A selection of eleven plants used as traditional Polynesian cosmetics and their development potential as anti-aging ingredients, hair growth promoters and whitening products

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Abstract

Ethnopharmacological relevance: In French Polynesia, embellishment of the hair and skin is an important cultural and everyday practice. Yet, little research has focused on traditional preparations used for beautification in this region and their potential development as innovative cosmetic ingredients.

Aim of the study: In this present study we aim to assess and compile the ethnocosmetic potential of plants of French Polynesia to select and further study plants showing the most promise to be developed as anti-aging, anti-blemish and hair care products.

Materials and Methods: A literature analysis of plants of the IECIC list, present in French Polynesia was conducted. The most interesting plants from a cosmetic development standpoint were selected based on four main criteria, i.e. their traditional use in Polynesian cosmetic-related preparations, their biogeographical status, their phytochemistry of cosmetic interest, and lastly their availability and absence from the UICN list. Furthermore, a preliminary screening of antioxidant and anti-inflammatory activities was also performed on several extracts obtained.

Results: Eleven plants were chosen, and a compilation of multidisciplinary data emphasized each selected plant's potentiality. Traditional allegations showed uses ranging from dermatology such as wound healing or anti-inflammatory properties, to hair growth promoting preparations or even skin ligthening ones. Preliminary screenings were useful in narrowing the number of extracts to study. Literature-based data associated to traditional uses depicted how the remaining plants and plant parts could be developed for targeted cosmetic applications.

Conclusions: A prospective approach of plants used traditionally for cosmetic purposes in French Polynesia gave insight on their development potential when paired with the appropriate multidisciplinary data. The eleven plants presented show promise in being developed sustainably as natural anti-aging or hair care products and as skin brightening agents.

Keywords: cosmetics, pharmacopoeia, Polynesia, inflammation, antioxidant, aging, hair care

1. Introduction

Consumers have growing demands for ethically sound, natural beauty products. This awareness has intensified a shift of cosmetic companies towards developing active compounds that are not only of-natural origin but also respect environmental and ethical norms. In this regard, there has been a renewed enthusiasm in the global cosmetic market to focus on biosourcing and as such, plants, algae, micro-organisms and minerals as source of natural bioactive compounds. In the search for innovative yet effective ingredients, researchers have delved into the ethnobotanical resources of countries worldwide to find plant-based preparations that are used by populations for their beauty and body care (Ahshawat *et al.,* 2008, Pervin *et al.,* 2014, Joshi & Pawar, 2015). A concept has arisen to better capture this idea: cosmetopoeia.

Cosmetopoeia describes the traditional uses of a plant or a mineral for the embellishment and/or maintenance of the body (Ansel, 2016). In this regard, it is analogous to pharmacopoeia for medicinal plants and purposes. While many countries now possess their own pharmacopoeia, cosmetopoeia remains poorly studied in comparison. Yet, promoting cultural cosmetic knowledge and developing it in a sustainable way, while applying Access and Benefit Sharing requirements, would be a non-negligible economic opportunity for many countries that possess the cultural knowledge, biomass abundance and floristic originality (Guezennec *et al.,* 2005). French Polynesia has a lot to offer in this respect. It is a French overseas territory part of Eastern Polynesia and is situated in the middle of the

Pacific Ocean. It is located between 7–28° S and 134–155° W, some 6500 km away from North America and 6000 km away from Australia. Polynesians are known for their rich culture in dance, in monoi and in beauty standards (Handy, 1923). Indeed, the image of the *vahine*, the seductive and beautiful young woman is associated with these Pacific islands (Martin, 2007; Layton, 2015). Embellishment is an inherent part of everyday life as well as a cultural practice. Both men and women use ointments - known as monoi – for their body and hair. Different leaves, barks, wood and flowers are added to coconut oil, namely tiare or Tahitian gardenia (*Gardenia taitensis* DC.), sandalwood (*Santalum insulare* Bertero ex A.DC.), *Fitchia nutans* Hook.f.*, Sigesbeckia orientalis* L., etc. (Girardi *et al.,* 2015; Ansel *et al.,* 2016c) and rubbed or massaged on the skin to perfume, hydrate and protect their hair and skin (Handy, 1923; Whistler, 1985; Pétard, 1986). Naturally, this has stimulated studies on defining cosmetopoeia and some applications in French Polynesia (Ansel *et al.,* 2016 a/b/c). Five groups of traditional cosmetic allegations stemmed from these articles. Dermatology (allegation 1) is a cosmetic allegation with a medicinal aspect. Indeed, this category includes claims like wound healing, treating burns, treating eczema, treating abscesses, antiseptic properties, anti-inflammatory, antimicrobial, treating cuts and rashes, astringent and healing or treating any other affections of the dermis and hypodermis. Ulcers were also accounted for as chronic wounds (Agyare, 2016; Jarić, 2018). Action on epidermis (allegation 2), includes all traditional treatments that affect the outmost layer of the skin (its elasticity, its hydration, its general aspect, maintenance and its protection). Pigmentation (allegation 3) incorporates any folk preparations used for skin whitening or inversely bronzing, against blemishes and as skin pigments. “Skin appendages” renamed “hair and nails” (allegation 4) encompasses all traditional uses and preparations concerning hair, hairs and nails, their coloration, care and maintenance. Lastly, “Toiletry” (allegation 5) includes all uses and preparations with properties such as cleansing, for dental hygiene, general hygiene, against sweat, perfume, makeup and invigorating baths as well as closely associated claims (Ansel *et al.,* 2016a). The results from the previous research on the topic led to a cosmetic-oriented ethnobotanical study in the Marquesas Islands (Jost *et al.,* 2016) that sheds light on the cosmetic richness of traditions in Polynesia. These traditional allegations are each linked to modern concepts of skin and hair care.

Our present work aims after this previous prospective as well as applied research, to select and further study plants of French Polynesia with great potential to be developed as anti-ageing, whitening and hair care ingredients. In this effort, a plant selection was conducted starting from the Inventory of Existing Cosmetic Ingredients in China or IECIC 2015 (CFDA, 2015). The plants were selected through literature review of traditional cosmetic allegations such as dermatology and action on epidermis that we linked to anti-ageing, pigmentation related to a whitening application and skin appendages focused on hair growth. Further literature analysis of known biological activities and

chemical composition of the plants was also necessary to pinpoint the most promising ones. Finally, a preliminary testing of the antioxidant and anti-inflammatory activities of the selected plants was useful in narrowing the number of plants to further our studies on. The compilation of the ethnobotanical data as well phytochemical data of the active plant extracts enabled us to better assess their development potentialities and area of cosmetic application to pursue in.

2. Materials and Methods

2.1. Bibliographical selection

The data compilation pertaining to traditional uses, biological activities and chemistry of the plants was done using several bibliographical sources, namely ScienceDirect, PubMed, Google scholar, grey literature, books and articles from international and national organizations. Traditional cosmetic uses of interest were those that applied to French Polynesia primarily, the whole Polynesian region and more widely the Pacific region. Asian traditional uses were also included, as various plants present in French Polynesia are originally South-East Asian plants introduced into the Pacific by the ancestors of the Polynesians since their migration across the Pacific Ocean (Christian, 1897; Whistler, 2009).

