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“A thing of beauty is a joy forever”. Plants and plant-based preparations for facial care in Suriname

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Abstract

People have probably used plant-based substances to improve their appearance since the existence of mankind. The first documented use of cosmetics dates back to 3,000 BC from ancient Egypt, but it is safe to say that this custom has been (and still is) an integral part of daily life in all civilizations. The initial use of plant-derived makeup - sometimes supplemented with paints and dyes - has come full circle and is back with the contemporary trend of using beauty products that are mainly derived from plant sources. The Republic of Suriname (South America) is renowned for its extensive ethnopharmacological knowledge and unique plant biodiversity that provides ample raw material that can be processed into cosmetics and cosmeceuticals. This paper gives some historical highlights on the use of makeup throughout the world with the emphasis on naturally-derived products; focuses on the herbal cosmetics industry in Suriname; extensively addresses the scientific rationale for incorporating extracts from plants in cosmetics and cosmeceuticals in the country; and concludes with the conditions to establish a beauty products industry in Suriname.

Introduction

Since times immemorial humans from all civilizations have used substances from a myriad of sources to increase their beauty, maintain a youthful appearance, heighten their sensuality, and, generally, preserve their health and hygiene [1,2]. Products that are used for these purposes are nowadays commonly known as cosmetics and cosmeceuticals. They are intended for ‘the art of beautifying’, the Latinized expression of the ancient Greek practices of ‘*kosmetike*’ and ‘*kosmetikos*’ meaning ‘the art of dress and ornament’ and ‘skilled in ordering or arranging’, respectively.

Cosmetics are articles for cleansing, beautifying, promoting the attractiveness, or positively altering the appearance of the body [1,2]. These products generally do not contain pharmacologically active ingredients, at least, not at the scientifically proven levels or in a delivery system to benefit the skin [1,2]. They are, furthermore, relatively safe, sold over the counter, and widely available from, among others, supermarkets, drug stores, salons, and on-line retailers. Typical cosmetics are lipsticks, eye shadows, moisturizers, toothpastes, regular shampoos and conditioners, hair dyes, fingernail polishes, and deodorants [1,2].

Cosmeceuticals - also called cosmedics or cosmedicals - are skin care products with bioactive ingredients with medicinal or drug-like benefits in addition to cosmetic features [1,2]. They contain active ingredients at scientifically proven levels that positively affect the skin and are in a delivery system that ensures penetration of the skin by the active ingredients [1,2]. These products can elicit structural changes in the skin and beneficial effects in skin conditions such as acne, hyperpigmentation, and ageing [1,2]. However, cosmeceuticals are not considered pharmaceutical products, do not require a medical prescription to dispense, and can regularly be used on the skin without risking major side-effects [1,2]. Examples of cosmeceuticals are natural and synthetic derivatives of vitamin A, antioxidants, anti-dandruff

shampoos containing an anti-fungal compound, sunscreens with proven sun protection factor, toothpastes supplemented with fluoride, and deodorants that contain antiperspirants [1,2].

Background

The ancient times

The discovery of red ochre including crayons from the African Middle Stone Age over 100,000 years ago [3] dates the application of cosmetic body art to the emergence of *Homo sapiens* in Africa [4]. Additional evidence for the early use of cosmetics comes from archeological finds demonstrating that already around 10,000 BC men and women in ancient Egypt used scented oils and ointments to clean and soften their skin and mask their body odor [5]. From about 3,000 BC on, the use of beauty products and makeup became more widespread in Egypt [6] and expanded to large parts of Africa and Asia [7].

Both men and women applied kohl as eyeliner and eyeshadow which also shielded the eyes from the hot sun and the dry winds [6,7] (Figure 1). People also protected their skin with balms and creams prepared from Castor oil; wore lipsticks containing extracts from red algae, sometimes enriched with a pearlescent substance from fish scales to obtain an iridescent effect; fought wrinkles with the aromatic resin frankincense from trees of the genus *Boswellia* (Burseraceae) and fresh *Moringa olifera* Lam. (Moringaceae); treated baldness and greying hair with a mixture of beeswax and resin; and chewed on licorice sticks from

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Figure 1. The British-American actress Elizabeth Taylor made up as the Egyptian queen Cleopatra (69 - 30 BC) in the 1963-movie 'Cleopatra' (from <https://goo.gl/images/x2IZx8>).

the roots of *Glycyrrhiza glabra* L. (Fabaceae) to improve their breath [5]. Important basic ingredients of most perfumes used in ancient (Egyptian) religious rituals were myrrh, thyme, marjoram, chamomile, lavender, lily, peppermint, rosemary, cedar, rose, aloe, olive oil, sesame oil, and almond oil [6,7].

Ancient Rome

The tradition of using makeup and beauty products carried on to ancient Rome, where around 100 AD it was incorporated into fashion and religion and became a vital part of everyday life [8]. Slaves bathed the aristocracy in perfume and Roman women daily used perfumes, body oils, skin creams, eye shadows, eye liners, powders, nail products, and teeth-whitening products. They also applied beauty masks to lighten their face as a sign of purity, while Roman men dyed their hair blond. Notably, a woman's social status, wealth, and attractiveness was determined by the makeup she wore and the clothes she was adorned in. In an effort to control lavish and self-indulgent expenditures on luxury and extravagance, the *Lex Oppia* was established in 215 BC which, among others, restricted the amount of beauty products and luxury services women could purchase and wear [9]. This law was revoked six years later, but the Ancient Romans took cosmetics to new heights and limits which may explain why Italy, specifically Milan, is one of the largest beauty empires of the world to this day.

The Middle Ages and the Renaissance

Cosmetics found their way to Europe during the Middle Ages and the Renaissance between 1,200 and 1,600 AD, after they were brought in from the Middle East in the wake of the Crusades [10]. Wearing makeup was then considered sinful and immoral and was heavily discouraged by church leaders but, nevertheless, grew in popularity. Particularly skin-whitening became fashionable among the aristocracy, as a paler skin complexion was associated with more leisure time to spend indoors and thus a higher social status [11]. This practice lasted until the twentieth century and made use of a broad variety of procedures ranging from the application of egg white and white powder on the face to self-bleeding and the use of deadly toxic substances such as white lead paint and arsenic [11]. One of the most revered users of white lead was Queen Elizabeth I of England (1533 - 1603) who created 'the Mask of Youth' [10,11] (Figure 2). Blonde hair also rose in popularity as it was considered angelic, and was achieved

by applying black sulphur, alum, and honey on the hair and having the mixture react with the hair in the sun [11].

The nineteenth century

The use of makeup experienced a decline in Europe in the nineteenth century, particularly after Queen Victoria from England (1819 - 1901) publicly declared it improper and vulgar and only acceptable for actresses and prostitutes [12]. 'Respectable' women wore in general as little makeup as possible which was, moreover, applied as discrete as possible. However, facial whitening was still practiced but was accomplished with zinc oxide powder instead of the deadly mixtures of lead and copper [12]. The use of cosmetics resurfaced at the end of the nineteenth century, but full makeup was still regarded as sinful and beauty products were usually home-made articles with natural tones.

The early twentieth century

Around 1910, makeup became increasingly more fashionable in Europe (as well as the USA) due to the influence of ballet and theatre stars. Colored makeup was introduced in Paris upon the arrival of the Russian Ballet in 1910 that typically used ochre and crimson shades. The start of the movie industry in Hollywood in the 1920s had a profound influence on cosmetics [13]. Movie stars such as Theda Bara - one of the most popular actresses of the silent movie era and one of cinema's earliest sex symbols - and her makeup artist Helena Rubinstein can be considered pioneers of the cosmetics industry [13]. Many other well-known manufacturers of beauty products such as Max Factor, Sr., Elizabeth Arden, Coco Chanel, and L'Oréal had their start in that period. Their products were in high demand and instilled self-awareness in American women of the 1920s. This led, among others, to the Flapper style which was characterized by daring dark eyes, red lipstick, and red nail polish, as well as a suntan [14] (Figure 3). Other accomplishments from that period are the eyebrow pencil, mascaras, synthetic hair dyes and nail polishes, as well as sunscreens.

Between 1939 and 1945 during the Second World War, cosmetics were in short supply throughout the entire world. This was for an important part attributable to the fact that petroleum and alcohol, basic ingredients of many beauty products, were desperately needed for the fabrication of fuels to fight the war. However, the post-war period led to a massive boom of the above-mentioned established corporations, but also to opportunities for newcomers such as Pond's who operated in the lower price range [15].



Figure 2. Queen Elizabeth I of England (1533 - 1603) wearing her 'mask of youth' (from <https://goo.gl/images/prQZBY>).

