiaging                                          | [47]         |
| Pumpkin seed oil     | *Cucurbita pepo* L.        | Antibacterial, antioxidative, anti-inflammatory                           | [48]         |
| Rice bran oil        | *Oryza sativa* L.          | Antioxidative, antiaging                                                 | [49, 50]     |
| Sesame oil           | *Sesamum indicum* L.       | Antioxidative, antiaging, healing effect                                  | [32]         |
| Soybean oil          | *Glycine max* (L.) Merr.   | Anti-inflammatory, skin lightening, antioxidative, antiaging, photoprotective | [51]         |
| Starflower oil       | *Borago officinalis* L.    | Skin barrier repair effect, anti-inflammatory                            | [32]         |
| Sunflower seed oil   | *Helianthus annuus* L.     | Emollient, moisturizing, nourishing, conditioning, antioxidative, antimicrobial | [32]         |
| Walnut oil           | *Juglans regia* L.         | Antioxidative, moisturizing, antimicrobial, nourishing                    | [52, 53]     |
| Watermelon seed oil  | *Citrullus lanatus* (Thunb.) Matsum. & Nakai | Nourishing, soothing, skin lightening, moisturizing                      | [54]         |

“botanical extracts.” However, many of these ingredients are various formulations of the same plant material [104]. Cosmetic ingredients that are not listed are regarded as new cosmetic ingredients. Therefore, new cosmetic ingredients, including botanicals, must be approved by CFDA first before they can be used in cosmetics in China. Furthermore, more information about the approved cosmetic plant ingredients can be found from this link (http://www.cirs-reach.com/China_Chemical_Regulation/SFDA_Registration_of_New_Cosmetic_Ingredient_in_China.html).

In India, traditional medicine literature like the Ayurveda has proved the concept of using herbs for beautification in the past. The cosmetic preparations were used for worship and sensual enjoyment. Moreover, herbal extracts have been used for various skin and hair ailments and for enhancing the overall appearance over centuries. Over the last couple of decades, the Indian cosmetics industry has witnessed rapid and strong growth. Today, it is recognized as one of the emerging industries with immense growth potential [106]. Next to China, India is the largest producer of medicinal plants, and India owns more than 40% of global diversity [16]. According to the research report [107], India is one of the 12 mega biodiverse countries around the world. In India, nearly 45,000 plants are used in the Indian system of medicine, while 9,500 plant species are used by tribals in their daily requirements. Out of these 9500 species, 7,500 plants have direct medicinal use, while 950 are giving new leads and claims that require scientific scrutiny [108]. Furthermore, in India, more than 70% of the population uses herbal cosmetics for health care [109]. However, as indicated in the “International cosmetic ingredient dictionary and handbook” issued in 2016, India has not been included as the country that recognizes the need for uniformity in cosmetic ingredient nomenclature and has not formally identified dictionary (potential cosmetic ingredients) in its regulations [110]. Table 5 lists the most common herbal plants used for cosmetics and toiletries in India.
| Source plant | English name | Plant part | Function and usage | Reference/Notes |
|--------------|--------------|------------|--------------------|-----------------|
| *Achyranthes bidentata* Blume | Ox knee | Root | Anti-inflammatory, antioxidant, antiaging properties | [59] |
| *Adenophora stricta* Miq. | Lady bell | Root | Humectant and skin conditioning | [60] |
| *Angelica dahurica* (Hoffm.) Benth. & Hook.f. ex Franch. & Sav. | Chinese angelica | Root | Anti-inflammatory and antioxidant properties | [61] |
| *Angelica sinensis* (Oliv.) Diels | Female ginseng | Root | Anti-inflammatory and antioxidant properties | [61] |
| *Asarum sieboldii* Miq. | Chinese wild ginger | Whole plant | Anti-inflammatory properties | [62] |
| *Asarum heterotropoides* F.Schmidt | Mongolian milkvetch | Root | | |
| *Astragalus propinquus* Schischkin | Chinese arborvitae | Shoot | Antimicrobial, antioxidant, antiaging properties | [63] |
| *Bletilla striata* (Thunb.) Rchh.f. | Chinese ground orchid | Rhizome | Anti-inflammatory and antioxidant properties | [64] |
| *Bupleurum falcatum* L. | Chinese thoroughwax | Root | Anti-inflammatory and antioxidant properties | [64] |
| *Calendula officinalis* L. | Scotch marigold | Flower, leaves | Used in numerous cosmetic formulations, i.e., creams, lotions, shampoo | [65] |
| *Camellia sinensis* (L.) Kuntze | Tea | Leaves | Relieving skin damage and promoting wound healing | [66] |
| *Centella asiatica* (L.) Urb. | Asiatic pennywort | Leaves | Wound healing, anti-inflammatory, antiviral, antibacterial, antifungal, and antioxidant properties | [67] |
| *Chrysanthemum indicum* L. | *Chrysanthemum* | Stem, flower | Anti-inflammatory properties | [68] |
| *Cimicifuga dahurica* (Turcz. ex Fisch. & C.A.Mey.) Maxim. | Silberkerze | Root | Anti-inflammatory, antiviral, and antioxidant properties | [69] |
| *Coptis chinensis* Franch. | Goldthread | Rhizome | Antimicrobial properties | [70] |
| *Eucommia ulmoides* Oliv. | Eucommia | Bark | Antioxidant, anti-inflammatory, antimicrobial, and antiaging properties | [71] |
| *Evodia ruticarpa* (A.Juss.) Hook.f. & Thomson | Evodia | Fruit | | |
| *Forsythia suspensa* (Thunb.) Vahl | Weeping forsythia | Fruit | Anti-inflammatory, antioxidant, antiviral, antibacterial properties | [72] |
| *Ginkgo Biloba* L. | Maidenhair tree | Leaves | Antiaging properties | [73] |
| *Glycyrrhiza glabra* L. | European liquorice | Root | Antiaging, anti-inflammatory, and antioxidant properties | [74] |
| *Glycyrrhiza uralensis* Fisch. | Chinese liquorice | Root | Skin conditioning, antioxidant, and anti-inflammatory properties | [75, 76] |
| *Hippophae rhamnoides* L. | Sea buckthorn | Fruit | | |
| *Saccharina japonica* (J.E.Areschoug) C.E.Lane, C.Mayes, Druehl & G.W.Saunders | Brown algae | Whole plant | | |
| *Lavandula angustifolia* Mill. | Common lavender | Flower, leaves | | |
| *Lentinus edodes* (Berk.) Singer | Shiitake mushroom | Mushroom | Antimicrobial, anti-inflammatory, and antioxidant properties | [77] |
| *Leonurus japonicus* Houtt. | Chinese motherwort | Fruit | Moisturizing, antiaging, and antioxidant properties | [78] |
| *Ligusticum striatum* DC. | Szechwan lovage | Root | Antimelanogenic and moisturizing properties | [79] |
| *Ligusticum sinense* Oliv. | Chinese lovage root | Rhizome | | |
| *Ligustrum lucidum* W.T. Aiton | Chinese privet | Root | Promoting growth and darkening of hair, reducing facial dark spots | [80] |
Table 4: Continued.