Several other criteria were examined for our plant selection such as being part of French Polynesia flora and their presence in the IECIC. The IECIC 2015 was used as our primary selection list. This inventory contains over 8,000 cosmetic ingredients with 1,562 plant extracts mentioned. It ensures that the selected plants are more easily marketable as cosmetic ingredients. It also lessens the financial demands and time consumption of proposing a new plant to be included in this authorized list. The Nadeaud database (Florence *et al.,* 2007), with 2,320 taxa listed, was used as the reference list of all plants present in French Polynesia. The comparison between the IECIC 2015 and Nadeaud botanical database led to establish a list of 257 plants' matches (Supplementary material Table S1). These 257 plants of French Polynesia flora were either indigenous, Polynesian introductions or modern introductions. Modern introductions are plants introduced from the 18^{th} – 19^{th} by European settlers till this day (Fourdrigniez & Meyer, 2008). Polynesian introductions occurred some 1,200 years ago and are plants that were carried and introduced by Polynesians during their voyages across the Pacific (Whistler, 2009). Indigenous species are those that were there prior to Polynesians arrival but are found elsewhere in the world, i.e. are not endemic to French Polynesia. Firstly, we considered the biogeographical status of the plants and their botanical relevance. Indigenous plants and Polynesian introductions were selected. Indeed, indigenous plants are of greater interest in our present aim to select plants from the region, but more so Polynesian introductions. The latter account for useful plants brought by the ancestors of the Polynesians on

their canoes, whether as dietary [crops] or medicinal plants (Whistler, 2009). Thus, these plants had a high likelihood of being part of the Polynesian pharmacopeia and potentially its cosmetopeia. Modern introductions were not excluded altogether. We included modern introductions well integrated in Polynesian ethnobotany, those having local cultigens of interest, and some invasive plant species that could be controlled by exploitation. Of the initial 257 plants, 41 remained after this first selection. A second processing step consisted in disregarding all modern introductions and Polynesian introductions that are common to many countries' flora and Polynesian introductions with no Polynesian ethnopharmacological uses or specificity. Also, their chemical composition paired to biological activities of cosmetic interest were analyzed. Also, because our approach considers a sustainable development of plants, the availability of the plant material, their conservation status (i.e. threatened or protected species) were also reviewed. Threatened species were naturally excluded from our selection. This led to a finalized list of the most promising ones.

2.2. Plant collection and extraction

All plants and plant parts chosen were collected between December 2017 and April 2018 in French Polynesia. Some were collected in the Society Islands and others in the Marquesas Islands. They were identified by the botanist Jean-François Butaud and vouchers were deposited at the herbarium of French Polynesia (PAP).

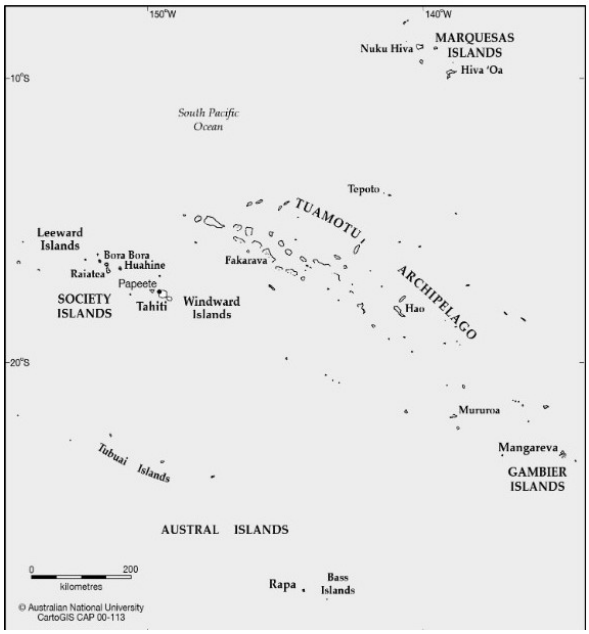

Figure 1 : Map of French Polynesia with the Society Islands in the West and the Marquesas Islands in the North-East

The different parts were oven-dried at 40°C then ground to a 2mm powder. A third of the powder of each plant part was extracted with 2L of ethyl acetate (AcOEt), a third was extracted in 2L of ethanol:water (1:1) (EHO) and a third was extracted in 2L of water water (H_2O). This resulted in three

extracts of differing polarity per plant part. The extractions were achieved by maceration for 12 hours, under agitation. The dried extracts were obtained after evaporation of volatile solvents and freeze-drying of aqueous extracts. An aliquot of each dried extract was later dissolved in dimethyl sulfoxide to obtain a solution used for the two biochemical screenings.

2.3. Fluorescence recovery after photobleaching (FRAP)

In order to evaluate the antioxidant properties of the extracts, an adapted FRAP assay was conducted according to previous papers (Benzie & Strain, 1996; Adebiyi *et al*., 2017). Different concentrations of Trolox ranging between 20 $mg.L^{-1}$ and 1 $mg.L^{-1}$ were prepared to make a standard curve.

A volume of 50 µL of extract or product tested were mixed with 50 µL of distilled water in a 96-well Greiner plate. Then, 200 µL of FRAP solution were added and the plate was left to incubate for an hour at 37°C. The resulting absorbance was read at 593 nm with a spectrophotometer (TECAN Spark).

The standard curve was plotted:

$DO = a^* [Trolox] + b.$

The antioxidant activity of the extracts is determined in µmol Trolox equivalent/g of dry matter. All results were obtained in triplicates and the standard deviation (SD) was calculated for each value.

2.4. 5-lipoxygenase assay

In order to assess the anti-inflammatory activity of the extracts, each was tested in a quartz cuvette. A volume of 2,95 mL of phosphate buffer at pH = 9 was mixed with 30 µL of the tested product or extract, 10 µL of 5-lipoxygenase at 50 000 $U.mL^{-1}$and 10 µL of either linoleic acid or blank solution for the positive or negative control respectively (Akula & Odhav, 2008). The absorbance was read at 233 nm for 60 seconds with 10 seconds intervals on a spectrophotometer U-2001 Hitachi. For each concentration, the 5-lox inhibition percentage was determined as follows

$$\% \text{ inhibition (at a given concentration)} = 100 (([\text{O. D sample}]_{t = 1 \text{ min}} - [\text{O.D. sample}]_{t = 0 \text{ min}}) * 100 / ([\text{OD control}]_{t = 1 \text{ min}} - [\text{O. D. control}]_{t = 0 \text{ min}}))$$

The IC50 in % dry mass is determined using the equation, y = ax + b, resulting from the percentage of inhibition as a function of the concentration where IC 50 = (50 -b)/a.

3. Results and discussion

3.1. Plant selection and literature data

In this present paper, we sought to study whether the Polynesian cosmetopoeia proposed interesting candidates for cosmetic development and what cosmetic applications were most relevant. Few ethnocosmetic studies exist in this region, so our first aim was to select the most interesting plants according to allegations described by Ansel *et al.* (2016). Upon several screening processes and literature analysis of the initial 257 plants that are explained in Materials and Methods part, we limited our selection to eleven plants that showed interesting ethnocosmetic uses in the Pacific region and accounted for compounds and biological activities relevant in skin and hair care. Table 1 represents a summary of the botanical and collection information of the eleven selected plants, *Adenanthera pavonina, Aleurites moluccanus, Bacopa monnieri, Bidens pilosa, Calophyllum inophyllum, Cordyline fruticosa, Fagraea berteroana, Gardenia taitensis, Morinda citrifolia, Sigesbeckia orientalis* and *Tephrosia purpurea* var. *purpurea*. Amongst these plants, *A. pavonina* and *B. pilosa* belong to the modern introductions category and were chosen because they possess interesting traditional cosmetic uses specific to Polynesia (Table 2; Whistler, 2009). The nine remaining plants are either Polynesian introduced ones or indigenous species possessing traditional cosmetic uses of interest for our study. A direct consequence of using the IECIC was that no endemic plants remained in this short list, whereas they account for 60% of native species (Florence & Moretti, 2006), the other 40% being indigenous species. Indeed, little work has been done on endemic plants of French Polynesia for their cosmetic development. Thus, none are listed in any international cosmetic inventory. This observation demonstrates the vast opportunity endemic plants offer for economic development in the cosmetic field. Our lack of endemic plants in this study is not penalizing and remains representative of the plants used as traditional cosmetics in French Polynesia. Indeed, in the Marquesas archipelago, endemic plants account for only 5% of the plants used in traditional beauty preparations (Jost *et al.,* 2016). They are more present in the overall folk cosmetics of French Polynesia as they make up 27% of used plants versus 32%, 26% and 15% for indigenous, modern introduced and Polynesian introduced plants respectively (Butaud, 2013).