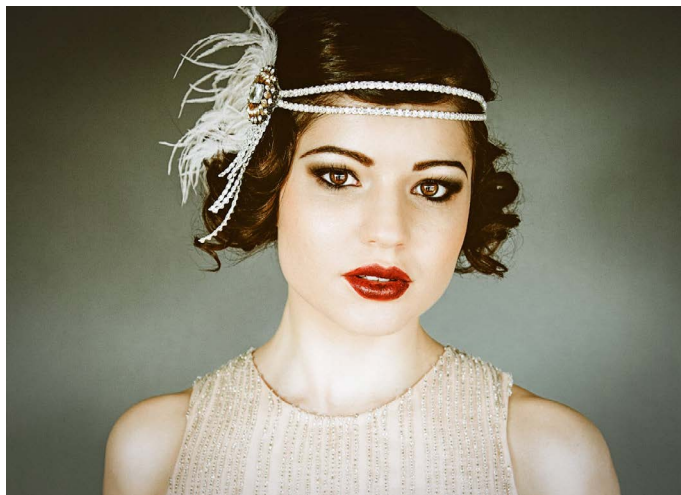


Figure 3. Characteristic 1920s Flapper style (from <https://goo.gl/images/DbKy3d>).

The late twentieth century

The feminism movement of the 1960s and 1970s led many women in the western world to abandon the use of beauty products as this would degrade women to sex objects [16]. One of the results of this trend was the development of more 'natural-looking' products in the 1970s. At the same time, non-allergic cosmetics and makeup with greater staying power in wear appeared, as well as new lipstick colors such as lilac, green, and silver rather than only the different shades of pink and red [16]. Also, an increasing number of males began to use cosmetics to enhance their facial features [17]. The concealer or color corrector developed to mask dark circles, age spots, large pores, and other small blemishes on the skin, became one of the most popular 'male cosmetics' [17].

The twenty-first century

The worldwide cosmetics and cosmeceuticals industry is currently among the largest in the world and had an estimated market price of over US\$ 200 billion in the year 2015 [18]. This value represented a growth of 4% when compared to the year before [18], which may be attributable to increases in global economies, changing lifestyles, and rising demands of skin and sun care products, as well as the exploitation of a new, profitable niche, naturally-derived beauty products. The leading markets are Asia and the Pacific region with a share of 36.9%, followed by North America and Western Europe with proportions of 24.8 and 19.3%, respectively [18]. Latin America, Eastern Europe, and Africa and the Middle East hold shares of 10.2, 6.0, and 2.9%, respectively [18]. The main players in 2015 were the L'Oréal Group (US\$ 28.02 billion), Unilever (US\$ 20.47 billion), the Procter & Gamble Company (US\$ 17.60 billion), Estée Lauder Companies, Inc. (US\$ 11.10 billion), and Shiseido Company, Ltd. (US\$ 7.11 billion) [18]. Skin care products accounted for 36.3% of global sales, hair care products for 22.9%, makeup for 18.2%, fragrances for 12.0%, and hygiene products for 10.5% [18]. These products were most frequently purchased from general department stores, supermarkets, drug stores, and brand outlets, and more recently, also on-line stores [18].

Back to the future

An important development in the modern cosmetics and cosmeceuticals industry is the returning trend of using herbal ingredients in cosmetic and cosmeceutical products [19]. As mentioned above and extensively reviewed by others [6,20,21], the use of herbal

beauty products is centuries old and represents the basis of the modern cosmetics and cosmeceuticals industry. Extracts from parts of aromatic and medicinal plants have been incorporated in perfumes and beauty products since ancient times [6,20,21]. And since the revived interest in makeup from the early 1900s on, the significance of naturally-derived substances to the cosmetic and cosmeceutical industry has dramatically increased [13,20]. This trend accommodates the increasing demand for natural or organic products by customers throughout the entire world, as the use of botanical products is believed to carry a lesser risk of undesirable effects [22] and may help preserve the environment from the detrimental effects of chemical waste products [22,23].

Background on Suriname

Geography, economy, and people

The Republic of Suriname has a surface area of approximately 165,000 km², is located on the north-east coast of South America and borders the Atlantic Ocean, and is situated adjacent to French Guiana, Guyana, and Brazil (Figure 4). Roughly 80% of the population of about 570,000 lives in the urban-coastal area comprising the capital city of Paramaribo and the Wanica district located in the narrow low-land coastal zone in the northern part of the country (Figure 4) [24]. The rural-coastal area of Suriname includes the districts of Marowijne, Commewijne, Saramacca, Coronie, and Nickerie (Figure 4), and is, together with the southern-rural interior consisting of the districts of Para, Brokopondo, and Sipaliwini (Figure 4), home to the remaining 20% of Suriname's inhabitants [24].

The latter part of the country (the hinterland) comprises more than three-quarters of Suriname's land surface, consists largely of sparsely inhabited savanna and dense, pristine tropical rain forest, contains high-quality fresh water and clean air, and harbors many endemic animal and plant species [25]. Suriname's very high biodiversity, notoriously fertile soils, and high mineral density sustain its most important means of subsistence, namely ecotourism, agriculture,



Figure 4. Map of the Republic of Suriname depicting the ten administrative districts as well as the location of the country in South America (insert).

fisheries, forestry, crude oil drilling, as well as gold and bauxite mining [26]. These activities contributed substantially to the country's gross domestic income in 2015 of US\$ 5.15 billion and the average per capita income in that year of US\$ 9,360 [26,27]. This positions Suriname on the World Bank's list of upper middle income economies [27].

Suriname is one of the smallest countries of South America. Nevertheless, it is renowned for its ethnic diversity comprising indigenous Amerindians; descendants from enslaved Africans brought in between the sixteenth and the nineteenth century called Creoles and Maroons; descendants from indentured laborers from China, India, and Indonesia who arrived between the second half of the nineteenth century and the first half of the twentieth century; descendants from various European countries; and more recently, immigrants from Latin American and Caribbean countries such as Brazil, Guyana, French Guiana, and Haiti [28]. All these ethnic groups have largely preserved their own specific identity including their ethnopharmacological practices [29]. This may result in a unique blend of traditional medicinal systems and an entirely novel form of complementary and alternative medicine [29].

Traditional medicine in Suriname

Despite the availability of affordable primary and secondary health care in both Suriname's coastal area and hinterland [30], the use of traditional medicines is deeply rooted in all ethnic groups and in all parts of Suriname. For instance, the centuries-old medicinal traditions of the indigenous Amerindians involve the use of more than three hundred plant species for treating approximately seventy-five distinct disease conditions and are still very much alive [31]. Importantly, many Amerindian disease descriptions closely correspond with those in Western allopathic medicine, and the treatments are often successful [31]. An example is the indigenous use of the dried leaves of the bitter melon *Momordica charantia* L. (Cucurbitaceae) (Figure 5) for treating the symptoms of diabetes mellitus, which is supported by the hypoglycemic effects of *M. charantia* preparations in various animal models [32].

Many traditional medicinal practices of Afro-Surinamese can directly be traced back to the ancient African belief that both physiological and psychological conditions result from an imbalance between 'hot' and 'cold' and can be reversed by removing the 'cold' [33].



Figure 5. The bitter melon *Momordica charantia* L. (Cucurbitaceae) (from <https://goo.gl/images/jLZSoR>).

Accordingly, Surinamese Creoles and Maroons may 'remove colds' and promote general health using kwasibita ('Kwasi's bitter'), an alcoholic extract of the bitterwood of *Quassia amara* L. (Simaroubaceae) [34]. This preparation was discovered around 1730 by the freedman Quassie van Timotibo (also known as Kwasi) who had successfully used it for treating malaria fevers and stomach troubles [35].

Examples of the dozens of medicinal plants introduced in Suriname by the Hindustani and the Javanese - the descendants from indentured laborers from India and Java (Indonesia), respectively - are the neem plant *Azadirachta indica* A. Juss. (Meliaceae) and the laos *Alpinia galanga* (L.) Willd. (Zingiberaceae), respectively. The bitter-tasting *A. indica* leaves are believed to boost the immune system and to treat, among others, colds, fevers, respiratory conditions, and chicken pox [36,37]. These applications may find their rationale in the anthelmintic, antifungal, antibacterial, and antiviral activities of nimbinin, one of the main bioactive compounds of *A. indica* [38]. The rhizomes of *A. galanga* are extensively used for treating the fungal skin infection 'lota' (pityriasis alba), as well as stomach cramps and dysentery [39]. This may be attributed to the potent antiparasitic properties of galangin, one of the bioactive constituents of this plant [40]. These applications have their origin in Indian Ayurveda and Indonesian Jamu, respectively.