| Source plant                  | English name      | Plant part            | Function and usage                                                                 | Reference/ source |
|-------------------------------|-------------------|-----------------------|-----------------------------------------------------------------------------------|-------------------|
| *Lycium chinense* Mill.        | Wolfberry         | Fruit                 | Antiaging, anti-inflammatory, and antioxidant properties                           | [81]              |
| *Magnolia biondii* Pamp.       | Chinese willow    | leaves magnolia       | Anti-inflammatory and antimicrobial properties                                     | [82]              |
| *Magnolia officinalis* Rehder & E.H. Wilson | Houpu magnolia | Flower               | Antioxidant and anti-inflammatory properties                                        | [83]              |
| *Matricaria reticulata* L.     | Scented mayweed   | Flower, seed          | Antioxidant, anti-inflammatory, antimicrobial, and antiviral properties             | [84]              |
| *Morus alba* L.                | Mulberry          | Fruit                 | Tyrosinase inhibitors activity                                                    | [85]              |
| *Nelumbo nucifera* Gaertn.     | Lotus             | Leaves                | Reduction of hyperpigmentation and antiwrinkling properties                         | [86]              |
| *Paeonia × suffruticosa* Andrews | Peony            | Leaves, root          | Antioxidant, anti-inflammatory, and antiaging properties                            | [87]              |
| *Panax ginseng* C.A. Mey.      | Asian ginseng     | Leaves                | Antiaging and antiwrinkling properties                                             | [88]              |
| *Phellodendron amurense* Rupr. | Amur cork tree    | Bark                  | Used to treat acne                                                                 | [89]              |
| *Pinus tabuliformis* Carriere  | Chinese red pine  | Wood, leaves          | Anti-inflammatory and healing properties                                           | [90]              |
| *Polygonatum officinale* All.  | Solomon’s seal    | Root                  | Potent tyrosinase inhibition, anti-inflammatory, antimicrobial, antiviral properties| [91]              |
| *Polygonum caspidatum* Siebold & Zacc. | Japanese knotweed | Root                 | Used for promoting hair growth and treating early hair greying (blackening). Antiaging, antioxidant, antimicrobial, and radioprotective properties | [92]              |
| *Polygonum multiflorum* Thunb. | Chinese knotweed  | Leaves, root tuber, rhizomes | Anti-inflammatory and antioxidant properties                                       | [93]              |
| *Prunus armeniaca* L.          | Apricot           | Seed                  | Used to treat premature aging, greying hair, and wrinkles                           | [94]              |
| *Rehmannia glutinosa* (Gaertn.) DC. | Rehmannia       | Root                  | Antiaging and anti-inflammatory properties                                          | [95]              |
| *Rhodiola rosea* L.            | Golden root       | Rhizome               | Anti-inflammatory and antioxidant properties                                        | [96]              |
| *Salvia miltiorrhiza* Bunge    | Chinese sage      | Root                  | Antimicrobial, antioxidation, and UV protection effects, and it can be used as a skin-whitening ingredient in the beauty industry because of its ability to inhibit melanin synthesis | [97]              |
| *Scutellaria baicalensis* Georgi | Chinese skullcap  | Root                  | Antioxidant and UV B-protective properties                                          | [98]              |
| *Silibum marianum* (L.) Gaertn. | Milk thistle      | Seed                  | Slowing down skin (photo) aging                                                    | [99]              |
| *Sophora flavescens* Aiton     | Korean cream pea  | Root                  | Reduction of skin hyperpigmentation                                                | [100]             |
| *Tribulus terrestris* L.       | Land caltrops     | Fruit                 | Antiaging, anti-inflammatory, and antioxidant properties                            | [101]             |
| *Vitis vinifera* L.            | Grape             | Fruit, seed           | Antifungal, anti-inflammatory, and antioxidant properties                         | [102]             |
| *Zanthoxylum alatum* Roxb.     | Prickly ash       | Bark                  | Used for scouring teeth                                                            | [103]             |

*The plants that were not included in the “Inventory of Existing Cosmetic Ingredients in China (IECIC)-2015.”

3.2. Sri Lanka as an Example for Tropical Asian Country: Possible Contribution to the Development of Herbal Cosmetics. Sri Lanka, formerly known as Ceylon, is an island with an area of approximately 65,610 km². Despite its relatively small size, Sri Lanka possesses a high level of biodiversity because of its varied climate and topographical conditions. In view of that, it is recognized as a biodiversity hotspot of global and national importance. Sri Lanka has a traditional system of medicine, which is as ancient as the civilization of the island and practiced from generation to generation [116]. Natural resources, including herbal, mineral, and animal products, are the key resources of the Ayurveda and indigenous systems of medicine in Sri Lanka. Since time immemorial, plants have been playing a
### Table 5: Most common herbal plants used for cosmetics and toiletries in India.