Table 1 : Botanical and collection data of the eleven selected plants from the Society and Marquesan archipelagoes

Plant parts: L (leaves), S (seeds), B (bark), WP (whole plant), F (fruits), Fl (flowers), St (Stem) and R (roots). UPF (University of French Polynesia). Local name T = Tahitian and M = Marquesan. Biogeographical status: Mod = Modern introduction, Pol = Polynesian introduction and Ind = Indigenous.

Scientific name	Family	Voucher number	Common name	Local name (T) or (M)*	Biogeographical status	Type of plant	Plant part*	Collection or arrival date	Location	Island (Archipelago)	GPS coordinates	Dry weight collected (g)
Adenanthera pavonina L.	Fabaceae (Leguminoseae)	K HUGHES & T THEOPHILUS 1	Coralwood	Pitipiti'o popa'a (T), Poniu hao'e (M)	Mod	tree	S	12/11/2017	UPF	Tahiti (Society)	17°34.620' S 149°36.445' W	1560 (fresh)
Aleurites moluccanus (L.) Willd. (syn. *A. moluccana*)	Euphorbiaceae	K HUGHES & JF BUTAUD 2	Candelnut tree	Ti'a'iri (T), 'Ama (M)	Pol	tree	L	12/1/2017	Papehue valley	Tahiti (Society)	17°39.602' S 149°34.444' W	350
							B					1400
Bacopa monnieri (L.) Wettst.	Plantaginaceae (formerly Scrophulariacae)	K HUGHES (leg C TAATA) 3	Water hyssop	Heiotona (M)	Ind	herb	WP	12/11/2017	Ho'oumi	Nuku Hiva (Marquesas)	08°53.250' S 140°01.767' W	443
Bidens pilosa L.	Asteraceae (Compositeae)	JF BUTAUD & K HUGHES 3594	Black-Jack	Piripiri (T)	Mod	herb	WP	12/9/2017	Mount Marau	Tahiti (Society)	17°35.986' S 149°34.222' W	1551
Calophyllum inophyllum L.	Calophyllaceae	K HUGHES 8	Alexandrian laurel	Tamanu (T), Temanu (M)	Pol	tree	L	2/9/2018	UPF	Tahiti (Society)	17°34.645' S 149°36.365' W	333
							F	3/29/2018	Provided by the *Laboratoire de Cosmetologie du Pacific Sud*			962
Cordyline fruticosa (L.) A.Chev. (syn. *C. terminalis*)	Asparagaceae (formerly Agavaceae)	K HUGHES 6	Cordyline	'Autī or Tī (T) & (M)	Pol	shrub	L	1/15/2018	Pamatai	Tahiti (Society)		222
Fagraea berteroana A.Gray ex Benth.	Gentianaceae (former Loganiaceae)	K HUGHES 4	Pua keni keni	Pua (T), Ka'upe (M)	Ind	tree	B	12/9/2017	Mount Marau	Tahiti (Society)	17°35.840' S 149°33.916' W	429
							L				17°35.840' S 149°33.916' W	1524
							F	4/26/2018	UPF		17°34.646' S 149°36.363' W	1350
Gardenia taitensis DC.	Rubiaceae	K HUGHES & T LEHARTEL 7	Tahitian gardenia	Tiare Tahiti (T), Tia'e (M)	Pol	shrub	Fl	1/10/2018	Taravao	Tahiti (Society)	17°44.147' S 149°16.933' W	240
Morinda citrifolia L.	Rubiaceae	K HUGHES 9	Noni	Nono (T), Noni (M)	Ind	shrub	L	2/12/2018	UPF	Tahiti (Society)	17°34.636' S 149°36.501' W	354
Sigesbeckia orientalis L.	Asteraceae (Compositeae)	JF BUTAUD 3659	Common St. Paul's wort	'Ami'a (T), Nio'u (M)	Ind.	herb	WP	3/21/2018	South of summit	Me'eti'a (Society)	17°52.555' S 148°04.0483'W	22
Tephrosia purpurea var. *purpurea* (L.) Pers (syn *T. piscatoria*)	Fabaceae (Leguminoseae)	K HUGHES (leg J SIMONNEAU) 5	Fishpoison	Hora (T), Kohuhu (M)	Pol	shrub	B	12/14/2017	Plateau des ânes	Ua Pou (Marquesas)	09°20.883' S 140°04.467' W	243
							L & St					1129

Table 2 presents a literature compilation of the ethnobotanical information gathered on the eleven selected plants while table 3 concentrates on phytochemical data. In order to assess each plant's cosmetic potential, we studied their ethnocosmetic uses in French Polynesia and Polynesia primarily, but also in South-East Asia. The eleven selected plants were classified according to the 5 pre-existing groups of cosmetic allegations (Ansel *et al.,* 2016a).

Table 2 : Traditional cosmetic uses and their corresponding allegations (number in brackets) of the different plant parts in the Pacific-Asian region

Scientific name	Parts used[+]	Traditional uses (and reported cosmetic allegation)	References
Adenanthera pavonina	S	Crushed seeds used as cataplasms to ripen abscesses (1)	Pétard, 1986
	B	Solomon Islands: bark used to treat leprosy (1)	WHO, 1998
Aleurites moluccanus	F (Nut, Seeds)	Raw nuts used to cleanse vaginal discharge Hawaii: oil to treat infants with dry skin, on burns, to prevent stretch marks during pregnancy, therapeutic massage oil (2), fruits for cuts and purulent cutaneous infections, ulcers and abscesses (1) Tonga: chewed nuts used as a soap substituent (5) Samoa: crushed seeds rubbed unto skin sores, head sores and on skin fungus called 'utu (1). Chewed preparations also applied to hair to give it an aroma (5) Marquesas: green fruits crushed as well as sap for skin diseases such as baby's thrush Fiji: the sap of the fruit is used to treat conjunctivitis (1) Hawaii and Tonga: fruits for scalp (4)	Brown, 1935 Zepernick, 1972 Pétard, 1986 Whistler, 1991, 1992, 2000 WHO, 1998
	B	Grated bark along with sap to treat coral wounds (1) Marquesas: bark for cuts (1) and genital hygiene (5) Fiji: treat gingivitis (1)	Zepernick, 1972 Pétard, 1986
	L, St	Marquesas islands: feminine intimate hygiene (5), lymphatic infections, oral and thyroidal abscesses (1) and skin diseases (1) Hawaii: leaves were used as poultice for swellings and infections (1)	Zepernick, 1972 Krauss, 1974 Girardi *et al.,* 2015
Bacopa monnieri	AP	Marquesas: medicinal herb (1) India: used to prevent dandruff and hair loss (4)	Brown, 1935
Bidens pilosa	L	Cook Islands: crushed or chewed and used to dress knife wounds (1) Powder obtained from rubbing the yellow flower between one's fingers is applied on boils to extract the pus (1) Philippines: leaves are used to treat boils (1) Marquesas and Rapa: used as poultice and to dress cuts (1) Tonga: leaves applied on inflamed eyes (1)	Brown, 1935 Chopra *et al.,* 1956 Zepernick, 1972 Whistler, 1985
	WP	Marquesas and Rapa: whole as poultice and to dress cuts (1)	Brown, 1935 Zepernick, 1972
Calophyllum inophyllum	NO	French Polynesia: eczema and infections, wound healing (1), hair care (4) Tonga: coconut oil and *C. inophylllum'*s nut oil mixed to prepare Tongan oil	Krauss, 1974 Pétard, 1986