An important medicinal plant introduced in Suriname by Chinese indentured laborers is the Mongolian milkvetch or huáng qí *Astragalus propinquus* Schischkin (Fabaceae). This plant is one of the fifty fundamental herbs of traditional Chinese medicine, and the rhizomes have since long been used in traditional Chinese medicinal systems [41]. Huáng qí preparations would strengthen the vital energy Qi and are commonly used for general health and well-being, to increase stamina and endurance, to stimulate the immune system, to prevent colds and upper respiratory infections, and to lower blood pressure and blood sugar levels [42,43].

Herbal cosmetics and cosmeceuticals in Suriname

Literature data on plant-derived cosmetics and cosmeceuticals

The examples mentioned in the preceding paragraph illustrate the rich and diverse traditional medicinal systems in Suriname and the wide variety of plants that are employed for medicinal purposes in the country. The use of these plants by Creoles and Maroons, Hindustani, and Javanese has comprehensively been addressed by van An del and Ruyschaert [44] and van 't Klooster [45], Raghoenandan [46], and Tjong Ayong [39], respectively. Together, these publications have compiled 789 Surinamese medicinal plants, seventy-two of which (roughly 10%) are used for cosmetic and cosmeceutical purposes.

The latter plants are given in Table 1, which further shows that the majority of them (fifty-eight or more than three-quarters) is used as cosmeceuticals, *i.e.*, for treating pimples, warts, scars, and pigment spots; flaky skin; skin irritation such as rash, dermatitis, and eczema; local skin lesions such as boils and pustules; as well skin fungi and skin parasites. This is understandable when considering that these plants are mainly mentioned in publications dealing with plants having medicinal properties. These 'cosmeceutical' plants belong to more than twenty-five different plant families, which indicates the usefulness of Surinamese medicinal plants for treating (facial) skin problems. The remaining fourteen of the seventy-two 'cosmetic' and 'cosmeceutical' plants (about 20%) is used for 'genuine' cosmetic purposes, *i.e.*, as makeup, for masking body odor, for skin and hair care, for skin refreshment and rejuvenation, and in genital steam baths.

Table 1. Compiled literature data on plants used for cosmetic and cosmeceutical purposes in Suriname (39,44-46).

Condition	Plant (vernacular name in English; Surinamese)	Family
Body odor	<i>Psidium guajava</i> L. (guava; guyaba)	Myrtaceae
Flaky skin	<i>Erechtites hieracifolia</i> (L.) Rief.ex DC. (fireweed; leta wiwiri)	Asteraceae
	<i>Senna alata</i> (L.) Roxb. (candle bush; slabriki)	Fabaceae
Genital steam baths	<i>Tripogandra serrulata</i> (Vahl.)Handlos (pink trinity; redi gadodede)	Commelinaceae
Hair care	<i>Maximiliana maripa</i> (Correa) Drude. (maripa palm; maripa)	Arecaceae
	<i>Morinda citrifolia</i> L. (noni; didibri apra)	Rubiaceae
	<i>Bertholletia excelsa</i> Humb. & Bonpl. (Brazilian nut; paranoto)	Lecythidaceae
Local skin lesions (e.g., boils and pustules)	<i>Mangifera indica</i> L. (mango; manya)	Anacardiaceae
	<i>Mikania micrantha</i> Kunth (bitter vine; brokobaka)	Asteraceae
	<i>Sphagneticola trilobata</i> (L.) Pruski (creeping daisy; kromanti wiwiri)	Asteraceae
	<i>Unxia camphorata</i> L.f. (sand bitters; masangobita)	Asteraceae
	<i>Momordica charantia</i> L. (bitter melon; wilde sopropo)	Cucurbitaceae
	<i>Senna alata</i> (L.) Roxb. (candle bush; slabriki)	Fabaceae
	<i>Azadirachta indica</i> A. Juss. (neem; nim)	Meliaceae
	<i>Cedrela odorata</i> L. (Spanish cedar; redi krapa)	Meliaceae
	<i>Cymbopogon citratus</i> (De) Stapf. (lemon grass; citroengras)	Poaceae
	<i>Citrus</i> sp.	Rutaceae
<i>Cecropia</i> sp.	Urticaceae	
Makeup	<i>Bixa orellana</i> L. (lipstick plant; kusuwe) <i>Zea mays</i> L. (corn; karu)	Bixaceae Poaceae
Pigment spots	<i>Sida rhombifolia</i> L. (Cuban jute; wadiwad) <i>Cedrela odorata</i> L. (Spanish cedar; redi krapa)	Malvaceae Meliaceae
Pimples	<i>Amaranthus</i> sp.	Amaranthaceae
	<i>Cocos nucifera</i> L. (coconut tree; kronto)	Arecaceae
	<i>Chromolaena odorata</i> (L.) R. King & H. Rob (Siam weed; isriwiwiri)	Asteraceae
	<i>Eclipta prostrata</i> (L.) L. (false daisy; luwisa wiwiri)	Asteraceae
	<i>Mikania micrantha</i> Kunth (bitter vine; brokobaka)	Asteraceae
	<i>Rolandra fruticosa</i> (L.) Kuntze (dos blanc; broko pangi)	Asteraceae
	<i>Unxia camphorata</i> L.f. (sand bitters; masangobita)	Asteraceae
	<i>Opuntia cochinellifera</i> Steud. (cochineal nopal cactus; watra mama kari)	Cactaceae
	<i>Vismia guianensis</i> (Aubl.) Choisy (bloodwood; pinya wiwiri)	Asteraceae
	<i>Cucumis sativus</i> L. (cucumber; komkommer)	Cucurbitaceae
	<i>Jathropa curcas</i> L. (purging nut; purgeernoot)	Euphorbiaceae
	<i>Ricinus communis</i> L. (castor bean; krapata)	Euphorbiaceae
	<i>Copaifera guianensis</i> Desf. (copaiba; hoepelhout)	Fabaceae
	<i>Senna alata</i> (L.) Roxb. (candle bush; slabriki)	Fabaceae
	<i>Tamarindus indica</i> L. (tamarind; tamarinde)	Fabaceae
	<i>Banara guianensis</i> Aubl. (none; pikinfowrudoti)	Fabaceae
	<i>Chelonanthus alatus</i> (Aubl.) Pulle (wild tobacco; todo tabaka)	Salicaceae
	<i>Coutoubea ramosa</i> Aubl. (centorel; diabita)	Gentianaceae
	<i>Malpighia glabra</i> L. (Barbados cherry; West-Indische kers)	Gentianaceae
	<i>Abelmoschus moschatus</i> Medik. (musk okra; yorka okro)	Malvaceae
	<i>Aciotis purpurascens</i> (Aubl.) Triana (none; swawiwiri)	Melastomataceae
	<i>Azadirachta indica</i> A. Juss. (neem; nim)	Meliaceae
	<i>Cedrela odorata</i> L. (Spanish cedar; redi krapa)	Oxalidaceae
	<i>Averrhoa bilimbi</i> L. (bilimbi; birambi)	Passifloraceae
	<i>Passiflora coccinea</i> Aubl. (passion flower; sneki markusa)	Poaceae
	<i>Oryza sativa</i> L. (rice; rijst)	Simarubaceae
	<i>Quassia amara</i> L. (bitter wood; kwasibita)	Solanaceae
	<i>Cestrum latifolium</i> Lam. (bitter greens; bita wiwiri)	Solanaceae
	<i>Solanum leucocarpon</i> Dual. (wolf apple; bradibita)	Solanaceae
	<i>Solanum stramonifolium</i> Jacq. (pea eggplant; makadroyfi)	Solanaceae
<i>Waltheria indica</i> L. (velvet bush; malva soldatenthee)	Sterculiaceae	
<i>Lueheopsis rosea</i> (Ducke) Burret (tickseed; katun udu)	Tiliaceae	
<i>Alpinia galanga</i> L. (Thai ginger; laos)	Zingiberaceae	