| Category | Source plant | English name | Plant part | Function and usage | Reference(s) |
|----------|--------------|--------------|------------|--------------------|---------------|
| Skin care | *Mangifera indica* L. | Mango | Plant | Antioxidant properties | [109, 111] |
|          | *Juniperus communis* L. | Juniper | Whole plant | Rejuvenation properties | [109, 111] |
|          | *Cuscuta reflexa* Roxb. | Dodder | Whole plant | Antimicrobial properties | [109, 111] |
|          | *Phyllanthus emblica* L. | Indian gooseberry | Fruit | Antioxidant properties | [109, 111–113] |
|          | *Withania somnifera* (L.) Dunal | Winter cherry | Whole plant | Antioxidant properties | [109, 111] |
|          | *Cullen coryfolium* (L.) Medik. | *Psoralea* | Seeds | Antimicrobial properties | [109, 111] |
|          | *Matricaria chamomilla* L. | Chamomile | Leaves | Antiacne properties, skin fairness properties | [109, 111] |
|          | *Prunus dulcis* (Mill.) D.A.Webb | Almond | Kernel | Antiacne properties | [109, 113] |
|          | *Lagerstroemia speciosa* (Lam.) Pers. | Giant crape-myrtle | Leaves | Antifungal properties | [109] |
|          | *Cydonia oblonga* Mill. | Quince | Seeds | Beautification and skin protection | [109, 111] |
|          | *Genus Arctium* | Burdock | Root | Deep cleaning the pores and purifying the surface of the skin | [109] |
|          | *Jasminum grandiflorum* L. | Spanish Jasmine | Flowers | Controlling skin diseases, protecting from sunburn | [109, 111] |
|          | *Santalum album* L. | Sandalwood | Hardwood | Antioxidant properties and beautification | [109, 111] |
|          | *Salvia hispanica* L. | Chia | Seeds | Antiacne properties | [109, 111] |
|          | *Euphorbia thymifolia* L. | Milk wort | Plant | Antimicrobial properties | [109, 111] |
|          | *Cucumis sativus* L. | Cucumber | Peel | Cooling, toning, and skin-tightening properties | [109, 111] |
|          | *Butea monosperma* (Lam.) Taub. | Bastard teak | Leaves and seeds | Antiaging properties | [109] |
|          | *Allium sativum* L. | Garlic | Cloves | Controlling sores, pimples, and acne | [109, 111] |
|          | *Aloe vera* (L.) Burm.f. | Aloe | Leaves | Improving skin smoothness, healing, controlling skin burn | [109, 111] |
|          | *Genus Vitis* | Grape | Seeds | Protecting skin elasticity | [109, 113] |
|          | *Curcuma longa* L. | Turmeric | Rhizome | Anti-inflammatory and antioxidant properties | [109, 111–113] |
|          | *Asparagus officinalis* (Link) Link | Thimble | Leaves | Controlling scabies, skin psoriasis, chronic skin, skin eruption, and eczema | [109, 111] |
|          | *Mallotus philippensis* (Lam.) Müll.Arg. | Monkey face tree | Flowers | Controlling scabies ringworm, leprous eruption | [109, 111] |
|          | *Rosa × damascena* Herrm. | Damask rose | Flowers | For beautification, smoothness, and protection from sunburns | [109, 111, 113] |
|          | *Lavandula vera* DC. | Lavender | Inflorescence | Antiacne properties | [109, 111] |
|          | *Lepidium meyenii* Walp. | Maca | Root | Promoting elasticity and maintaining the suppleness of the skin | [109] |
|          | *Allanthis excelsa* Roxb. | Tree of heaven | Leaves | Checking skin eruption | [109, 111] |
|          | *Zea mays* L. | Maize | Stigma | Rejuvenation properties | [109, 111] |
|          | *Cocos nucifera* L. | Coconut | Kernel | For skin itching and rashes | [109, 111, 113] |
|          | *Azadirachta indica* A.Juss. | Neem | Bark, seeds, fruits and leaves | Antioxidant properties | [109, 111–113] |
|          | *Citrus limon* (L.) Osbeck | Lemon | Fruit | Reducing skin itching and nourishing the skin | [109, 111] |
|          | *Senna tora* (L.) Roxb. | Sickle senna | Leaves and seed | Antimicrobial properties | [109, 111] |
|          | *Carica papaya* L. | Papaya | Leaves and seed | Improving skin softness and removing blemishes | [109, 111] |
|          | *Plukenetia volubilis* L. | Mountain peanut | | Promoting skin elasticity | [109] |
|          | *Genus Hippophae* | Sea buckthorn | | Nourishing the skin | [109] |
|          | *Genus Helianthus* | Sunflower | | Enhancing the brightness of the skin | [109, 113] |
|          | *Sesamum indicum* L. | Sesame | Seeds | Rejuvenation properties | [109, 111] |
|          | *Ocimum basilicum* L. | Basil | Leaves | Protecting from skin infections and rejuvenation properties | [109, 111] |
|          | *Plukenetia stratiotes* L. | Water lettuce | Leaves | Controlling chronic skin disorders | [109, 111] |
|          | *Justicia adhatoda* L. | Malabar nut | Leaves | Protecting skin and controlling scabies | [109, 111] |
| Category     | Source plant                          | English name | Plant part     | Function and usage                                                                 | Reference(s) |
|--------------|---------------------------------------|--------------|----------------|------------------------------------------------------------------------------------|---------------|
| Hair care    | Juglans regia L.                      | Walnut       | Leaves and hull| Hair dyeing                                                                        | [109, 113]    |
|              | Aloe vera (L.) Burm.f.                | Aloe         | Gel            | Dissolving the dead skin cells and excessive sebum that can clog hair follicles     | [109, 113]    |
|              | Phyllanthus emblica L.                | Indian       | Fruit          | Promoting hair growth                                                               | [109, 111, 114]|
|              | Ocimium basilicum L.                  | Basil        |                | Anti-inflammatory properties, strengthening hair against breakage, and improving circulation in the hair follicles, which helps to stimulate growth | [109]         |
|              | Eclipta prostrata (L.) L.             | False daisy  | Herb           | Encouraging hair growth                                                             | [109, 111, 112]|
|              | Thymus serpyllum L.                   | Wild thyme   | Herb           | Useful for preparing hair tonics                                                    | [109, 111]    |
|              | Ficus racemosa L.                     | Cluster fig  | Aerial root    | Checking falling hairs                                                              | [109, 111]    |
|              | Terminalia bellirica (Gaertn.) Roxb.  | Belleric     | Seeds          | Use for hair dying preparation                                                      | [109, 111]    |
|              | Betula pendula Roth                   | Birch        | Leaves         | Antidandruff properties                                                             | [109, 111]    |
|              | Centella asiatica (L.) Urb.           | Pennywort    | Whole plant    | Improving circulation and promoting stronger hair growth                             | [109, 111, 114]|
|              | Terminalia chebula Retz.              | Ginger       | Seeds          | Use in hair care formulations                                                       | [109, 111]    |
|              | Lawsonia inermis L.                   | Henna        | Leaves         | Use for hair dyeing and nourishment                                                 | [109, 111–114]|
|              | Nardostachys jatamansi (D.Don) DC.    | Spikenard    | Rhizome        | Use in hair tonics for growth                                                       | [109, 111, 112, 114]|
|              | Lavandula angustifolia Mill.          | Lavender     | Inflorescence  | Stimulating circulation in the scalp, strengthening new hair growth, and helping balance the natural oil production of the scalp | [109]         |
|              | Calendula officinalis L.              | Marigold     | Flowers        | Smoothening effect of hair                                                           | [109, 111]    |
|              | Brassica spp.                         | Mustard      | Seeds          | Nourishing the hair                                                                 | [109, 111]    |
|              | Cocos nucifera L.                     | Coconut      | Kernel         | Use for preparing hair oils and tonics                                              | [109, 111, 113, 114]|
|              | Mentha × piperita L.                  | Peppermint   |                | Use as a healing scalp treatment                                                    | [109]         |
|              | Sapindus mukorossi Gaertn.            | Soap nut     | Fruit coat     | Natural shampoo and cleansing hair                                                  | [109, 111]    |
|              | Carthamus tinctorius L.               | Safflower    |                | Use in hair tonics                                                                  | [109, 111]    |
|              | Salvia officinalis L.                 | Sage         |                | Use as a hair conditioner                                                           | [109, 111]    |
|              | Acacia concinna (Willd.) DC.          | Soap pod     | Pods           | Use as hair cleanser and for control of dandruff                                    | [109, 111, 112, 114]|
|              | Sesamum indicum L.                    | Sesame       | Seeds          | Major source of hair oils and use for preparing specific hair oils                  | [109, 111, 114]|
|              | Nasturtium officinale R.Br.           | Watercress   |                | Supporting the stronger hair growth                                                 | [109]         |
vital role in the healthcare system of Sri Lankans’ livelihoods [117].

As specified in the literature, Sri Lanka has rich traditional systems of medicine, such as Ayurveda, Siddha, Unani, and Deshiya Chikitsa. It plays a pivotal role by fulfilling 60% to 70% of the rural populations’ primary health care needs [118]. Sri Lanka is one of the most biologically diverse countries in Asia and currently possesses 29.7% of forest cover [119]. There are 3,771 flowering plant species, out of which about 927 (24%) are endemic to the country [120]. According to Sugathadasa et al. [121], 1,430 species representing 181 families and 838 genera can be considered medicinal plants. Out of the total number of species, 174 (12%) are endemic to Sri Lanka. About 250 species of medicinal plants are commonly used in traditional medicine, of which 50 species are heavily used [122].

### Table 5: Continued.

| Category | Source plant | English name | Plant part | Function and usage | Reference(s) |
|----------|--------------|--------------|------------|-------------------|--------------|
| Oral care | Achyranthes aspera L. | Prickly chaff flower | Root | Use as a toothbrush, good for dental caries | [115] |
|          | Argemone mexicana L. | Mexican pricklypoppy | Seeds | Good for gum troubles | [115] |
|          | Azadirachta indica A.Juss. | Neem | Twigs | Use to clean teeth and is considered good for dental caries and gum infection | [113, 115] |
|          | Berberis lyicum Royle | Indian lyicum | Peeled stem | Considered good for scouring teeth | [115] |
|          | Calotropis procera (Aiton) Dryand. | Sodom | Latex | Used for toothache | [115] |
|          | Capsicum annuum L. | Paprika | Fruits | Good for toothache | [115] |
|          | Senna occidentalis (L.) Link | Coffee senna | Leaves | Use for scouring teeth | [115] |
|          | Cinnamomum tamala (Buch.-Ham.) T.Nees & Eberm. | Bay leaf | Leaves | Good for gum inflammation | [115] |
|          | Citrus limon (L.) Osbeck | Lemon | Leaves | Use for scouring teeth | [115] |
|          | Citrus medica L. | East Indian arrowroot | Rhizome | Appling on gums for pyorrhoea | [115] |
|          | Ficus hispida L.f. | Hairy fig | Latex | Use for toothache | [115] |
|          | Ipomoea carnea Jacq. | Bush morning glory | Leaves | Good for toothache | [115] |
|          | Jatropha curcas L. | Physic nut | Twigs | Use as a toothbrush | [115] |
|          | Juglans regia L. | Walnut | Bark and leaves | Use for scouring teeth | [115] |
|          | Mangifera indica L. | Mango | Leaves | Use for scouring teeth | [115] |
|          | Murraya koenigii (L.) Spreng. | Curry leaf | Stem | Use for scouring teeth and for healthy gums | [115] |
|          | Carya illinoinensis (Wangenh.) K.Koch | Pecan | Leaves | Used for scouring teeth | [115] |
|          | Plumbago zeylanica L. | Ceylon leadwort | Stem | Good for gums | [115] |
|          | Prunus cerasoides Buch.-Ham. ex D.Don | Himalayan cherry | Twigs | Use for scouring teeth | [115] |
|          | Psidium guajava L. | Guava | Leaves and stem | Use for scouring teeth | [115] |
|          | Robinia pseudoacacia L. | Black locust | Bark | Good for toothache | [115] |
|          | Vitex negundo L. | Chinese chaste tree | Twigs | Good for pyorrhoea, gum inflammation, dental caries | [115] |
|          | Zanthoxylum armatum DC. | Winged prickly ash | Twigs | Use for scouring teeth | [115] |