		used in massages (2) Fiji: used to grease bodies (2)	Whistler, 1991 Dweck & Meadows, 2002 Jost *et al.,* 2016
	L	Papua New Guinea: skin problems such as skin ulcers, boils, cuts and pimples, sores, skin rash (1) New Caledonia and Samoa: skin inflammations and wounds, leg ulcers (1) Tonga: infusion of leaves applied on sores and rashes (1)	Whistler, 1992 Dweck & Meadows, 2002
	B	Samoa: bark for skin inflammations (1) Tubuai: bark as remedy for any infected sores and skin ailments (1)	Aitken, 1930 Zepernick, 1972
	Fl	Tonga, Samoa: flowers perfume coconut oil for scalp care (4)	Zepernick, 1972
Cordyline fruticosa	L	Marquesas : umbilical hernia, ulcers (1)Indonesia: anti-balding lotion from rhizome and leaves (4), on sunburns, to ripen abscesses (1) Tahiti: vulnerary, sprains, contusions, dress wounds, the pulp (+monoi tiare) rubbed on the ear for anti-otorrhea action, anti-lymphangitis, emmenagogue for internal tumors and intestinal antispasmodic (1) Tonga: Juice (of whole plant?) used on swollen eyes and toothaches (5) and gum infections (1) Samoa: dipped into water very commonly used by healers and lay people to treat inflammation such as skin inflammation, headches and other body aches. Also used in general massage (1)	Zepernick, 1972 Pétard, 1986 Whistler, 1991, 1992, 2000
	R	Fiji: roots used to treat baldness (4) and toothaches (5)	Zepernick, 1972 WHO, 1998
Fagraea berteroana	F	Prevent hair loss on embalmed cadavers (4)	Handy, 1923 Brown, 1935
	Fl	French Polynesia and Samoa: flowers used in monoi (2), floral crowns and leis	Whistler, 2000 Girardi *et al.,* 2015
	L & B	New Caledonia: rheumatisms and irritations caused by the latex of *Semecarpus spp* (1)	Billo *et al.,* 2005
Gardenia taitensis	Fl	French Polynesia, Tonga, Samoa: tiare flowers macerated in coconut oil for massages (2) Samoa: leaves or crushed flowers massaged unto the skin. Infusion used as potion to treat inflammation (1) American Samoa: plant used to treat infants' inflammations (1) Tonga: monoi used for newborn's hair (2)	Zepernick, 1972 Pétard, 1986 Whistler, 1991, 2000 WHO, 1998
	FlB	Treat abscesses, on infected wounds (1)	Pétard, 1986
Morinda citrifolia	F	Samoa, Tonga, Futuna: crushed fruits for toothaches (1) Micronesia: fruits applied on ulcerated sores on the feet (1) Tahiti: ripe fruits to treat corneal abrasions (1) Hawaii: ripe fruits used as poultice (1). Juice obtained from fruits applied to head to clear hair of lice (4)	Krauss, 1974 Grépin & Grépin, 1984 WHO, 1998
	L	Tokelau: chewed leaves used against anthrax, swelling, boils and abcesses. Heated leaves used to treat hemorrhoids or cut to pieces and mixed with coconut oil to massage inflammations. (1, 2) French Polynesia: leaves applied on skin to reduce breast inflammation (1) Hawaii: leaves for wounds, bruises and contusions as well as to treat skin inflammation (1) sometimes mixed with the ripe fruits for the same use Fiji: young sprouts to heal skin ailments and leaves against rheumatism and to	Zepernick, 1972 Pétard, 1986 Whistler, 1988, 1992, 2000

		treat skin inflammation (1) Samoa: Leaves or infusion of leaves sometimes massaged unto body aches and various types of inflammation. The same medicine sometimes used for boils, infected wounds and swellings (1) Tonga: leaves applied to boils (1)	
	S	Hawaii: seeds and bark for cuts (1)	Zepernick, 1972
	R	Hawaii: roots against skin eruptions (1) New Guinea: roots unto centipede bites. Infusion of root bark to treat skin diseases and sores on the feet (1) Cook: infusion of grated roots to treat stone fish stings (1)	Zepernick, 1972 Whistler, 1992 WHO, 1998
	B	Tonga and Fiji: relieve skin inflammation (1)	Zepernick, 1972
	Fl	Tonga and Samoa: petioles and flowers used to treat sties (1)	Whistler, 1992
Sigesbeckia orientalis	L, R	Tahiti: treat wounds and contusions (1), also used in monoi (2) Leaves are pounded and rubbed on the face for skin whitening (3) New Caledonia: leaves are used to dress wounds (1) New Guinea: leaves softened from being warmed over a fire are applied to sores (1) Tonga: crushed leaves used to treat infants skin ailments (1)	Handy, 1923 Chopra *et al.,* 1956 Rageau, 1973 Pétard, 1986 Holdsworth *et al.,* 1989 Whistler, 1991 Girardi *et al.,* 2015
	AP	Samoa: used in scented oil (2) Cook: treat wounds or skin sores (1)	Whistler, 1992, 2000
Tephrosia purpurea var. purpurea	L	Hawaii: leaves used as lotion for skin ailments, impetigo, ring worms, and rashes (1)	Whistler, 1992

Cosmetic allegations classes 1 to 5 as determined by Ansel et al., (2016a). 1 dermatology, 2 action on epidermis, 3 pigmentation 4 hair and nails and 5 toiletries. [+]Plant parts abbreviations S = Seeds, AP = Aerial Parts, W = Wood, R= Roots, B= Bark, L = Leaves, N = Nut, St = Stem, F =Fruits, NO = Nut Oil, SB = Stem Bark, Fl = Flowers, CC = Cell culture, FlB = Flower bud, WP = Whole plant

We focused on cosmetic applications of interest regarding anti-ageing / well-ageing, anti-blemish, hair care, pigmentation and UV-protection as they cover the main cosmetic demands. Thus, the most relevant traditional allegations were allegations 1 and 2 for anti-ageing, allegation 4 for hair care and depigmentation linked to the third allegation. In this study, the main hair-related allegations targeted were promotion of hair growth or prevention of hair loss. The fifth allegation concerning toiletries was not prioritized in our study and was only mentioned for plants within traditional preparations falling in categories 1 through 4. While toiletry-related uses will briefly be discussed, no cosmetic development will be proposed for the corresponding plant parts.

The eleven plants have dermatology related uses, allegation 1. The main claims are for wound healing or wound dressing and to treat boils and abscesses (Table 2). Also, an ointment of great importance in the Pacific region is produced from expressing oil from *Calophyllum inophyllum* kernels. The resulting tamanu oil was used to treat a plethora of skin ailments, but its main property

remains to heal wounds. Another aspect of dermatology-related preparations cited is plants used as ointments or cataplasms for their anti-inflammatory properties. For example, *Morinda citrifolia* leaves are used in massages to reduce inflammation, including breast inflammation. Our results, showing that the first allegation is the most cited followed by the second allegation, concur with those of a previous study on cosmetopoeia in tropical regions. This study showed that the main allegations cited for families of lignified plants are the first allegation followed by the second allegation, except in the *Arecaceae* family, where the order of importance was inverted (Ansel *et al.,* 2016a). Furthermore, the greater number of plants, plant parts and citations in this first category only proves the focus given on pharmacological uses of plants. Indeed, these claims can be included in both pharmacopoeia and cosmetopoeia. As for the second allegation, it is supported by four plants. The nut oil of *A. moluccanus* is used to prevent chapped skin and as therapeutic massage oil. *S. orientalis*, the flowers of *G. taitensis* and the fruits of *F. berteroana* are each three macerated in coconut oil to prepare distinct monoi. While the main hydration claim is met by the excipient used i.e coconut oil for the plants of the second allegation, the macerated plant organs and their intrinsic properties could bring added benefits and activities to the resulting oils (Ansel *et al.,* 2016c).
Preparations regarding wound-healing, treatment of boils and abscesses, inflammation reduction and skin hydration were of interest for an anti-ageing application. Indeed, the occurrence of abscesses is due to bacterial infection and swelling (Bass, 1975). The latter being a consequence of the activation of inflammation responses. Ultraviolet rays are the most common cause of extrinsic skin aging (Tobin, 2017). Exposure to UV rays leads to inflammation by upregulating the mitogen activated protein kinase MAPK pathway and causing the phosphorylation of c- Jun terminal kinase JNK, factor p38 and Extracellular signal-regulated Kinases 1 & 2, ERK1/2 in keratinocytes (Carlson *et al.,* 2008; Lei *et al.,* 2017). It also subsequently leads to the release of pro-inflammatory cytokines such as Interleukin-1 (IL-1), IL-6, Tumor Necrosis Factor-alpha (TNF-α). Both skin-ageing and wound-healing implicate the MAPKinase pathway (Zhao *et al.,* 2017) which explains why we chose to focus on these traditional uses. To summarize, plants having biological activities such as anti-microbial, anti-inflammatory, MAPKinase suppressant were evaluated to determine whether they would be relevant for an anti-aging application. We also reviewed if the plants had effects on collagen, elastin, proteoglycans and metalloproteinases production.