Scars	<i>Aloe vera</i> (L) Burm.f. (aloë; aloe) <i>Cedrela odorata</i> L. (Spanish cedar; redi krapa) <i>Alpinia galanga</i> L. (Thai ginger; laos)	Asphodelaceae Meliaceae Zingiberaceae
Skin care	<i>Eryngium foetidum</i> L. (culantro; sneki wiwiri) <i>Cocos nucifera</i> L. (coconut tree; kronto) <i>Euterpe oleracea</i> Mart. (acai; podosiri) <i>Maximiliana maripa</i> (Correa) Drude. (maripa palm; maripa) <i>Morinda citrifolia</i> L. (noni; didibri apra) <i>Laportea aestuans</i> (L.) Chew. (West Indian wood nettle; krasiwiwiri)	Apiaceae Arecaceae Arecaceae Arecaceae Rubiaceae Urticaceae
Skin fungi	<i>Allium sativum</i> L. (garlic; knoflook) <i>Lablab purpureus</i> (L.) Sweet (hyacinth bean; komata) <i>Senna alata</i> (L.) Roxb. (candle bush; slabriki) <i>Senna reticulata</i> (Willd.) HS Irwin et Barneby (carrion crow bush; slabriki)	Amoryllidaceae Fabaceae Fabaceae Fabaceae
Skin parasites	<i>Unxia camphorata</i> L.f. (sand biters; masangobita) <i>Carapa guianensis</i> Aubl. (crabwood; krapa)	Asteraceae Meliaceae
Skin irritation (e.g., rash, dermatitis, and eczema)	<i>Eclipta prostrata</i> (L.) L. (false daisy; luwisa wiwiri) <i>Mikania micrantha</i> Kunth. (bitter vine; brokobaka) <i>Unxia camphorata</i> L.f. (sand bitters; masangobita) <i>Crescentia cujete</i> L. (calabash; krabasi) <i>Bixa orellana</i> L. (lipstick plant; kusuwe) <i>Tournefortia ulei</i> Vaupel. (West Indian soldierbush; alamankina) <i>Commelina difussa</i> Burm.f. (climbing dayflower; gadodede) <i>Cnidioscolus urens</i> (L.) J.C. Arthur. (bull nettle; krasiwiwiri) <i>Maprounea guianensis</i> Aubl. (awati; dek' ati) <i>Senna alata</i> (L.) Roxb. (candle bush; slabriki) <i>Leonotis nepetifolia</i> (L) R. Br. (lion's ear; bradi bita) <i>Ocimum tenuiflorum</i> L. (holy basil; tulsi) <i>Abelmoschus moschatus</i> Medik. (musk okra; yorka okro) <i>Azadirachta indica</i> A. Juss. (neem; nim) <i>Carapa guianensis</i> Aubl. (crabwood; krapa) <i>Cedrela odorata</i> L. (Spanish cedar; redi krapa) <i>Ficus schumacheri</i> (Liebm.) Griseb. (bearded fig; kromanti oby) <i>Piper marginatum</i> Jacq. (marigold pepper; aneysi wiwiri)	Asteraceae Asteraceae Asteraceae Bignoniaceae Bixaceae Boraginaceae Commelinaceae Euphorbiaceae Euphorbiaceae Fabaceae Lamiaceae Lamiaceae Malvaceae Meliaceae Meliaceae Meliaceae Moraceae Piperaceae
Skin refreshment	<i>Plectranthus amboinicus</i> Lour. (thick leaf thyme; dekminti) <i>Gossypium barbadense</i> L. (sea island cotton; redi katun) Orchid spp. (orchid; orchidee)	Lamiaceae Malvaceae Orchidaceae
Skin rejuvenation	<i>Phtirusa stellis</i> (G.Mey) Maguire (mistletoe; pikin fowrudoti) <i>Laportea aestuans</i> (L.) Chew. (West Indian wood nettle; krasiwiwiri)	Loranthaceae Urticaceae
Warts	<i>Asclepias curassavica</i> L. (tropical milkweed; koningsbloempje) <i>Plumeria acuminata</i> Ait. (temple tree; franchepane) <i>Commelina difussa</i> Burm.f. (climbing dayflower; gadodede) <i>Bryophyllum pinnatum</i> (Lam) Oken. (mother of thousands; wonderblad) <i>Gossypium barbadense</i> L. (sea island cotton; redi katun)	Apocynaceae Apocynaceae Commelinaceae Crassulaceae Malvaceae

Production of plant-derived cosmetics and cosmeceuticals

The data mentioned in the preceding paragraphs indicate that there is ample raw plant material in Suriname that can be processed into medicinal preparations as well as cosmetics and cosmeceuticals. As a result, an increasing number of individuals and small and medium-sized enterprises earn their living in the medicinal plants sector in the country [47]. They either cultivate and/or collect the raw materials themselves and act as suppliers for retailers or middlemen, or are involved in the processing and/or fabrication of semi-finished or end-products [47].

According to the Surinamese Chamber of Commerce and Industry, there are at this moment nineteen companies in Suriname - in general,

small business - that manufacture herbal medicines [48]. Interviews with the managers of these companies at the Made in Suriname Fair of 2016 indicated that four of them are involved in the production of facial care products, namely Jomi Cosmetics, Jedally's Cosmetics, Skin Glanz Cosmetics, and Odany Jewa [49]. Jomi Cosmetics has specialized in facial cosmetics and cosmeceuticals from the start (Figure 6), some fourteen years ago, but the other companies only started relatively recently with these activities, even though they are for some years active on the herbal market [49]. The managers have acquired their knowledge and skills about skin care and skin care products either from their ancestors, or by following (accredited) courses and trainings on cosmetic sciences, herbalism, and/or beautifying in specialized institutions in, among others, The Netherlands and Germany [49]. Their products are distributed through a wide network of retailers in Suriname, and in the case of Jomi Cosmetics, also in French Guiana, Brazil, Antigua, and The Netherlands [49].

Together, Jomi Cosmetics, Jedally's Cosmetics, Skin Glanz Cosmetics, and Odany Jewa manufacture a broad assortment of cosmetics and cosmeceuticals for facial care [49]. This includes facial cleansers, facial washes and scrubs, face masks, and several day and night creams, as well as ointments to remove impurities in the face, eye bags, liver spots, etc. [49]. Jomi Cosmetics offers the broadest assortment of facial care products [49]. In all cases, information about the raw materials used, indications, contraindications, and potential side-effects (such as allergic skin reactions including photosensitivity reactions) are properly indicated on the instructions for use [49]. Some of the companies also offer standard facial treatments as well as therapies for acne, wrinkles, and ageing skin [49]. Cases of severe infections are referred to a general physician or a dermatologist [49].

The beauty products are mostly prepared from fresh fruits, fresh plant parts or constituents, as well as semi-finished products such as vegetable oils and waxes from twenty-two plants (Table 2) [49]. The use as cosmetics and/or cosmeceuticals of some of them has already been mentioned in Table 1. The scientific rationale for using these plants is addressed later in this paper. The raw plant materials are procured from cultivators, collectors, and vendors on contract who mainly operate in the districts of Para, Sipaliwini, Brokopondo, and Marowijne [49]. In these parts of Suriname, many of the plants can easily be grown and are



Figure 6. Beauty products from Jomi Cosmetics, Suriname (from <https://goo.gl/images/dKWVjR>).

relatively frequently encountered in the wild. An exception is the West Indian wood nettle *L. aestuans* that is relatively rare [49].

Other important ingredients such as the oils extracted from the coconut tree *C. nucifera*, the crabwood *C. guianensis*, and the copaiba *C. guyanensis* Desf. (Fabaceae) require elaborate processing [49]. Still others such as shea butter (a fat extracted from the seeds of the African shea tree *Vitellaria paradoxa* C.F.Gaertn. (Sapotaceae)), jojoba oil (a liquid wax from the seeds of the jojoba *Simmondsia chinensis* (Link) C. K. Schneid. (Simmondsiaceae)), and grapeseed oil (the oil extracted from grape seeds as a by-product of winemaking) are not available in Suriname and must be imported [49].

Ingredients of plant-based cosmetics and cosmeceuticals

The most commonly used plants for manufacturing cosmetics and cosmeceuticals in Suriname are mentioned in Table 2 and have been dealt with in ref. 49. Fresh leaves of *A. vera*, *A. indica*, *C. citratus*, *M. oleifera*, and/or *T. indica*, along with coconut oil are typically included in facial washes. The leaves of *C. citratus* are also used to prepare facial milks, as are those of *P. amboinicus*. The juice from the fruits of *C. nucifera*, *C. sativus*, *E. oleracea*, *M. citrifolia*, certain orchid species, and extracts from the leaves of *T. indica* and *A. indica*, and the calyces of *H. sabbdariffa* L. are used to prepare day and night creams.

The finely ground granules from *E. oleracea* fruits are the main ingredients of an exfoliant to remove dead skin cells and stimulate blood circulation, forming the basis of facial scrubs. The leaf juices of *E. prostata*, *S. alata*, and *T. indica* are essential components of deep skin cleansers. Extracts from the leaves of *L. aestuans* and *M. oleifera* are important ingredients of formulations for treating acne, eczema, scars, insect bites, and chapped lips. Preparations from *T. serrulata* leaves or whole plant are included in hair growth-stimulating products. Notably, many of the above-mentioned substances are also incorporated in other skin care products, creams for skin regeneration, and anti-ageing lotions.