The study conducted by Kankanamalage et al. [123] reveals the sources of medicinal plant materials that are obtained for numerous medicinal plant-based trades. Approximately 71.13% of these medicinal plants/herbal materials are obtained from local sources, and 26% are imported. Moreover, it reveals that 80% of the fresh and dry plant materials contribute to the herbal industry. Thus, it implies the importance of medicinal plants in different systems of medicine in Sri Lanka. Moreover, the study conducted by Dissanayake [124] on “Medicinal plant research in Sri Lanka: A scientometric study based on Scopus database” highlights the research studies of 190 plants, including 22 endemic plants. It reveals that most of the conducted studies were activity-based studies, such as toxicity, antibacterial, antifungal, hypoglycemic, antioxidant, anti-inflammatory, and diuretic activities. It was followed by general studies, such as physicochemical, chemical, post-harvest, horticultural, and propagation studies of plants.
This study shows the largely unexplored knowledge gap of medicinal plants in Sri Lanka.

However, considering the herbal cosmetics in Sri Lanka, the available data on herbal cosmetics’ production and cosmetic potential medicinal plants are very scarce. Although the herbal cosmetic industry has exponentially increased throughout the world, the supply of potential cosmetic herbal products from Sri Lanka is still very limited. As Napagoda et al. [125] stated, only a handful of scientific evidence is available on the bioactivity studies of medicinal plants in Sri Lanka that could lead to the development of herbal cosmetics. Apart from the study on “cosmetic perspective of ethnobotany in the northern part of Sri Lanka,” [126] there has been hardly any ethnobotany report on the cosmetic potential of Sri Lankan medicinal plants. A total of 62 plant species belonging to 36 families have been identified based on the traditional knowledge and practices of the local community through this study. The identified plants are used for beautifying purposes, such as skin care, hair care, nail care, lip care, and eye care. However, the assembling of the multidisciplinary cooperation of botanists, chemists, toxicologists, researchers, and biologists is crucial to analyze interesting functional properties, efficacy, and effectiveness of documented cosmetic potential medicinal plants. Furthermore, Napagoda et al. [125] highlighted the probable usage of Atalantia ceylanica (Arn.) Oliv., Hibiscus fucatus Mullend., Leucas zeylanica (L.) W.T.Aiton, Mollugo cerviana (L.) Ser., Olax zeylanica L., and Ophiopogon nigricans L. for the development of photoprotective cosmetic products by analyzing the antioxidant activity and the sun protection factor (SPF). Moreover, the research study conducted by Liyanaarachchi et al. [9] reveals the possible usage of Artocarpus nobilis Thwaites, Artocarpus altillis (Parkinson ex F.A.Zorn) Fosberg, Elaeocarpus serratus Heyne, Curcuma aromatica, and Artocarpus heterophyllus Lam. in the treatment of various skin disorders, such as hyperpigmentation, wrinkling, premature aging, and biological aging by analyzing tyrosinase, elastase, and hyaluronidase enzyme inhibitory and antioxidant activities.

Furthermore, Dissanayake [124] reports that most of the medicinal plant-related studies in Sri Lanka are still on the laboratory scale. Thus, investigating the cosmetic potential medicinal plants, isolation of active compounds, and bioactivity studies of medicinal plants has become necessary for Sri Lanka to support herbal cosmetic productions and innovations.

3.2.1. Strengths of Sri Lanka as a Tropical Asian Country for the Development of Herbal Cosmetic Industry. Medicinal plants have played a pivotal role in many ancient traditional systems of medicine in Asia, such as the Ayurvedic and Unani systems of India and the traditional Chinese medicine and their derivatives in most Asian countries. Tropical Asian countries are unique among the geographical regions of the world because of high biological diversity, high cultural diversity, diverse ancient civilizations, and abundant raw materials. Because of their widely diversified ecological conditions, particularly in tropical rain forests, they have relatively high biological diversity that is the greatest of all world regions. This high diversity of the region is reflected by the number of species of plants and animals, including medicinal plants. The areas of high biological diversity are among the most culturally disparate, with large numbers of distinct communities inhabiting adjacent areas, each with its own language, culture, and system of traditional medicine. A wealth of traditional knowledge about medicinal plants to cure illnesses has been accumulated over a long period and has been handed down from generation to generation until the present time [127].

Medicinal plants have been used for centuries in medicinal, therapeutic, and beauty applications in Sri Lanka by different traditional systems of medicine, which have a documented history of over 2,500 years. Many formulae of medicinal preparations in the Sri Lankan traditional system of medicine are handed down from generation to generation. Some formulae are found only in the scripts of old “ola leaf” books treasured by traditional and Ayurvedic practitioners [128]. Table 6 lists the traditional usage of medicinal plants in Sri Lanka for cosmetic treatments.

As listed in Table 6, a total of 108 different plant species belonging to 58 families were identified from the books, “Compendium of medicinal plants, Sri Lankan study, Volume I to IV” and “A collection of medicinal plants in Sri Lanka.” The most dominant family was the family Fabaceae (13 plant species). A wide range of plant parts has been used for traditional cosmetic treatments. Based on the remedies, the identified plant parts were the leaves, bark, seeds, fruits, roots, flowers, rhizome, stem, heartwood, flower buds, tuber, gum, fruit rind, shoots, bulb, flower stamens, fruit kernel, inner bark, leaf gel, thorns, and wood. Medicinal plants are used in cosmetic treatments for various reasons, such as skin care, hair care, and oral care. Myristica fragrans Houtt. (Sadhihkka) and Kaempferia galanga L. (Ingurupiyali) are reported in all three cosmetic treatment categories. Furthermore, 04 plants, namely Ocimum tenuiflorum L. (Heen Maduruthala), Chrysopogon zizanioides (L.) Robery (Sawandara), Citrus hystrix DC. (Gada dehi), and Curcuma zedoaria (Christm.) Roscoe (Haran Kaha) are fragrant agents that have possible usage in the perfume industry.