UV exposure also induces pigmentation. During melanogenesis, melanocytes produce melanosomes that contain a pigment called melanin. Melanin is essential to protect the skin against UV radiations and photo-induced carcinogenesis (Berlotto *et al.,* 2001; Costin & Hearing, 2007; Yamaguchi & Hearing, 2009, Yamaguchi *et al.,* 2016). They do so through tyrosinase, one of the main targets used in the cosmetic industry to test compounds' lightening (or brightening) activity.

Tyrosinase is~~s~~ an enzyme that catalyzes the reaction of substrate L-tyrosinase to L-DOPA further transformed to dopaquinone. The last product will lead to the production of either to pheomelanins, yellow-reddish pigments with the addition of cysteine, or eumelanins, brown-black pigments, in the presence of tyrosinase related proteins 1 and 2, TRP1 and TRP2 (Berlotto *et al.*, 2001). The involvement of keratinocytes in the pigmentation process makes them an interesting cellular target to study, as well as melanocytes, when screening for cellular pigmentation activity of extracts. Indeed, UV radiations stimulate tumor protein p53 in keratinocytes, that bind to the promoter of pro-opiomelanocortin (POMC) and leads to the synthesis of this precursor molecule. POMC cleaves into two hormones, the adrenocortinicotrophic hormone (A-CTH) and the melanocyte stimulating hormone (α-MSH) (Cui *et al.,* 2007; Yamaguchi & Hearing, 2009). Either A-CTH or α-MSH agonist will bind to melanocyte receptor, M1CR. The activation of M1CR will subsequently lead to stimulation of the microphthalmia-associated transcription factor (MITF) via up-regulation and production of AMPc. MITF stimulates the expression of TRP1, TRP2 and tyrosinase and thus eumelanogenesis, which leads to skin browning or tanning (Berlotto *et al.*, 2001; Yamaguchi & Hearing, 2009). Our focus is primarily on induced melanogenesis and preventing the appearance of irregular skin tone and dark spots. *Sigesbeckia orientalis* is the only plant among those retained that is traditionally used for an effect on pigmentation. Indeed, the pounded leaves served as a skin bleaching preparation used by women in the Marquesas Islands (Handy, 1923; Table 2). At this preliminary level, we reviewed if any of the eleven plants produced compounds known to inhibit tyrosinase, to target the proliferation of melanocytes and their dendricity, the transport of eumelanin from melanocytes to keratinocytes or any component of the melanogenesis cascade.

Four plants are used in traditional preparations to prevent hair loss or promote hair growth, *B. monnieri*, *C. inophyllum*, *C. fruticosa* and *F. berteroana*. *A. moluccanus* and *M. citrifolia* have hair related uses for the scalp and to reduce lice respectively. Quite interestingly, both in Indonesia and in Fiji, the roots or rhizomes are used against baldness. In Indonesia, the leaves are also used in the preparation. The choice of plants of interest for their putative hair growth abilities was achieved by pairing traditional uses in the 4th allegation category with literature information supporting such claims, when possible. During normal growth, hair undergo cycling in three phases: anagen or hair follicle formation and elongation phase lasting 2 to 6 years, catagen corresponding to the apoptotic phase of the epithelial cells, hence growth arrest lasting 10 days and telogen characterized by a resting/quiescent phase and finally shedding for 3 months (Sennett & Rendl, 2012; Oh *et al.,* 2016). Thus, in studying plants capable of preventing hair loss or promoting hair growth, two transition phases are targeted: telogen to anagen and anagen to catagen. The longer the anagen phase, the longer the hair produced. From the telogen to anagen phase, the Bone Morphogenic Protein (BMP)

pathway is inhibited while the Wnt pathway is activated. Its activation by binding to its Frizzled (Fzl) receptor will inactivate GSK3-β through phosphorylation, allowing β-catenin to accumulate in the cytoplasmic region – as opposed to β-catenin being ubiquitinated and degraded when the pathway is inactivated. An accumulation of β-catenin in the cytoplasm will allow it to translocate to the nucleus and activate cell proliferation factors and genes Insulin-like Growth Factor 1 (IGF1), Vascular endothelial growth factor (VEGF), cyclin D1, lef1 in human hair follicle dermal papilla cells HFDPC (Li *et al.,* 2012; Plikus, 2012). This promotes angiogenesis and enables epithelial stem cells to proliferate, divide and begin the process of creating a new hair follicle through DP cells signalling. In comparison, entry into the catagen phase is mediated by several factors including the Fibroblast Growth Factor 5 (FGF5) that binds to Fibroblast Growth Factor Receptor 1, resulting in an inhibition of genes implicated in hair elongation and Dikkopf-1 DKK1 that inhibits Wnt pathway and namely Wnt10 (Kwack *et al.,* 2012 Higgins *et al.,* 2014). Herbal compounds able to interfere with pathways or molecules involved in hair cycling, especially in the anagen and catagen phase are already available (Herman & Herman, 2016). They include targets that alleviate the effects of AGA and AA. Androgenetic alopecia is thought to be caused by a shortening of the anagen phase (Inui & Itama, 2011). Indeed, androgenetic alopecia is caused by testosterone catalyzed to dihydroxytestosterone (DHT) by type II 5α- reductase. The resulting DHT binds to androgen receptors causing a down-regulation of the Wnt pathway and up-regulation of BMP/TGFβ pathway leading to miniaturization of hair follicle via cell apopotosis, thus shortening the anagen phase and entering and prolonging catagen and later telogen phases (Hibino & Nishiyama, 2004, Lu *et al.,* 2016). Alopecia areata (AA) is an autoimmune disease that causes hair follicles to attack and destroy themselves. Its precise cause and mechanisms are yet to be discovered. As inflammatory pathways are upregulated in patients suffering from AA, broad inhibitors of the JAK/STAT pathway are used (Han, 2017; Gilhar *et al.,* 2019). At this stage, apart from the traditional use in capillary protection, the chemical composition of the four plants or otherwise explicit biological activity to prevent hair loss were the only means to determine the plant's potential. Any biological activity recorded concerning factors, mechanisms and pathways involved in hair cycling (elongation, arrest, and quiescence) as described above as well as effects resulting in amelioration of AGA were reviewed or searched for.

As for the fifth allegation, the nuts from *A. moluccanus* were used as a soap substituent while the leaves and bark are both used to prepare a cleansing solution for the vagina. This particular use in feminine hygiene is noted for the Marquesas Islands (Table 2). The toiletry allegation from the Marquesas Islands observed in our ethnobotanical data is quite revealing of this specificity. Intimate hygiene whether female or male is an important cultural practice that is more prevalent in the Marquesan archipelago than in other areas of French Polynesia. According to Jost *et al.* (2016), intimate hygiene is the third category having most citations after skin and hair care as private parts

are the third most cited application area. During our literature review, many plants had preparations treating genital diseases (gonorrhea, leucorrhea…) with more of a medicinal or healing aspect but a limited number were specific on hygienic uses that cover a cosmetic aspect. Other aspects of toiletries such dental hygiene with toothache cures, and perfume were also found among the 11 reviewed plants.