The oils extracted from the fruits or seeds of *B. excelsa*, *C. nucifera*, *C. guianensis*, and *M. maripa*, and that from the trunk of *C. guyanensis*, give Brazil nut oil, coconut oil, krapa oil, maripa oil, and hoepel oil, respectively, and are locally manufactured semi-finished products. These substances are abundantly used for hair care and the production of soaps, and are, together with extracts from *A. indica*, *L. nepetifolia* and/or *B. pinnatum* leaves, included in eye masks as well as ointments for treating eye bags and acne.

Examples of imported semi-finished ingredients are shea butter, jojoba oil, and grapeseed oil. These substances are widely used for skin- and hair-related products such as soaps, skin moisturizers, sunscreens, lip balms, anti-wrinkle formulations, anti-stretch mark creams, hair conditioners, baby oils, and ointments against skin inflammation [50-52]. They are also, together with the leaf juice from *A. indica* and/or *P. amboinicus*, common constituents of facial masks.

Scientific rationale for using Surinamese plants as cosmetics and cosmeceuticals

The scientific rationale for the cosmetic and cosmeceutical use of the above-mentioned plants based on their phytochemical composition is extensively presented in this section. The data are summarized in Table 3.

Aloe vera (L) Burm.f.

Parts of *A. vera* are abundantly used in traditional medicinal systems as a treatment for, among others, microbial infections,

Table 2. Plants used for manufacturing cosmetics and cosmeceuticals in Suriname.

Plant species (vernacular name in English; Surinamese)	Plant family	Main cosmetic /cosmeceutical use in Suriname
<i>Aloë vera</i> (L.) Burm.f. (aloe; aloe)	Asphodelaceae	Skin care products, facial washes, day and night creams, skin regeneration and anti-ageing creams
<i>Azadirachta indica</i> A.Juss., 1830 (neem; nim)	Meliaceae	Facial washes, facial masks, eye masks, day and night creams, anti-eye bag products, anti-acne creams
<i>Bertholletia excelsa</i> Humb. & Bonpl. (Brazilian nut; paranoto)	Lecythidaceae	Soaps, skin care products, eye masks, anti-eye bag products, anti-acne creams, hair care products
<i>Bryophyllum pinnatum</i> (Lam) Oken. (mother of thousands; wonderblad)	Crassulaceae	Skin care products, skin regeneration products, eye masks, anti-eye bag products, anti-acne creams
<i>Carapa guianensis</i> Aubl. (crabwood; krapa)	Meliaceae	Soaps, skin care products, skin regeneration creams, eye masks, anti-eye bag products, anti-acne creams, anti-cellulite formulations, hair care products
<i>Cocos nucifera</i> L. (coconut tree; kronto)	Arecaceae	Soaps, skin care products, facial washes, facial masks, eye masks, day and night creams, skin regeneration and anti-ageing creams, eye masks, anti-eye bag products, anti-acne creams hair care products
<i>Copaifera guyanensis</i> Desf. (copaiba; hoepelhout)	Fabaceae	Soaps, eye masks, anti-eye bag products, anti-acne creams, hair care products
<i>Cucumis sativus</i> L. (cucumber; komkommer)	Cucurbitaceae	Skin care products, day and night creams, skin regeneration creams
<i>Cymbopogon citratus</i> (Dc) Stapf. (lemon grass; Citroengras)	Poaceae	Facial washes; facial milks
<i>Eclipta prostrata</i> (L.) L. (false daisy; Luisawiwiri)	Asteraceae	Deep skin cleaners
<i>Euterpe oleracea</i> Mart. (acai; podosiri)	Arecaceae	Skin care products, facial scrubs, day and night creams, skin regeneration and anti-ageing creams, hair care products
<i>Hibiscus sabdariffa</i> L. (roselle; syuru)	Malvaceae	Skin care products, day and night creams, skin protection creams, anti-ageing creams, hair care products
<i>Laportea aestuans</i> (L) Chew. (West Indian wood nettle; brandnetel)	Urticaceae	Skin care products, anti-acne creams, anti-eczema formulations, lip balms
<i>Leonotis nepetifolia</i> (L) R. Br. (lion's ear; bradi bita)	Lamiaceae	Eye masks, anti-eye bag products, anti-acne creams
<i>Maximiliana maripa</i> (Correa) Drude. (maripa palm; maripa)	Arecaceae	Soaps, eye masks, anti-eye bag products, anti-acne creams, hair care products
<i>Morinda citrifolia</i> L. (noni; didibri apra)	Rubiaceae	Skin care products, facial washes, day and night creams, skin regeneration and anti-ageing creams, anti-acne creams, hair care products, deodorants
<i>Moringa oleifera</i> Lam. (moringa; moringa)	Moringaceae	Facial washes, acne, eczema, scars, insect bites, lip balms
Orchid spp.	Orchidaceae	Skin care products, skin regeneration and anti-ageing creams
<i>Plectranthus amboinicus</i> Lour. (thick leaf thyme; dekminti)	Lamiaceae	Anti-acne creams
<i>Senna alata</i> (L.) Roxb. (candle bush; slabriki)	Fabaceae	Deep skin cleaners
<i>Tamarindus indica</i> L. (tamarind; tamarinde)	Fabaceae	Skin care products, facial washes, face masks, day and night creams, deep skin cleaners, skin regeneration and anti-ageing creams, lip balms, sun screens
<i>Tripogandra serrulata</i> (Vahl.) Handlos (pink trinity; redi gadodede)	Commelinaceae	Hair growth promotion products

constipation, diabetes mellitus, and skin conditions [53,54]. Their alleged therapeutic efficacy may be associated with the presence in the leaves of phytochemicals such as acetylated mannans, polymannans, anthraquinones, and lectins [55,56]. For this reasons, the leaf gel is included in various health-promoting beverages and dietary supplements to support digestion [57]. It is furthermore used for manufacturing disposable facial tissues, makeup, moisturizers, soaps, sunscreens, shaving creams, shampoos, skin lotions, and ointments for minor burns and sunburns [55-59]. These applications are presumably based on the soothing, moisturizing, and emollient effects of *A. vera* leaf gel [58,59] which may particularly be associated with the polysaccharides in the gel [58,59].

***Azadirachta indica* A. Juss.**

Preparations from the leaves of the neem *A. indica* have been used in Indian Ayurveda for over two millennia against a wide variety of diseases, ranging from colds, fevers, and respiratory conditions to high blood pressure and diabetes mellitus [36,37,60]. The oil extracted from *A. indica* fruits and seeds has been used as a folk medicine against acne

and redness and inflammation of the skin [36,37,61]. These beneficial effects may be related to the antiparasitic and antimicrobial activities of the limonoids azadirachtin and nimbinin in the leaves [38,62], as well as the soothing and moisturizing effects of oleic acid, linoleic acid, stearic acid, and palmitic acid in the oil [62]. As a result, neem oil is used for preparing a large variety of cosmetics such as soaps, shampoos, balms, creams as well as toothpastes and nail polishes [63].

***Bertholletia excelsa* Humb. & Bonpl.**

The edible seeds of the Brazilian nut *B. excelsa* are rich in dietary fiber, vitamins, and dietary minerals, and are a staple diet of the natives residing in the Amazon forest [64]. The seeds are also commercially harvested and included in mixed nuts and confections coated with chocolate [64]. The oil extracted from the seeds contains 75% unsaturated fatty acids composed mainly of oleic and linoleic acids, as well as phytosterols, several phenolic compounds, vitamin E, and remarkably high levels of selenium [65-67]. It is used in creams, lotions, conditioners, and hair care products, as well as in formulations for alleviating dry, flaky skin, ageing skin, acne, and skin inflammation.

Table 3. Plants and main plant part(s) used for manufacturing cosmetics and cosmeceuticals in Suriname and their presumed key active constituent(s).