The recent survey conducted by Gamage et al. [12] discloses the current usage of 115 plant species in herbal cosmetic productions in Sri Lanka. Furthermore, this study highlights the lack of proper cultivation systems of medicinal plants with cosmetic potential within the country for continuous herbal cosmetic productions. Although established cultivation systems are available for some highly used plants in the herbal cosmetic industry of Sri Lanka, such as Aloe vera (L.) Burm.f., most of the other medicinal plant materials are obtained either from the wild or through importation. Consequently, harvesting restrictions were imposed by the government for some wild species, such as Coscinium fenestratum (Goetgh.) Colebr. The adulteration of medicinal plant materials, lack of growers, declining suppliers, and lack of proper cultivation systems are major hindrances to the success of the herbal cosmetic industry in Sri Lanka.
| No | Family         | Scientific name                  | English name       | Vernacular name      | Traditional uses                                                                 | Reference/s |
|----|----------------|----------------------------------|--------------------|----------------------|---------------------------------------------------------------------------------|-------------|
| 1  | Acanthaceae    | Barleria prionitis L.*           | Crossandra         | Katu karandu          | The juice of the crushed leaves is applied to promote skin and scalp health.     | [116, 129]  |
| 2  | Justicia adhatoda L. | Malabar nut                  | Adhatoda           |                      | Prevent early grey or white hair.                                              | [116]       |
| 3  | Acoraceae      | Acorus calamus L.*              | Sweet flag         | Wada-kaha            | Ground rhizome is applied for pediculosis and to improve skin complexion.        | [116, 130]  |
| 4  | Amaranthaceae  | Alternanthera sessilis (L.)      | Sessile joyweed    | Mukunuwenna           | Leaf juice promotes healthy hair and is used for manufacturing shampoo.          | [116, 130]  |
| 5  | Amaryllidaceae | Allium sativum L.*              | Garlic             | Sudulunu             | Ground garlic mixed with honey or mixed with turmeric and honey is applied for curing pimples. | [130]       |
| 6  | Annonaceae     | Annona muricata (L.) R.Br. ex DC. | Prickly custard apple | Katu-anoda          | The juice of crushed young leaves is applied for pediculosis.                    | [116, 129]  |
| 7  | Apioideae      | Centella asiatica (L.) Urb.      | Indian pennywort   | Gotukola             | The crushed leaves are used for damaged hair treatments and skin healing.        | [116, 131]  |
| 8  | Apocynaceae    | Holarrhena pubescens Wall. ex G.Don* | Indian sarsaparilla | Iramusu            | The juice of the crushed leaves is applied to reduce hair loss and to improve skin complexion. | [116, 129]  |
| 9  | Caryota urens L.* | Wine palm                     | Kithul             |                      | The decoction of the bark is used as a mouth wash.                               | [131]       |
| 10 | Areca catechu L.* | Areca nut                     | Puwak              |                      | The decoction of the flowers is used as a mouth wash and is used in toothpaste manufacturing. | [116, 131]  |
| 11 | Cocos nucifera L. | King coconut/ Pol               | Thambili/ Coconut  |                      | The bark and tender flowers improve hair growth.                               | [116]       |
| 12 | Asparagus racemosus Willd. | Wild asparagus              | Hathawariya        |                      | The juice of the crushed leaves is applied to improve skin colour, promote hair growth, and prevent hair loss and early grey hair or white hair. | [130]       |
| 13 | Asparagaceae   | Aloe vera (L.) Burm.f.          | Aloe plant         | Komarika             | Possesses antiaging properties.                                                 | [116, 131]  |
| 14 | Asphodelaceae  | Eclipta prostrata (L.) L.      | False daisy        | Keekirindiya         | The juice of the crushed leaves is applied to improve skin complexion and to remove skin freckles. Sustaining youthful appearance, leaf gel is used to remove dead cells around the eye, freckles, and for curing pimples. | [116, 131]  |
| No | Family       | Scientific name                  | English name       | Vernacular name | Traditional uses                                                                 | Reference/s |
|----|--------------|----------------------------------|--------------------|----------------|----------------------------------------------------------------------------------|--------------|
| 16 | *Baccharoides anthelmintica* (L.) Moench* | Purple fleabane | Sanninayam         | Crushed seeds are applied to treat freckles | [132]         |
| 17 | Berberidaceae | *Berberis aristata* DC.*          | Indian barberry    | Daruharidra     | Crushed seeds with lime juice is applied for pediculosis                        | [131]        |
| 18 | Bombacaceae   | *Bombax ceiba* L.*                | Red silk cotton tree | Imbul           | The decoction of the bark is used as a mouth wash                              | [129]        |
| 19 | Brassicaceae  | *Brassica juncea* (L.) Czern.*  | Indian mustard     | Aba             | Crushed thrones are applied to improve the skin complexion, to remove freckles, and for curing pimples | [129]        |
| 20 | Calophyllaceae | *Mesua ferrea* L.                | Iron wood         | Na              | Seed oil is used for manufacturing soaps                                       | [116]        |
| 21 | Cannabaceae   | *Celtis timorensis* Span.*        | Stinkwood         | Gurenda/Burenda | Seed oil is applied on the hands and legs to soften the skin and improve the complexion | [116]        |
| 22 | Caricaceae    | *Carica papaya* L.                | Papaya            | Gaslabu         | The crushed flower stamens mixed with khas-khas powder is applied on the body to remove the malodors of the body, remove freckles, and improve complexion by frequent application | [116]        |
| 23 | Celastraceae  | *Kokoona zeylanica* Thwaites     | Kokun             | -               | Wood powder mixed with gingelly oil is applied on the skin for dryness to improve complexion | [116]        |
| 24 | Convolvulaceae | *Argyreia populifolia* Choisy*     | Sri Lankan elephant creeper | Giritilla       | Soaps made from the crushed bark with water have been used for bathing by men and women since ancient times | [132]        |
| 25 | Clusiaceae    | *Garcinia x mangostana* L.*      | Mangosteen         | Mangus          | The bark powder is used to treat pimples and to improve skin complexion         | [116]        |
| 26 | Combretaceae  | *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.* | Arjuna myrobalan     | Kumbuk          | The decoction of the bark is used as a mouth wash for healthy gums and teeth    | [131]        |
| 27 | *Terminalia bellirica* (Gaertn.) Roxb. | Beleric myrobalan | Bulu              | It is used for manufacturing toothpastes                                       | [131]        |
| 28 | *Terminalia chebula* Retz. | Myrabalans | Aralu            | The bark powder mixed with honey is applied on pimples, and the bark is used for manufacturing toothpaste | [131]        |
| 29 | Convolvulaceae | *Argyreia populifolia* Choisy*     | Sri Lankan elephant creeper | Giritilla       | Possesses antiaging properties and is used to manufacture yellow colour dye     | [116, 129]  |
| 30 | *Cuscuta chinensis* Lam.* | Dodder | Agamula nathival | The juice of the young shoots is applied on the gums for sanitation              | [116]        |