For the eleven plants, leaves, flowers, fruits and nuts as well as resulting oils are the main constituents of traditional cosmetic-related preparations. They all correspond to renewable plant parts rendering their use less environmentally harmful. Nevertheless, the bark is also used according to several citations, for example *A. moluccanus* to treat wounds infected by corals (Pétard, 1986) or *F. berteroana* whose leaves and bark were used against irritations caused by the latex of trees of the *Semecarpus* species in New Caledonia and Vanuatu (Billo *et al.,* 2005). The roots are also mentioned for *Sigesbeckia orientalis* (Table 3) or *C. fruticosa*. Most uses in this study imply one plant part, according to our literature accounts, except for two citations where the bark is associated with another plant part. *A. moluccanus* bark and sap are used and *F. berteroana* bark and leaves. In both cases, the application involves the reduction of irritation either directly or indirectly. The involvement of single plants or single plant parts in traditional preparations makes their biological study less challenging as it simplifies the attribution of a detected activity. However, some plant associations are noticeable. The pulp of *C. fruticosa* is mixed with monoi tiare to apply on ear inflammations (otorrhea). The most common mixture remains coconut oil (Girardi *et al.,* 2015; Jost *et al.,* 2016) in which, in our case, fruits or flowers are macerated. Once the plant parts were selected and our activities of interest were defined in accordance with traditional allegations, plant parts of interest were chosen and extracts were screened using various bioassays to identify the most active ones.

Table 3 : Chemical composition and related biological activities of the eleven plants

Scientific name	Parts used[+]	Chemical composition	Biological activities
Adenanthera pavonina	S	Fatty acids such as linoleic, gadoleic, palmitic, lignoceric, oleic, arachidic and stearic acids (Ezeagu *et al.,* 2004)	Antibacterial (Soares *et al.,* 2014), anti-inflammatory *in vivo* (Olajide *et al.,* 2004), anti-inflammatory on macrophages (Koodalingam *et al.,* 2015), antiviral (de Godoi *et al.,* 2014) antidiabetic (Pandhare *et al.,* 2012)
	AP	Pavonin lactone (Ali *et al.,* 2005)	
	W	Flavonoids (robinetin, butein) and flavanonols (ampelopsin or dihydromyricetin and dihydrorobinetin) (Gennaro *et al.,* 1972)	Antioxidant (Gennaro *et al.,* 1972)
	R & B	Triterpenoids: stigmasterol, methyl oleanolate, methyl echinocystate, stigmasterol glycoside and acid echinocystic methyl ester (Yadav *et al.,* 1976; Chandra *et al.,* 1982)	Anti-inflammatory (Mayuren & Ilavarasan, 2009)

	L	Flavonoids : quercetin 3-O-α-dirhamnopyranosyl-(1''' -> 2'',1'''' -> 6'')-β-glucopyranoside-4'-methoxy, kaempferol-3-O- α -dirhamnopyranosyl-(1''' -> 2'',1'''' -> 6'')- β-glucopyranoside, isovitexin, quercetin, kaempferol, quercetin-3-O- β -glucopyranoside, quercetin-3-O-rhamnopyranosyl(1''' -> 4'')- β -glucopyranoside, quercetin-3-O-β-glucopranoside-4'-O-rhamnopyranoside, kaempferol-3-O- α-rhamnopyranosyl(1''-> 2'')-β-glucopyranoside and quercetin-3-O-rhamnopyranosyl (1''' -> 2'')-β-glucopyranoside (Mohammed *et al.,* 2014) stigmasterol glucoside, dulcitol, stigmasterol, octacosanol and glucosides of β-sitosterol (Nigam *et al.,* 1973)	Anti-inflammatory (Ara *et al.,* 2010) Antioxidant (Mohammed *et al.,* 2014; Wickramaratne *et al.,* 2016) Anti-quorum sensing (Vasavi *et al.,* 2015)
Aleurites moluccanus	N	Nut oil: Palmitic, stearic, oleic, linoleic and linolenic acids (Ako *et al.,* 2005)	Antioxidant (Athar & Nasir, 2005; Siddique *et al.,* 2011) Anti-rheumatic arthritis (Cock *et al.,* 2015)
	B	3-acetylaleuritolic acid and scopoletin (Prabowo *et al.,* 2013), tannins of the mid red bark (Pétard, 1986) and acetylaleuritolic acid (Meyre-Silva *et al.,* 1997)	
	L, St	Leaves: Various megastimanes vomifoliol-9-O-β-apiofuranosyl-(1'' -> 6')-β-glucopyranoside, (6S,9R)-roseoside, debiloside, 3-oxo-α-ionol-O-β-apiofuranosyl-(1'' -> 6')-β- glucopyranoside and 3-oxo-α-ionol-O-β-glucopyranoside (da Silva *et al.,* 2012) Flavonoids such as 2''-O-rhamnosylswertisin and swertisin (Quintao *et al.,* 2011), phytosterols namely β-sitosterol, stigmasterol, campesterol as well as triterpenes α- amyrin, β- amyrin and n-hentriacontane (Meyre-Silva *et al.,* 1998). Also, moluccanic acid, methyl ester moluccanic acid, 6,7-dehydromoluccanic acid (Liu *et al.,* 2008) Stem: Coumarinolignoids extract such as moluccanin (Shamsuddin *et al.,* 1988) Twigs: Moluccanic acid, methyl ester moluccanic acid and 6,7-dehydromoluccanic acid (Liu *et al.,* 2008)	Cutaneous anti-inflammatory activity (Cesca *et al.,* 2012; Hoepers *et al.,* 2015), antinociceptive (Cesca *et al.,* 2012; Quintao *et al.,* 2011 and 2012), analgesic (Meyre-Silva *et al.,* 1998) and porcine pancreatic lipase inhibitor (Ado *et al.,* 2013)
Bacopa monnieri	AP	Bacosterol-3-O-β-D-glucopyranoside, bacopasaponin-C, bacopaside-I, bacopaside-II, bacosterol, bacosine and luteolin-7-O-b -glucopyranoside (Bhandari *et al.,* 2007)	Wound healing (Sharath *et al.,* 2010), anti-inflammatory for the nervous system (Nemetcheck *et al.,* 2017)
	WP	p-hydroxyl benzenemethanol, p-hydroxyl benzoic acid, 5,24(28)-ergostadien-3β-ol, ursolic acid, lupeol, 28-hydroxyllupeol, stigmasterol-3-O-β-D-glucopyranoside, β-daucosterin, ampelozigenin, 3,4-dimethoxycinnamic acid, feruloyl glucoside, rosavin, quercetin, apigenin, luteolin, zizyotin, loliolide, bacopasides VI-VIII, bacopasides I & II and bacopasaponin (Zhou *et al.,* 2007)	Herbal formulation as hair growth stimulant (Banerjee *et al.,* 2009)
	L	Triterpenes saponosides derivatives of jujubogenine and pseudojujubogenine of the methanolic extract, bacopasaponins E and F, bacopasides I- V, bacopasaponine C, bacopasides N1 and N2, bacopaside X, bacoside A3 (Sivaramakrishna *et al.,* 2005) bacopasaponins A-C (Garai *et al.,* 1996)	