Plant species	Main plant part(s) used	Presumed key active constituent(s)
<i>Aloe vera</i> (L) Burm.f.	Gel from fresh leaves	Polysaccharides
<i>Azadirachta indica</i> A. Juss.	Extracts from fresh leaves, seed oil	Limonoids
<i>Bertholletia excelsa</i> Humb. & Bonpl.	Seed oil	Fatty acids, phenolic compounds, vitamin E
<i>Bryophyllum pinnatum</i> (Lam) Oken.	Extracts from fresh leaves	Glycosides, saponins
<i>Carapa guianensis</i> Aubl.	Seed oil	Limonoids, fatty acids
<i>Cocos nucifera</i> L.	Extracts from fresh fruits, seed oil	Phenolic compounds, vitamin E, terpenes, saponins
<i>Copaifera guyanensis</i> Desf.	Trunk oil	Terpenes
<i>Cucumis sativus</i> L.	Extracts from fresh fruits	Water, antioxidants
<i>Cymbopogon citratus</i> (Dc) Stapf.	Extracts from fresh leaves	Essential oils
<i>Eclipta prostrata</i> (L.) L.	Extracts from fresh leaves	Coumestans, glycosides, amyris
<i>Euterpe oleracea</i> Mart.	Extracts from fresh fruits, ground seeds	Anthocyanins
<i>Hibiscus sabdariffa</i> L.	Extracts from fresh calyces	Anthocyanins, vitamin E, flavonoids
<i>Laportea aestuans</i> (L) Chew.	Extracts from fresh leaves	Essential oils
<i>Leonotis nepetifolia</i> (L) R. Br.	Extracts from fresh leaves	Flavonoids, terpenes, essential oils, coumarins
<i>Maximiliana maripa</i> (Correa) Drude.	Seed oil	Vitamins A and E compounds, fatty acids
<i>Morinda citrifolia</i> L.	Extracts from fresh fruits, seed oil	Flavonoids, fatty acids
<i>Moringa olifera</i> Lam.	Extracts from fresh leaves	Ben oil
Orchid spp.	Seed extracts	Essential oils
<i>Plectranthus amboinicus</i> Lour.	Extracts from fresh leaves	Essential oils
<i>Senna alata</i> (L.) Roxb.	Extracts from fresh leaves	Phenolic compounds, essential oils
<i>Tamarindus indica</i> L.	Extracts from fresh leaves, seed extracts	Polyphenols, flavonoids, xyloglucan, fatty acids
<i>Tripogandra serrulata</i> (Vahl.) Handlos	Extracts from fresh leaves or whole plant	Unknown

These applications may be supported by the moisturizing effects of the fatty acids [68] and the antioxidant properties of particularly the phenolic compounds and vitamin E [67].

***Bryophyllum pinnatum* (Lam) Oken.**

Preparations from the mother-of-thousands *B. pinnatum* (Figure 7) are abundantly used as traditional astringent, anti-inflammatory, and antiseptic substances to treat burns, wounds, bruises, boils, and sores [69-71]. This may account for the inclusion of *B. pinnatum* constituents in a variety of cosmetics and cosmeceuticals such as products for facial cleansing, creams for fighting wrinkles, ointments for treating acne, rashes and warts, anti-dandruff shampoos, hair growth-promoting tonics, anti-ageing creams, and skin regeneration-promoting formulas [72,73]. Further support for these applications comes from the beneficial effects of fumaric acid in *B. pinnatum* leaves against skin conditions such as psoriasis [74], and the cicatrizing and amphiphatic and antimicrobial properties of the saponins in various parts of the plant that may promote wound healing [75].

***Carapa guianensis* Aubl.**

The bark of the crabwood *C. guianensis* contains alkaloids such as carapina which possess antipyretic properties [76]. Concoctions

prepared from the leaves and fruits are traditionally used to relieve itching and treat intestinal worms [76]. The seed oil from the plant is also known as carap oil or crab oil and contains limonoids with, among others, anti-inflammatory, anti-allergic, antiparasitic, antimicrobial, and wound healing-promoting properties [76,77-79]. For these reasons, carap oil is commonly included in skin care preparations, skin-regenerating products, anti-ageing treatments, anti-cellulite creams, and anti-inflammatory acne medications [80]. The oil also contains a number of unsaturated fatty acids such as palmitic acid, oleic acid, and linoleic acid which make it useful as an ingredient of soaps, body washes, skin conditioners, facial moisturizers, facial masks, eye creams, as well as shampoos and hair conditioners [81,82].

***Cocos nucifera* L.**

Parts of the coconut tree *C. nucifera* are traditionally used for treating a variety of diseases. For instance, a tea from the husk fibers is used in Brazil against diarrhea [83] and in Haiti against amenorrhea [84], a tea from the roots would treat diarrhea and stomach pains in Papua New Guinea [85], while coconut oil would prevent hair loss and promote wound healing according to Fijian and Indonesian beliefs [86]. These actions may be associated with the presence of phenols, tannins, leucoanthocyanidins, flavonoids, triterpenes, steroids, alkaloids, triterpenes, saponins, and condensed tannins in several parts of the plant [87], as well as that of vitamin E and a number of fatty acids in coconut oil [88]. For these reasons, coconut oil is an important base ingredient of shower gels, shampoos and hair conditions, moisturizers, emollients, nourishing agents, body butters, fragrances, sunscreens, formulations to prevent drying of the skin, anti-redness agents, anti-ageing agents, and remedies for skin infections [89].

***Copaifera guyanensis* Desf.**

The medicinal properties of the oil from the copaiba tree *C. guyanensis* (Figure 8) were already known by American Indians, who observed that injured animals rubbed themselves on the tree's trunk to heal their wounds [90,91]. Copaiba oil is obtained by tapping the tree's trunk and was traditionally used against inflammations, infections, malignancies, to stimulate wound healing, and to treat skin diseases [92,93]. The biologically active substances of copaiba oils are sesquiterpenes such as caryophyllene and diterpenes such as copalic acid and kaurenoic acid [92,93]. These compounds display

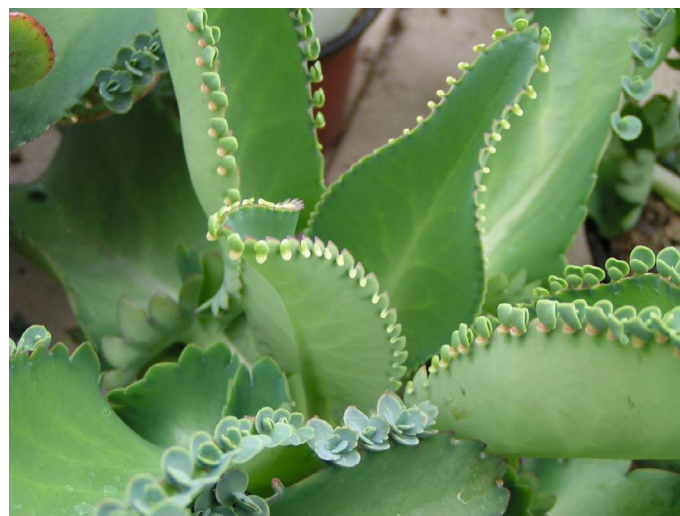


Figure 7. The mother-of-thousands *Bryophyllum pinnatum* (Lam) Oken. (Crassulaceae) (from <https://goo.gl/images/fbgqpR>)

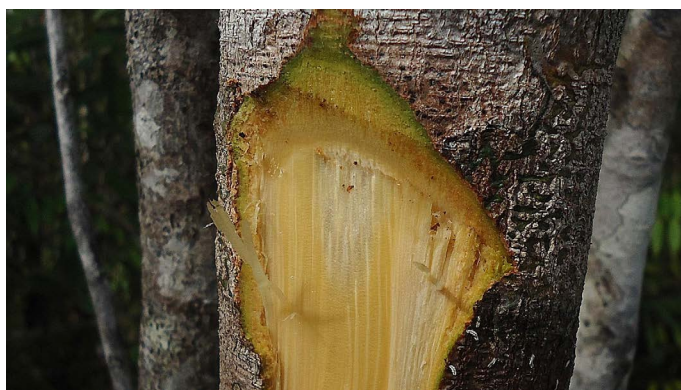


Figure 8. Harvesting copaiba oil from the trunk of *Copaifera guyanensis* Desf. (Fabaceae) (from <https://goo.gl/images/ib4aaL>).

substantial anti-inflammatory and antimicrobial effects including activity against *Staphylococcus aureus* (Staphylococcaceae) [92,94,95] which is a common cause of skin infections. For these reasons, copaiba oils are extensively used by the cosmetic industry in anti-acne creams, formulations for treating stretch marks and scars, as well as shampoos, capillary lotions, soaps, and bathing foams [96].

***Cucumis sativus* L.**

The fruits of the cucumber plant *C. sativus* consist for more than 90% of water [97], and contain, among others, vitamin K, B vitamins, as well as vitamin C and other antioxidants such as β -carotene, flavonoids, and phenolic compounds [98,99]. The high water contents is considered beneficial to the skin [97,100], while the antioxidants may protect the skin from the effects of ageing [101,102]. For these reasons, *C. sativus* fruits, fruit extracts, fruit water, fruit juice, and seed extracts are abundantly used as skin-conditioning agents and included in numerous cosmetic formulations [97,100,103]. A few are foundations, facial and eye makeup, face and neck products, cleansing products, skin-hydrating products, bath foams, soaps and detergents, facial peel-off masks, hair care products, nail care products, body and hand lotions, and products for skin rejuvenation [97,100,103].