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| No | Family       | Scientific name                          | English name              | Vernacular name     | Traditional uses                                                                 | Reference/s |
|----|--------------|------------------------------------------|---------------------------|---------------------|--------------------------------------------------------------------------------|--------------|
| 31 |              | *Evolvulus alsinoides*(L.)L.*            | Slender dwarf morning-glory | Vishnukranti       | Plant extracted oil is applied to promote healthy hair growth                  | [130]        |
| 32 | Costaceae    | *Ipomoea pes-caprae* (L.) R. Br.*        | Goats foot creeper        | Binthamburu         | The decoction of the leaves is used for foot health                            | [131]        |
| 33 |              | *Cheilocostus speciosus* (J.Koenig) C.D.Specht* | Crape ginger             | Thebu               | The bark is used to remove freckles, especially those that occurred during chicken pox | [132]        |
| 34 | Cucurbitaceae| *Cucumis melo* L.*                       | Bitter cucumber           | Gon kakiri          | The crushed fruit mixed with the nux-vomica tree (*Strychnos nux-vomica* L.) seeds is used to treat pimples | [131]        |
| 35 |              | *Cucumis sativus* L.                     | Cucumber                  | Pipingna            | Fruit slices are used to treat darkness under the eyes and are used for skin cooling, soothing, and healing | [116]        |
| 36 |              | *Trichosanthes cucumerina* L.*           | Wild snake gourd          | Dummalla            | The decoction of leaves is used to control early grey or white hair             | [131]        |
| 37 | Cyperaceae   | *Cyperus rotundus* L.                    | Nutgrass                  | Kalanduru           | Crushed tubers are used to treat acne                                           | [129]        |
| 38 | Dilleniaceae | *Dillenia retusa* Thunb.                 |                           | Godapara            | The fruit pulp is used to cleanse the scalp and promote healthy hair growth    | [116, 131]   |
| 39 | Ebenaceae    | *Diospyros malabarica* (Desr.) Kostel.*  | Riber ebony               | Timbiri             | The decoction of unripe fruit slices is used as a mouthwash or gargle for mouth sanitation | [116]        |
| 40 | Elaeocarpaceae| *Elaeocarpus serratus* L.                | Wild olive                | Weralu              | The leaves are boiled with true lime slices to clean the scalp and hair         | [116]        |
| 41 | Euphorbiaceae| *Jatropha curcas* L.                     | Purging nut               | Rata endaru         | The decoction of the bark is used for mouth sanitation                          | [116]        |
| 42 | Fabaceae     | *Abras precatorius* L.*                  | Wild liquorice            | Olinda              | Grounded seeds with true lime are used to treat acne                           | [116]        |
| 43 |              | *Caesalpinia bonduc* (L.) Roxb.*         | Molucca bean              | Kumburu             | Seeds’ oil is applied to cure pimples, and fried seeds’ powder is used for brushing the teeth | [131]        |
| 44 |              | *Crotalaria verrucosa* L.*               | Blue rattle weed          | Nil-adanahiriya     | Gargling and the infusion of young shoots and leaves promote mouth sanitation   | [116]        |
| 45 |              | *Entada rheedii* Spreng.*               | Elephant creepes mackay   | Pus well            | Seed kernel powder mixed with white sandalwood powder in true lime juice is used to treat pimples | [116, 132]   |
| 46 |              | *Indigofera tinctoria* L.                | Indigo                    | Nilawari            | The ground seeds, stem, and bark, along with water, are used to clean the scalp and hair along with water, are used to clean | [116]        |
| 47 |              | *Mimosa pudica* L.*                     | Sensitive plant           | Nidikumba           | Ground with false daisy, turmeric, and kurchi, it is applied to control hair loss, and the oil extracted from the leaves promotes hair growth | [116]        |
|    |              |                                         |                           |                     | The ground aerial parts with gingelly oil are applied on the skin because of healing properties, and a decoction of the roots is used as a mouth wash to improve mouth hygiene | [116]        |
| No. | Family                | Scientific name                     | English name     | Vernacular name | Traditional uses                                                                 | Reference/s |
|-----|-----------------------|-------------------------------------|------------------|-----------------|----------------------------------------------------------------------------------|--------------|
| 48  |                       | *Pongamia pinnata* (L.) Pierre       | Indian beech     | Karanda         | Seed oil is used in soap manufacturing because of its antimicrobial properties   | [130]        |
| 49  |                       | *Pterocarpus marsupium* Roxb.*      | Indian kino tree | Gammalu         | Dissolved dried gum in warm water is used as a mouthwash for healthy gums and teeth | [116, 131]  |
| 50  |                       | *Pterocarpus santalinus* L.f.       | Red sandalwood   | Rath-handun     | Crushed heartwood mixed with turmeric powder and milk is used to treat pimples and is used in soap manufacturing | [116, 130]  |
| 51  |                       | *Senna alata* (L.) Roxb.            | Candle bush      | Eththora        | The leaves are used in antiseptic soap manufacturing because of antimicrobial properties | [116, 129]  |
| 52  |                       | *Senna auriculata* (L.) Roxb.*      | Tanner’s cassia  | Ranawara        | Crushed flowers are applied to the skin to improve complexion                    | [130]        |
| 53  |                       | *Tephrosia purpurea* (L.) Pers.     | Purple tephrosia | Kathurupila     | The roots are used for mouth sanitation and are used in manufacturing toothpastes | [116, 131]  |
| 54  |                       | *Trigonella foenum-graecum* L.*     | Fenugreek        | Ululhal         | Boiled with unripe true limes to treat dandruff                                  | [131]        |
| 55  | Hypoxidaceae          | *Curculigo orchoides* Gaertn.*      | Black musale     | Binthal         | The crushed tuber has been used to improve the beauty of the face by men and women since ancient times | [131]        |
| 56  | Lamiaceae             | *Ocimum tenuiflorum* L.             | Holy basil       | Heen maduruthala| The extracted leaf oil is used as a fragrant agent, and the juice of the crushed leaves is used to treat pimples and freckles | [130]        |
| 57  |                       | *Pogostemon heyneanus* Benth.*      | Patchouli        | Gas-kollanoka   | Infusion of fresh or dried leaves is used as a mouthwash for healthy gums and teeth | [116]        |
| 58  |                       | *Premna obtusifolia* R.Br.*         | Heen midi        |                | Leaves mixed with coconut oil are used to clean the scalp and hair                | [130]        |
| 59  |                       | *Tectona grandis* L.f.*             | Teak             | Thekka          | Dried fruit powder promotes hair growth                                           | [116]        |
| 60  | Lauraceae             | *Cinnamomum verum* J.Presl.         | Ceylon cinnamon  | Kurundu         | The dried inner bark is used as a mouth wash for gum and teeth sanitation         | [116]        |
| 61  | Lecythidaceae         | *Barringtonia acutangula* (L.) Gaertn.* | Indian oak     | Midella         | Cinnamon powder mixed with honey is applied to treat pimples                     | [130]        |
| 62  |                       | *Careya arborea* Roxb.*              | Patana oak       | Kahata          | The decoction of the leaf, bark, and flower is used as a mouth wash for healthy, strong gums | [130]        |
| 63  |                       | *Couroupita guianensis* Aubl.*      | Cannon ball tree | Sal             | Bark gum is used to soften the skin                                             | [132]        |
| 64  | Lythraceae            | *Lawsonia inermis* L.               | Henna            | Marathondi      | Leaves stimulate the dermal fibroblast proliferation                             | [116]        |
| 65  |                       | *Punica granatum* L.                | Pomegranate      | Delum           | Leaves are boiled in water with true lime fruit pieces are used to treat grey or white hair, and the leaves stimulate hair growth and are used to colour nails | [116]        |
| 66  | Malvaceae             | *Abutilon indicum* (L.) Sweet*      | Country mallow   | Behetanoda      | The decoction of the roots and fruit rind is used as a mouth wash, and the decoction of the leaves is good for the eyes | [116, 131]  |
| 67  |                       | *Gossypium arboreum* L.*            | Cotton           | Kapu            | Crushed leaves are used as a mouth wash                                           | [131]        |
| No | Family          | Scientific name                     | English name       | Vernacular name | Traditional uses                                                                                                                                                                                                 | Reference/s |
|----|----------------|-------------------------------------|--------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 68 |                | *Abelmoschus moschatus* Medik.       | Musk mallow        | Kapukinissa     | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116, 129] |
| 69 |                | *Hibiscus rosa-sinensis* L.          | Shoe flower        | Pokuru wada     | Oil prepared by boiling the leaves and flowers with coconut oil or gingelly oil is applied to promote healthy hair growth, prevent early grey or white hair, hair loss, and dandruff. Crushed flowers and leaves are applied to remove suntan, to cure pimples, and to remove freckles on the skin. | [116]      |
| 70 | Meliaceae      | *Theobroma cacao* L.                | Coco               | Kokova          | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116]      |
| 71 |                | *Azadirachta indica* A.Juss.         | Neem               | Kohomba         | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [131]      |
| 72 | Menispermaeae  | *Coscinium fenestratum* (Goetgh.) Coelbr. | Calumba wood     | Weniwel         | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116, 130] |
| 73 | Moraceae       | *Ficus racemosa* L.                 | Country fig        | Attikka         | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [129]      |
| 74 | Myristiciaceae | *Myristica fragrans* Houtt.          | Nutmeg             | Sadhikka        | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116, 130] |
| 75 | Myrtaceae      | *Melaleuca leucadendra* (L.) L.     | Cajuput tree       | Lothsumbulu     | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116]      |
| 76 |                | *Syzygium aromaticum* (L.) Merr. & L.M.Perry | Clove             | Karabu          | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116, 129] |
| 77 |                | *Syzygium cumini* (L.) Skeels*       | Indian black berry | Madan           | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116, 130] |
| 78 | Nymphaeaceae   | *Nymphaea nouchali* Burm.f.         | Blue water lily    | Nil manel       | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [130]      |
| 79 | Oleaceae       | *Jasminum grandiflorum* L.          | Jasmine            | Samanpichcha    | Seeds’ paste is applied for skin itching, and chewing the seeds removes the malodor of the mouth.                                                                                                                   | [116, 130] |
| 80 |                | *Jasminum multiflorum* (Burm.f.) Andrews* | Sambac            | Geta pichcha    | Paste made by grinding the flower buds is applied on the skin for improved complexion.                                                                                                                             | [116]      |
| 81 | Oxalidaceae    | *Averrhoa bilimbi* L.*             | Bilimbi            | Bilin           | Paste made by grinding the flower buds is applied on the skin for improved complexion.                                                                                                                             | [116]      |
| No | Family          | Scientific name                    | English name     | Vernacular name | Traditional uses                                                                 | Reference/ Source(s) |
|----|----------------|------------------------------------|------------------|----------------|----------------------------------------------------------------------------------|----------------------|
| 82 | Pedaliaceae    | *Sesamium indicum* L.              | Gingelly         | Thel-thala     | Liniments to promote hair growth, possesses healing properties                    | [116]                |
| 83 | Phyllanthaceae | *Phyllanthus emblica* L.           | Emblic myrobalan | Nelli          | Used in manufacturing herbal hair oil, shampoo, conditioner, and skin care products | [131]                |
| 84 | Plantaginaceae | *Bacopa monnieri* (L.) Wettst.     | Thyme leaved     | Lunuwila       | Possesses antiaging properties and antidandruff properties                        | [116]                |
| 85 | Poaceae        | *Cymbopogon citratus* (DC.) Stapf | Lemon grass      | Sera           | Shampoo containing essential oil is effective for pediculosis and dandruff        | [116, 130]           |
| 86 |               | *Chrysopogon zizanioides* (L.)     | Khas-khas        | Sawandara      | Root-extracted oil is used in the perfume industry and soap manufacturing and is used as a fragrant agent, and the crushed roots are applied on the skin Root infusion is used as a mouthwash for mouth inflammations | [116, 130]           |
| 87 | Ponterderiaceae| *Monochoria vaginalis* (Burm.f.)  C.Presl | Oval leaved pondweed | Diyahabarala | The juice of the fruits in salt water is used as a mouthwash for healthy gums, and the crushed leaves are used to exfoliate the skin and for dermal fibroblast proliferation Crushed leaves are used to treat pimples Ripe fruit mixed with green gram powder is applied to improve skin complexion and can be used as an eye lotion Acts as a cleanser, unripe fruits are boiled with fenugreek to treat dandruff, fruits are ground with lotus leaves to treat pediculosis Fruit juice is used to treat dandruff and is used in aromatic baths and as a shampoo | [116, 129]           |
| 88 | Rubiaceae      | *Morinda citrifolia* L.*           | Indian mulberry  | Ahu            |                                                                                   | [116, 129]           |
| 89 |               | *Rubia cordifolia* L.              | Heart leaved     | Velmadata      | Crushed roots mixed with honey are used to remove freckles and skin discolorations | [130]                |
| 90 | Rutaceae       | *Acronychia pedunculata* (L.) Miq. | Claw flowered   | Ankenda        | Crushed leaves are used to treat pimples                                           | [116]                |
| 91 |               | *Aegle marmelos* (L.) Corrêa       | Bael fruit tree  | Beli           |                                                                                   | [116, 131]           |
| 92 |               | *Citrus aurantiifolia* (Christm.) Swingle | True lime       | Dehi           |                                                                                   | [131]                |
| 93 |               | *Citrus hystrix* DC.*              | Kaffir lime      | Gada dehi     |                                                                                   | [116]                |
| 94 |               | *Melicope lunu-ankenda* (Gaertn.) T.G. Hartley* | Lunu-ankenda |                                                                                   | [116]                |
| 95 |               | *Murraya koenigi* (L.) Spreng.*    | Curry leaf       | Karapincha    |                                                                                   | [129]                |
| 96 |               | *Ruta graveolens* L.               | Garden rue       | Aruda          |                                                                                   | [129]                |
| 97 | Santalaceae    | *Santalum album* L.                | Sandalwood       | Sudu handun   |                                                                                   | [116, 130]           |
| 98 | Sapindaceae    | *Schleichera oleosa* (Lour.) Merr. | Ceylon oak       | Kon            | Seed oil is applied to promote healthy hair                                        | [116]                |
However, a comparison between the plant list identified through this survey and the plant list identified from the local books shows the possible usage of 49 plant species in the herbal cosmetic industry as new ingredients. Thus, these findings can be utilized for inventing new products in the future. As global demand for herbal cosmetics increases, there are ample opportunities for Sri Lanka to expand global export with its unique biodiversity and a rich base of traditional knowledge. It will lead to the upliftment of people’s livelihoods and the county’s economic development.