Bidens pilosa	L	Sesquiterpenes and polyacetylenes E-caryophyllene, β-gurjunene, α-humulene, germacrene-D, biciclogermacrene, α-muurolene, Z-γ-bisabolene, selina-3,7(11)-diene (Grombone-Guaratini *et al.,* 2005) Stigmasterol, squalene, elaidic and behenic acids, and phytyl heptanoate (Zulueta *et al.,* 1995) Several volatile compounds were found in the hydrodistillate, some being 1 -phenyl hepta-1,3,5-triyne, α-pinene, limonene, p-caryophyllene, germacrene-D, β-copaene, β-cyclogermacrene, linalol, α-cadinol (Zollo *et al.,* 1995)	
	AP	Astilbin, esculetin, quercetin-7-O-β-D-glucopyranoside, quercetin-3-O-β-D-glucopyranoside, rutin, luteolin-5-O-β-D-glucopyranoside, kaempferol-3-O-β-D-glucopyranoside, isorhamnetin 3-O-β-D-glucopyranoside, quercetin 3,3′-dimethyl ether-7-O-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside, quercetin 3,4′-dimethyl ether-7-O-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside, quercetin acetyl dihexoside, quercetin 3,3′-dimethyl ether-7-O-β-D-glucopyranoside, quercetin hexoside as well as p-hydroxybenzoic, cafeic, p-coumaric, ferrulic and vanillic acids (Chen *et al.,* 2016)	Cyclooxygenase and PGE2 inhbitor (Yoshida, 2006) Antioxidant: ROS inhibition and NO activation in dermal endothelial cells (Kohda *et al.,* 2013) antimicrobial (Geissberger & Séquin, 1991)
	WP	Phenolic compounds heptanyl 2-O-β-xylofuranosyl-(1→6)-β-glucopyranoside, quercetin 3-Orabinobioside, quercetin 3-O-rutinoside, jacein, centaurein, chlorogenic acid, 3,4-di-O-caffeoylquinic acid, 3,5-di-O-caffeoylquinic acid and 4,5-di-O-caffeoylquinic acid (Chiang *et al.,* 2004) Centaurein and centaureidin (Chang *et al.,* 2007) Flavonoids and other compounds such as linolic et α-linolenic acids, squalene, friedelin, friedelan-3-β-ol, stigmasterol, β-sitosterol, campestrol, luteolin 7-O-β-D-glucopyranoside, quercetin 3-O- β -D-glucopyranoside, quercetin 3-O- β -D-galactopyranoside and quercetin 3-O- β-D-glucuronopyranoside (Geissberger & Sequin, 1991) Rutin, hyperoside, and 4,5-O-dicaffeoylquinic acid (Cortés-Rojas *et al.,* 2013)	Antioxidant: DPPH, anti-radical and NO inhibitor (Chiang *et al.,* 2004; Cortés-Rojas *et al.,* 2013) immunomodulatory (Chang *et al.,* 2007) anti-aging activity of phytol (Dieamant *et al.,* 2015).
Calophyllum inophyllum	NO	Fatty acids such as palmitic acid, palmitoleic acid, stearic acid, oleic acid, linoleic acid, alpha-linoleic, arachidonic acid, alpha-gadoleic, dihomo-gamma-linolenic acid, behenic acid, docosadienoic acid (Adewuyi *et al.,* 2014; Raharivelomanana *et al.,* 2018) Flavanoids such as tamanolides D and P, inophyllum C, D, E and P as well as calanolides A, B, Gut 70 and P (Ansel *et al.,* 2016) Inophyllum A, C and E as well as calophylloide, calophynic acid, 11,12-anhydroinophyllum,1,7-dihydroxy-6-methoxyxanthone, n-nonacosane and sitosterol-3-O-D-glucopyranoside (Zakaria *et al.,* 2014)	Antibacterial (Adewuyi *et al.,* 2014; Léguillier *et al.,* 2015) Antiacneic (Léguillier *et al.,* 2015) Wound healing (Léguillier *et al.,* 2015; Ansel *et al.,* 2016b) Anti-inflammatory and wound-healing calophyllolides (Nguyen *et al.,* 2017) Anti-inflammatory (Perumal *et al.,* 2017)
	L	Coumarins such as calophyllolide, inophyllums B, C, G1, G2 and P (-)-12-methoxyinophyllum A, (+)-12-methoxyinophyllum H-1, (-)	Antimicrobial activity (Ali *et al*., 1999) Antitumoral activity against HL-60

		-12-methoxyinophyllum H-2, and inophyllum J, 12-ethoxyino-phyllum D and isoinophynone (Laure *et al.,* 2008; Li *et al.,* 2016) Triterpenoids: 3β,23-epoxy-friedelan-28-oic acid, epifriedelanol, canophyllal, oleanolic acid friedelin, inophynone, canophyllol and canophyllic acid (Ali *et al.,* 1999; Li *et al*., 2010; Prasad *et al.,* 2012) Amentoflavone (Prasad *et al*., 2012) (2S,3R)-2,3-dihydro-5-hydroxy-2,3,8,8-tetramethyl-6-(l-phenylethenyl)-4H,SHbenzo[1,2-b:3,4-b'] dipyran-4-one and (2R,3R)-Benzodipyranone: 2,3-dihydro-5-hydroxy-2,3,8,8-tetramethyl-6-(1-phenylethenyl)-4H,8H-benzo [1,2-b:3,4-b'] dipyran-4-one (Khan *et al.,* 1996) Aerial parts: Phenylcoumarins such as Inophyllum-A, C, D and E, calocoumarin-A, calophyllolide, apetatolide, calocoumarin-B, calocoumarin-C, isocalophyllic acid (Itoigawa *et al*., 2001)	cells (Li *et al.,* 2010) and Epstein-Barr virus early antigen suppressing activity (Itoigawa *et al.*, 2001) Antidyslipidemic activity (Prasad *et al*., 2012) Anti-inflammatory (Tsai *et al.,* 2012)
	SB	friedelin and betulinic acid, inophinnin, inophyllin A, caloxanthone C, pyranojacareubin and stigmasterol and 4-hydroxyxanthone (Ee *et al.,* 2011) nophinnin, inophinone, pyranojacareubin, rheediaxanthone A, macluraxanthone, 4-hydroxyxanthone (Mah *et al*., 2015)	Inophinnin, mild anti-inflammatory (Ee *et al.,* 2011) Anti-arthritic (Perumal *et al.,* 2017)
Cordyline fruticosa	L	Quercetin 3-rutinoside, apigenin 8-C-β-D-glucopyranoside, farrerol, isoquercitrin, quercetin 3-O-[6-trans-p-coumaroyl]-bD-glucopyranoside and 3 steroidal saponins, fructicosides H, I and J (Fouedjou *et al.,* 2014); 4 cholestane glycosides, (22S)-3β,7β,16β,22-tetrahydroxycholest-5-en-1β-ylβ-D-glucopyranoside, (22S)-3β,16β,22,25 tetrahydroxycholest-5-en-1β-yl β-D-glucopyranoside, (22S)-3β,16β,22,25- tetrahydroxy-5α-cholestan-1β-yl β-D-glucopyranoside and (22S)-16β,22,25-trihydroxycholest-5-en-3β-ylO-α-L rhamnopyranosyl-(1→2)-β-D-glucopyranoside (Yokosuka *et al.,* 2012) Tubers: Glucofructan (Boggs & Smith, 1956)	Antimicrobial (Fouedjou *et al.,* 2014)
Fagraea berteroana	F	Fruits: monoterpenes alkaloids (Kun-Anake & Ragvatin, 1976) ursolic and oleanolic acids (Basir *et al.,* 2018) Roots: lignans (Okuyama *et al.,* 1995)	
	Fl	Benzyl acetate, methyl benzoate, benzylbenzoate, (E)-β-ocimene, methyl salicylate, benzyl salicylate, acetoin, acetic acid, nerolidol, henicosane, tricosane and myristic acid (Hayashi, 1995)	
	L & B	Wood and bark: iridoids, coumaric and caffeic acids (Cambie *et al.,* 1990), di-O-methylcrenatin, potalioside B, adoxosidic acid, adoxoside, (þ)-pinoresinol, salicifoliol, sweroside, taxifolin-6-C-glucoside, aromadendrin-6-C-glucoside, secologanoside, loganic acid (Suciati *et al.,* 2011) Leaves: flavonoids (Qasim *et al.,* 1987), monoterpenes alcaloids (Kun-Anake & Ragvatin, 1976) and blumeosides A-D (Cuendet *et al.,* 1997)	
Gardenia	FlB	Over 150 volatile compounds such as linalool, dihydroconiferylic	