***Cymbopogon citratus* (Dc) Stapf.**

Preparations from the lemongrass *C. citratus* leaves are popularly used, among others, as antimicrobials, antiprotozoals, anti-inflammatory compounds, antidyspeptics, spasmolytics, antipyretics, diuretics, and insect repellents [104,105]. These applications are supported by the antibacterial, antifungal, antiparasitic, antidiarrheal, anti-inflammatory, cytoprotective, and antioxidant effects noted in preclinical models [106]. At least part of these observations may be attributable to the presence in the leaves of flavonoids and phenolic compounds as well as essential oils containing citral, geraniol, citronellol, citronella, and myrcene [107,108]. The pleasantly smelling essential oils are widely included as fragrances in perfumes, soaps, detergents, and creams [109]. Citral also serves as starting material for the synthesis of ionones for perfumes and cosmetics [107,109]. The by-products from the distillation process that yields the oils are used for the production of skin care products such as lotions, creams, and facial cleansers [107,109]. These applications are primarily attributed to the meaningful antimicrobial properties of the oils [110].

***Eclipta prostrata* (L.) L.**

The main traditional indications for the false daisy *E. prostrata* are gastrointestinal complaints, liver ailments, respiratory tract disorders,

fever, spleen enlargement, skin problems, cuts and wounds, microbial and parasitic infections, as well as hair loss and graying of hair [111]. The latter uses are supported by the addition of an ethanol extract of *E. prostrata* leaves to hair oils in Ayurveda [111] and the hair growth-stimulatory effects of petroleum ether extracts of these parts of the plant in shaved laboratory rats [112,113]. These applications may be attributable, at least partially, to the presence in *E. prostrata* of, among others, coumestans such as wedelolactone; oleanane-type glycosides such as eclalbasaponins; and triterpenes such as amyryns, precursors of ursolic acid and oleanolic acid [114]. These compounds possess, among others, antibacterial, anti-inflammatory, antieczema, as well as antioxidant properties [115-118] which may confer protection from damage caused by ultraviolet irradiation [114]. For these reasons, *E. prostrata* extracts and oils are included in many hair growth promoters, products to prevent hair loss, as well as skin-nourishing and anti-ageing agents [22].

***Euterpe oleracea* Mart.**

The fruits of the açai palm *E. oleracea* are in various parts of the world - particularly Brazil - processed into pulp for supply to food product manufacturers or retailers; sold as frozen pulp or juice; incorporated in beverages, smoothies, and other food products; and formulated as dietary supplements [119]. The popularity of these products is based on the remarkably high polyphenolic anthocyanin contents [120,121] and the superior antioxidant qualities of the açai berry [122] which would provide a host of health benefits [123]. These claims, together with the relatively high levels of oleic and palmitic fatty acids in the oil extracted from açai berries [124], have encouraged the production of a variety of açai-based cosmetics. The anthocyanins and phenolic compounds would treat and prevent skin damage and are included in, among others, skin regenerating and anti-ageing creams, anti-inflammatory products, and sunscreens [125,126]. The soothing and nourishing fatty acids would make it suitable for use in cosmetics as soaps, skin moisturizers shampoos, and hair conditioners [125,126].

***Hibiscus sabdariffa* L.**

Preparations from the calyces of the roselle *H. sabdariffa* (Figure 9) are used in many folk medicinal systems for treating a broad range of conditions such as microbial infections, cough and bronchitis, kidney



Figure 9. The roselle *Hibiscus sabdariffa* L. (Malvaceae) (from <https://goo.gl/images/75wRmG>).

problems, and gastrointestinal conditions [127]. These applications may be attributable, at least in part, to the presence in the plant of antioxidant anthocyanins [127,128] and vitamin E [127,129]; a number of flavonoids with notable antibacterial activity [127,130]; and the phenolic compound protocatechuic acid that exerted an anti-inflammatory effect in laboratory animals [131]. For these reasons, extracts from *H. sabdariffa* calyces are commonly included in skin care products, skin-protecting agents, anti-ageing creams, and hair care products [132]. Notably, crude polysaccharides in *H. sabdariffa* flowers had a potent stimulatory effect on the proliferation of cultured keratinocytes [133].

***Laportea aestuans* (L) Chew.**

Preparations from the West Indian wood nettle *L. aestuans* are traditionally used for treating many ailments including microbial and parasitic infections, minor eye infections, as well as syphilis and gonorrhoea [134,135]. At least some of these applications may be attributable to the presence in the plant of bioactive substances with antimicrobial and antioxidant properties [136-138]. A few examples are the chrysen-2-ol derivative and methyl salicylate in the essential oils from the leaves which exhibited *in vitro* antimicrobial activity [138,139]. These observations suggest that substances from *L. aestuans* may be useful against cellular injury and ageing. As a result, extracts from this plant are widely used in massage oils, lotions, creams, ointments, lip balms, face masks, scrubs, facial toners, antidandruff shampoos and conditioners, as well as remedies for treating acne, eczema, blemishes from chicken pox and insect bites, and scarring from burns [136]. Some of these preparations may be scented with the essential oils from the plant [139].

***Leonotis nepetifolia* (L) R. Br.**

The lion's ear *L. nepetifolia* (Figure 10) contains various bioactive constituents such as flavonoids, alkaloids, quinines, saponins, terpenoids and terpenes, coumarins, as well as essential oils [140,141]. These compounds are present at varying concentrations in the sepals, leaves, stems, roots, and flowers of the plant [142,143] and possess meaningful free radical-scavenging, antibacterial, antiparasitic, insecticidal, and anti-inflammatory properties [141]. This may account for the broad traditional use of parts of *L. nepetifolia* in order to suppress allergy symptoms, counteract muscle spasms, calm agitation, relieve



Figure 10. The lion's ear *Leonotis nepetifolia* (L) R. Br. (Lamiaceae) (from <https://goo.gl/images/rwb9QF>).

pain, heal burns, alleviate the symptoms of bronchial asthma, treat fever and colds, ease pain from arthritis, and fight malaria [141,144]. *L. nepetifolia* leaf extracts are also included in formulations for treating acne, skin rashes, and skin infections, as well as in skin-rejuvenating and -regenerating products [145,146]. The flavonoids have antioxidant activities while the essential oils have emollient as well as antibacterial properties [145,146] and confer, together with the coumarins and diterpenes [140,146] a pleasant fragrance to these products.

***Maximiliana maripa* (Correa) Drude.**

The pulp and seed kernels of the fruits of the maripa palm *M. maripa* yield an edible oil that consists of, among others, α -carotene, tocotrienols, tocopherols, phytosterols, glycolipids, and fatty acids [147-149]. These compounds have emollient, antioxidant, and antimicrobial properties [150], which may explain the long traditional use of maripa oil for skin care, to prevent skin ageing, to stop alopecia and stimulate hair growth, to fight stretch marks, and to smoothen scarred skin [151-152]. It is also used as a massage oil to bring relief in rheumatic parts of the body [152]. For these reasons, *M. maripa* oil is commonly included in soaps, moisturizers and other skin care products, rejuvenation and anti-ageing formulations, creams for treating acne, as well as shampoos and hair conditioners [148,152].

***Morinda citrifolia* L.**

Preparations from the noni *M. citrifolia* are used for treating a long list of ailments ranging from wounds, sores, burns, sprains, and dislocations to diabetes mellitus, high blood pressure, AIDS, and malignant neoplasms [153-155]. More recently, clinical studies found that noni leaf extracts protected the skin from erythema caused by ultraviolet light [155], and that noni seed oil had meaningful anti-inflammatory activity in acne [156]. As a result, a host of noni-based cosmetics and cosmeceuticals have been manufactured, including hand and facial soaps, shampoos and conditioners, foot and body lotions, body powders, deodorants, ointments for treating acne, formulations to fight wrinkles, as well as eye creams, rejuvenating face masks, moisturizers, and night creams to reduce signs of aging [155]. The antioxidant activity of flavonoids and the emollient properties of fatty acids in the fruits and leaves of the plant [153,154,157-159], and the anti-inflammatory action of ingredients in the seed oil [156,159] may contribute to the beneficial effects of these products.