3.2.2. Major Challenges and Possible Solutions for Sri Lanka to Develop Plant-Based Cosmetic Productions. At present, most developed countries’ cosmetic manufacturers are continuously probing for new products and ingredients of tropical origin because their raw materials often have interesting properties. The interesting properties of tropical origin ingredients could vary based on climatic and topographical conditions [11]. However, the Association of Southeast Asian Nations (ASEAN) integration report issued in 2015 clearly indicates that developing cosmetic products and cosmetic product markets based on indigenous ingredients is one of the major challenges [133]. The lack of ethnobotanical and ethnopharmacological surveys to identify the cosmetic potential plants, insufficient or absence of continuous supply of raw materials for production in line with the existing demand, lack of quality control of raw materials and finished cosmetic products, improper systematic cultivation systems for medicinal plants, poor postharvest practices, lack of innovations, and the lack of efficacy tests (in vivo and in vitro) to ensure the safety are the major challenges found in Sri Lanka for the development of the herbal cosmetic industry [12, 104, 123, 124, 134].

To overcome the aforementioned challenges, collecting information on medicinal plants, traditional drugs, ethnobotany, and ethnopharmacology related to cosmetic treatments with traditional practitioners, Ayurveda physicians, and local communities in each country is required. As most of the traditional knowledge on medicinal plants and treatments in Sri Lanka is passed from generation to generation within families, conducting ethnobotanical and ethnopharmacological surveys will aid to identify cosmetic potential plants, important plant parts, remedies while preserving the traditional knowledge. Furthermore, information gathered through surveys could ultimately be

### Table 6: Continued.

| No | Family       | Scientific name                  | English name | Vernacular name | Traditional uses                                                                 | Reference/   |
|----|--------------|----------------------------------|--------------|----------------|----------------------------------------------------------------------------------|---------------|
| 99 | Sapotaceae   | Mimusops elengi L.               | Bullet wood  | Munamal         | The decoction of the mature bark is used as a mouthwash for healthy gums and teeth, herbal toothpaste formulated with other plants is effective for oral hygiene | [116, 130]   |
| 100| Solanaceae   | Datura metel L.*                 | Datura       | Attana          | The root powder is applied on the gums for mouth sanitation                        | [116]         |
| 101| Symplacenae  | Symplocos cochinchenensis (Lour.) S. Moore* | Bommu      | Thae            | Bark decoction is used as a mouthwash for healthy gums                              | [116]         |
| 102| Theaceae     | Camellia sinensis (L.) Kuntze    | Tea          | Thae            | Possesses antiwrinkle properties                                                  | [116]         |
| 103| Vitaceae     | Leea indica (Bur. L) Merr.*       | Bandicoot   | Gurulla         | Crushed leaves are applied on skin patches to improve skin complexion              | [130]         |
| 104| Zingiberace  | Alpinia malaccensis (Burm.f) Roscoe | Rankihiriya |                | Flower bud juice in lukewarm water is used as a mouth wash for healthy gums and teeth | [116]         |
| 105| Curcuma longa | L.                            | Turmeric     | Ath kaha        | The crushed rhizome is used to improve skin complexion, prevents UV B-induced skin aging | [116]         |
| 106| Carcuma zedoaria | (Christm.) Roscoe                  | Zedoary     | Haran kaha      | Crushed rhizome improves skin complexion, and it is used as a fragrant agent       | [130]         |
| 107| Kaempferia galanga | L.*                           | Java galanga | Ingurupiyali    | Dried sliced rhizome infusion is used as a mouth wash, powdered rhizome with coconut oil on the skin to improve skin complexion, improves lustrous of hair, possesses antidandruff properties and skin whitening properties | [116, 129]   |
| 108| Zingiber officinale | Roscoe                          | Ginger       | Inguru          | Juice-extracted ginger pulp is applied on pimples, and it is used to improve skin complexion | [129]         |

*The plant species that are currently not used in the herbal cosmetic industry of Sri Lanka (in comparison with the survey conducted on “Emerging herbal cosmetic production in Sri Lanka: Identifying the possible interventions for the development of herbal cosmetic industry” [12]).
utilized to develop the herbal cosmetic industry by the isolation and characterization of bioactive compounds from identified plants. Cosmetic companies work with a wide range of suppliers to obtain botanical raw materials. These suppliers purchase plant biomass from a wide array of sources ranging from large to small scale. However, harvesting plants from the wild is still popular for many medicinal herbs among local suppliers. Consequently, overharvesting can reduce plant populations to the point where the species’ biodiversity is threatened, some species even to their extinction. Therefore, establishing proper systematic cultivation systems for identified medicinal plants is paramount. Furthermore, future research must be focused on nursery techniques, field establishments, and the harvest management of medicinal plants. Cultivated plant materials are preferred for the cosmetic industry as it is easier to control the whole supply chain and chemical variations. With the use of cultivated plants, problems such as adulteration and misidentification of material are mostly eliminated. It is also easier to adhere to quality standards and has less batch-to-batch variation as the plants are grown under controlled conditions. Furthermore, the utilization of biotechnology techniques, such as tissue culture, will benefit from preserving biodiversity by utilizing the endangered or unavailable plants using conventional production or wild-crafting. Product development and innovation are other key factors to succeed in the herbal cosmetic industry in Sri Lanka. The process to bring a medicinal plant from field to finished good can be quite complicated with many challenges along the way. Stability testing on raw materials to anticipate any issues with color change, odor, viscosity, precipitation, separation, or degradation of actives must be carried out routinely by cosmetic manufacturers. The characteristics of cosmetic products can be affected by environmental factors, such as temperature, pH, light, air, and humidity, which impact their stability contributing to severe damage to the constituents of the product [135]. Because of the wide variety of cosmetic products and their inherent complexity, it is hard to find standard stability tests that can be applied to a vast range of products. However, generally used stability tests can be categorized into several categories namely stability and physical integrity of cosmetic products (under appropriate conditions of storage, transport, and use), chemical stability, microbiological stability, and the compatibility between the contents and the container. For example, the organoleptic characteristics of cosmetic preparations, such as color, smell, texture, and consistency, can be evaluated by visual inspection. Additionally, several physicochemical analyses can be performed, such as centrifugation, mechanical vibration, light tests, pH, density, viscosity determination, and spectrophotometric assays, besides accelerated and microbial stability tests [136]. Quality control testing must be performed and continuously monitored to ensure its physical and analytical characteristics are up to standard. Some current techniques used by the cosmetic industry can be applied to the evaluation of cosmetic’s quality control in an efficient manner, such as sensory analysis, rheology, and small-angle X-ray scattering [137]. Efficacy/safety tests should be performed on medicinal plant ingredients as well. For instance, cosmetics companies can perform in vitro testing to screen for cell damage in skin cell cultures or irritation in skin construct models and animal testing to avoid adverse events. However, the European Commission Cosmetics Directive has executed an animal testing ban on finished cosmetic products and ingredients. In such situations, cosmetic manufacturers have to find an alternative method to ensure product safety. At present, many alternatives to animal testing have been developed and validated for the safety and efficacy testing of cosmetic products and cosmetic ingredients. For example, 2D cell culture models derived from the human skin for evaluating anti-inflammatory properties, or predicting skin sensitization potential and 3D human skin equivalent models for evaluating skin irritation potential and excised human skin are being currently used as the gold standard for evaluating dermal absorption [138]. If a medicinal plant ingredient is safe and stable, it can move on to the formulation phase, where it is added to a cosmetic formula and retested for the same parameters, safety, and stability. With careful management, cosmetic companies can offer innovative beauty products that enhance living standards while conserving natural resources, promoting economic development for the poor, and protecting the environmental resources of Sri Lanka [11, 104, 108, 124, 127, 139, 140].

In addition, the cosmetics industry must employ scientists from the discovery stage to product development. Universities can play an active role in medicinal plant research in Sri Lanka. Universities can initiate transferring technology to industries for product development using active natural compounds. In the discovery stage, many different strategies should be used, including monitoring consumer trends, evaluating scientific advances in developed countries for possible technology transfer opportunities, monitoring scientific publications, and press reports. Furthermore, external collaborations with universities, institutes, or non-governmental organizations will secure the supply chains of raw materials, gain certification of their raw materials, or find higher quality and more sustainable plant-based raw materials. For instance, collaborative research studies on medicinal plants between different faculties in the Wayamba University of Sri Lanka, faculty of agriculture and plantation management, faculty of technology, faculty of medicine, and the pioneer semigovernmental research organization, Industrial Technology Institute in Sri Lanka would be ideal for new discoveries in herbal cosmetics discipline by sharing knowledge and utilizing available facilities to a maximum extent in these two entities. Through these partnerships, the companies not only increase cosmetic manufacturers’ scientific knowledge and acquire innovative raw materials but also contribute positively to society [104, 124].

4. Conclusion

Medicinal plants provide accessible and culturally relevant sources of health care for most of the world’s human population. There has been an increase in preference for herbal beauty products globally in recent years with rising
consumer awareness regarding long-term health benefits. India and China have successfully utilized their traditional systems of medicine to become major producers in the global plant-based cosmetic industry. As cosmetic manufacturers in developed countries show their interest in herbal ingredients of tropical origin, Sri Lanka has a good potential to create numerous new avenues in herbal cosmetics, which can be easily capitalized on the global trends. However, the increasing interest in herbal cosmetics has raised important issues and highlighted vital gaps in the knowledge of cosmetics medicinal plants, their usages, cultivation technologies, postharvest technologies, and bioactivity studies in Sri Lanka. To overcome these issues, conducting ethnobotanical and ethnopharmacological surveys to identify medicinal plants with cosmetic potential, product development, and innovation in collaboration with universities, institutes, and non-governmental organizations are possible solutions. The study’s findings could ultimately be utilized for the development of the herbal cosmetic industry by the isolation and characterization of bioactive compounds from identified plants while preserving traditional knowledge.

Data Availability

The data used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this article.

Acknowledgments

The authors are thankful to the funding organization and Industrial Technology Institute (ITI) and National Science Foundation (NSF) in Sri Lanka for providing necessary facilities and support to the study. This review was written as part of the research project, “Systematic survey on flora with cosmetic potential, development of agronomic and post-harvest aspects for selected medicinal plants” (project number: WU/SRHDC/MPHIL/2017/86), funded by ALBION Co., Ltd, Japan.

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