***Moringa oleifera* Lam.**

M. oleifera is traditionally used to stimulate diuresis, to relieve spasms, for treating the symptoms of diabetes mellitus, as a cardiac stimulant, as an antimicrobial and antiparasitic substance, and for treating many other conditions [160]. The edible oil from the seeds is called ben oil because of its high contents of the fatty acid behenic acid [161,162]. Ben oil is included in moisturizing and emollient oils for therapeutic massages and is used as a carrier oil for aromatherapy [161,162]. Ben oil as well as *M. oleifera* leaf extracts also contain substantial quantities of vitamins A, C, and E as well as β -carotene and polyphenols which may possess anti-inflammatory and anti-oxidant properties [163,164]. For these reasons, both the seed oil and leaf extracts are included in creams, lotions, balms, soaps, scrubs, body oils, moisturizers, hair care products, and sunscreens [161,162,165-167]. Ben oil is also used as a base for perfumes because of the capacity of behenic acid to neutralize malodors [167].

Orchidaceae

Members of the orchid family Orchidaceae (Figure 11) have a long traditional use in various medicinal systems [168]. This holds



Figure 11. The tiger orchid *Oncidium jonesianum* (Orchidaceae) (from <https://goo.gl/images/hLYpNu>).

particularly true for traditional Chinese medicine that used certain species for treating a variety of diseases ranging from urinary tract disorders to diabetes mellitus, hypertension, and cancer [169]. The apparent therapeutic efficacy of these preparations may be attributable to alkaloids with medicinal properties [169], but this remains to be established. At least one orchid species - the vanilla orchid *Vanilla planifolia* Jacks. ex Andrews - is renowned as a flavoring in baking, for perfume manufacture, and in aromatherapy [170]. Extracts from other orchid species are also incorporated in a variety of cosmetics and cosmeceuticals. Some contain phenolics and flavonoids with meaningful antioxidant and anti-inflammatory activity and are important ingredients of anti-ageing creams [168,171-173]. Others contain substances with a high water-binding capacity and/or constituents that increase stratum corneum hydration, and have become essential ingredients of skin moisturizers and emollients [172]. Orchid flowers are also an important source of fragrances for toiletries, skin care products, bathing products, and hair care products [174]. In many cases, their scent is analyzed by perfumers to identify potentially novel bouquets [175].

***Plectranthus amboinicus* Lour.**

Preparations from *Plectranthus* species are traditionally used for treating a broad range of conditions including gastrointestinal, respiratory, and genitourinary ailments as well as infections and fever [176,177]. Extracts from the leaves and the strongly oregano-like scented essential oils from this plant genus are also used against a variety of skin problems including burns, wounds, sores, insect bites, parasitic infections, and allergies [178,179], as well as an antiseptic dressing for wounds [180]. Some of these traditional uses may be explained by the presence in these plant species of monoterpenes and sesquiterpenes diterpenoids and phenolic compounds with, among others, antimicrobial, anti-inflammatory, and antioxidant properties [181,182]. For these reasons, extracts and essential oils from the leaves of the thick leaf thyme *P. amboinicus* are included in soaps, moisturizers, skin cleansers; anti-acne formulations; anti-wrinkle, skin-rejuvenating, and anti-ageing night creams; and ointments for treating insect bites and itchy skin [176,177].

***Senna alata* (L.) Roxb.**

The leaves, seeds, fruits, bark, and roots of the candle bush *S. alata* (Figure 12) contain a number of bioactive compounds such as

anthraquinones, phytosterols, tannins, alkaloids, flavonoids, terpenes, phenolic compounds, and essential oils [183,184]. Some of these compounds have been associated with the laxative and purgative properties of *S. alata* preparations [183,184]; their efficacy against scabies and ringworm infections as well as fungal infections of the skin such as *Pityriasis versicolor* [185]; their antibacterial effects [186], their anti-inflammatory activity [187], and their capacity to reduce ultraviolet irradiation-induced skin damage [188]. For these reasons, *S. alata* leaf extracts are included in many cosmetics and dermatological skin care products such as soaps, sunscreens, anti-ageing agents, and skin-repairing agents [189].

***Tamarindus indica* L.**

Preparations from *T. indica* are traditionally used for treating a broad range of ailments such as abdominal ailments, parasitic infestation, fever, malaria, and respiratory problems [190]. These properties may be attributable to the presence in the plant of various phytochemicals with, among others, antibacterial, antifungal, antiviral, antiparasitic, anti-inflammatory, and antioxidant properties [191,192,193,194]. *T. indica* leaves contain various polyphenols and flavonoids with wound healing-stimulating properties [195,196], the seeds contain the hemicellulose xyloglucan which can protect the skin from the damaging effects of ultraviolet radiation [197], and the seed oil contains abundant amounts of linoleic acid and oleic acid [194]. For these reasons, *T. indica* preparations are included in regenerating and anti-ageing night creams, sunscreens, ointments for treating minor skin rashes, as well as serums, gels, facial toners, moisturizers, face masks, lip balms, body lotions, and soaps [198].

***Tripogandra serrulata* (Vahl) Handl.**

Preparations from the whole plant or the leaves of the pink trinity *T. serrulata* - ether alone or together with parts from other plants - are highly valued in various South American and Caribbean countries. *T. serrulata*-containing remedies are traditionally used against biliousness and kidney disorders, as a purgative, and to cleanse the uterus and the oviducts [199], but also for treating traumas and wounds [200,201] along with inflammations and fractures [202]. In addition, the macerated leaves are used to prevent hair loss and promote hair growth [44,203] and are applied to the face to stimulate beard growth [199]. For these reasons, *T. serrulata* leaf extracts are included in a number of hair care products [200,203], despite the lack of comprehensive data on the phytochemical information about the extracts.



Figure 12. The candle bush *Senna alata* (L.) Roxb. (Fabaceae) (from <https://goo.gl/images/woZP5q>).

Future prospects

This paper has addressed the beauty industry in Suriname, the commonly used plants for manufacturing these products in the country, as well as the scientific rationale for using these plants. So far, only a relative handful of Suriname's abundant plant biodiversity encompassing an estimated 5,000 higher plants is used for cosmetic and cosmeceutical purposes. Furthermore, these plants are mainly collected (and sometimes cultivated) in the accessible parts of the country's hinterland rather than in the less approachable and ill-explored regions in the remote south of the country [49]. Thus, it is possible that Suriname is in the possession of a largely untapped reservoir for the development of the currently much-sought-after herbal cosmetics and cosmeceuticals.

This holds the prevision of identifying numerous plant products for developing novel naturally-derived beauty products. For instance, the orange-red wax from the seeds of the annatto or lipstick plant *Bixa orellana* L. (Bixaceae) (Figure 13) has a long use of facial and body ornamentation by the Indigenous peoples of the Amazon basin [204] and may not only be included in lipsticks but also in rouge powders and cream blushes, eye shadows, and nail polishes. The young shoots of the sour orange *Citrus x aurantium* L., 1753 (Rutaceae) are commonly chewed on by particularly older Creole women to freshen their breath, and the essential oil in these parts of the plant may be included in mouth washes, soaps, skin care products, and deodorants. And the essential oil from the seeds of the tonka bean tree *Dipteryx odorata* (Aubl.) Willd. (Fabaceae) is widely used in the perfume industry because of its high contents of coumarins with very pleasant odors, but may also be incorporated into hair and skin care products because of the folkloristic use of tonka bean oil to fortify the scalp and improve hair growth [205].

However, important conditions to take advantage of these opportunities are the creation of a favorable technological environment, the reinforcement of good manufacturing practices, and the implementation of successful marketing strategies. Furthermore, information about the pharmacologically active ingredient(s) and mechanism(s) of action of cosmetics and cosmeceuticals should be mandatory, even though neither of these products has to undergo the thorough and lengthy evaluations required for pharmaceutical products. Unfortunately, this is by no means always the case.

For instance, despite some supporting evidence for wound healing-promoting activity of *A. vera*, "there is a need for high-level evidence and



Figure 13. Seeds of the annatto *Bixa orellana* L. (Bixaceae) (from <https://goo.gl/images/w2V5BE>).

further large, randomized control trials to support the use of *A. vera*-derived products as topical agents or incorporated within dressings for the treatment of skin lesions" [206]. Products from *E. olearacea* are among the most popular functional foods and cosmetics/cosmeceuticals throughout the world, but the scientific evidence to support their many claims of health benefits is insufficient [121]. And although tonics for general health from freshly squeezed noni fruits, 'power' and energy drinks that contain noni fruit juice, and powders from dried noni fruits or leaves formulated as capsules or pills are in high demand, most of the claims of *M. citrifolia* are not supported by hard scientific evidence [154].

Clearly, further development of the herbal cosmetics/cosmeceuticals industry including that in Suriname requires close attention to these aspects. Evidently, such information is not only of benefit to the consumer but also supports the reliability of the manufacturer.

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