taitensis		alcohol, 2-methoxy-4-vinyl-phenol, isoeugenol, benzyles benzoate and salicylate, dihydroconiferyl acetate, benzoate and salicylate, ethyl hexanoate, geranyl benzoate, (Z)-3-hexenyl benzoate and salicylate, hexyl benzoate, methyl salicylate, 2-phenylethyl benzoate and salicylate, phenylacetonitrile, phenylacetaldoxime and 2-phenylnitroethane (Claude-Lafontaine *et al.,* 1992) Four triterpenes namely 9,19-cyclolanostane-3,23-dione (Davies *et al.,* 1992) Flavonoid: 6-methoxy-3-O-methylkaempherol (Miller *et al.,* 1989)	
Morinda citrifolia	CC	2-methyl-3,5,6-trihydroxyanthraquinone, 3-hydroxymorindone, 5,6-dihydroxylucidin, 2-methyl-3,5,6-trihydroxyanthraquinone-6-β-primeveroside, 3-hydroxymorindone-6-β-primeveroside, 5,6-dihydroxylucidin-3-β-primeveroside, rubiadin, lucidin, morindone, lucidin-3-β-primeveroside and morindone-6-β-primeveroside (Inoue *et al.,* 1981)	Roots: analgesic (Younos *et al.,* 1990); antioxidant (Zin *et al.,* 2002)
	F	51 volatiles compounds including 3-methyl-3-buten-1-ol and the octanoic, hexanoic and decanoic acids (Farine *et al.,* 1996) 6-O-(β-D-glucopyranosyl)-1-O-octanoyl-β-D-glucopyranose, 6-O-(β-D-glucopyranosyl)-1-O-hexanoyl-β-D-glucopyranose and 3-methylbut-3-enyl 6-O-β-D-glucopyranosyl-β-D-glucopyranoside (Wang *et al.,* 2000), 2,6-di-O-(β-D-glucopyranosyl)-1-O-octanoyl-β-D-glucopyranose, rutin and asperulosidic acid (Wang *et al.,* 1999), 5,15-dimethylmorindol, morindacin as well as other anthraquinones and iridoids Kamiya *et al.,* 2005)	Anti-inflammatory activity of the fruits (Akihisa *et al.,* 2007) and juice (McKoy *et al.,* 2002). Antitumoral (Hirasumi & Furusawa *et al.,* 1999; Liu *et al.,* 2001) and antioxidant activities (Ramamoorthy & Bono, 2007; Zin *et al.,* 2002),
	L	Citrifolinins Ba and Bb, quercetin-3-O-β-D-glucopyranoside, kaempferol-3-O-R-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside, kaempferol-3-O-R-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside, quercetin-3-O-R-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside and quercetin-3-O-β-D-glucopyranosyl-(1→2)-[R-L-rhamnopyranosyl-(1→6)]-β-D-galacopyranoside (Sang *et al.,* 2001) (E)-phytol, cycloartenol, stigmasta-4-en-3-one, stigmasta-4-22-dien-3-one, β-sitosterol, stigmasterol et campesta-5,7,22-trien-3 -ol (Saludes *et al.,* 2002) 6 lignans namely 3,3'-bisdemethylpinoresinol, americanol A, americanin A, americanoic A acid, morindolin of isoprincepin (Kamiya *et al.,* 2004)	Wound healing (Nayak *et al.,* 2009), antiartherosclerosis (Kamiya *et al.,* 2004), antitubercular (Saludes *et al.,* 2002) and antioxidant (Sang *et al.,* 2001; Zin *et al.,* 2002)
	S	ursolic acid, americanin A, 3,3'-bisdemethylpinoresinol and quercetin (Masuda *et al.,* 2009)	Anti-tyrosinase and anti-elastase (Masuda *et al.,* 2009)
Sigesbeckia orientalis	L, R, AP	Orientin (Rybalko *et al.,* 1976), orientalide (Baruah *et al.,* 1979), germacranolide and 8 derived compounds namely 9β-hydroxy-8β-isobutyryloxycostunolide, 14-hydroxy-8β-isobutyryloxycostunolide and 9β-hydroxy-8β-isobutyryloxy-1β,10a-epoxycostunolide, melampolide and 3 melampolide derivatives, 15-hydroxy-9α-acetoxy-8β-isobutyryloxy-14-oxo melampolide, 9α,15-dihydroxy-8β-isobutyryloxy-14-oxo melampolide and 15-hydroxy-8β-isobutyryloxy-14-oxo melampolide, derivatives of geranylnerol and	Anticancer (Chang *et al.,* 2014), anti-inflammatory (Hwang *et al.,* 2001; Wang *et al.,* 2011; Hong *et al.,* 2014) and immunosuppressive (Sun *et al.,* 2006)

		three ent-pimarenes (Zdero *et al.,* 1991) Orientalin A and B (diterpenes), β-sitosterol, 3,7-dimethylquercetin, kirenol, daucosterol, ent-16β,17-dihydroxykauran-19-oic acid-16β,17-acetonide and ent-16β,17-dihydroxykauran-19-oic acid (Xiong *et al.,* 1997) 8 diterpenes (ent-pimarane and glycosides) including ent-12α,16-epoxy-2β,15α,19-trihydroxypimar-8-ene, ent-12α,16-epoxy-2β,15α,19-trihydroxypimar-8(14)-ene and ent-2-oxo-3β,15,16-trihydroxypimar-8(14)-en-3-O-β-glucopyranoside as well as 16-acetylkirenol, isopropylidenkirenol, pubeside A-D (Xiang *et al.,* 2004) sesquiterpenes (Xiang *et al.,* 2005) 6 ent-pimaranes including 7β-hydroxydarutigenol and 15,16-di-O-acetyldarutoside (Wang *et al.,* 2009)	
Tephrosia purpurea var. purpurea	WP	Rutin and quercetin (Bhadada *et al.,* 2016)	
	St	Flavones: lanceolatins A and B, semiglabrin and terpurinflavone (Juma *et al.,* 2011)	
	L	2-propenoic acid, 3-(4-(acetyloxy)-3-methoxypheny)-3(4-actyloxy)-3-methoxyphenyl)-2-propenyl ester, 4-isopropyl-1,8-dimethyl-decahydro-azulene-5,8,9-triol and apollinin (Kalafalah *et al.,* 2010)	
	AP	Flavonoids: tephropurpulin A, isoglabratephrin and glabratephrin (Hegazy *et al.,* 2009) tephrosin, pongaglabol et semiglabrin (Ahmad *et al.,* 1999)	Wound healing (Lodhi *et al.,* 2006)

[+] *Plant parts abbreviations S = Seeds, AP = Aerial Parts, W = Wood, R= Roots, B= Bark, L = Leaves, N = Nut, St = Stem, F =Fruits, NO = Nut Oil, SB = Stem Bark, Fl = Flowers, CC = Cell culture, FlB = Flower bud, WP = Whole plant*

3.2. Bioassay results

3.2.1. Choice of plant parts and extraction

The plant parts chosen for further extraction were those that had traditional uses as specified in Table 2. For herbs, such as *B. monnieri* and *B. pilosa* (table 1), the whole plant was extracted. Traditional uses for the leaves and whole *B. pilosa* plant are similar*,* so the whole plant was chosen. As for *B. monnieri*, aerial parts are mentioned in table 2, but according to table 3, the whole plant is used in an herbal formulation for hair growth, this supports the use of the whole plant for extraction. Renewable plant parts were focused on unless the whole plant was provided, such is the case for *T. purpurea* although only the leaves are reported as having traditional uses. In the case of *A. moluccanus* and *F. berteroana*, the barks were also available and enabled their study. Flowers were not studied if their noted ethnocosmetic use was to perfume coconut oil. This corresponds to allegation 5, that is not being studied, as precised above.

Furthermore, each selected plant part led to three extracts, an ethyl acetate extract, an ethanol: water extract and a water extract. Nevertheless, some extracts yielded a too small amount

to carry out the preliminary assays (< 20 mg) (Supplementary data List S2). The list of 32 extracts in sufficient quantity is given with their yield and mass in Table 4.

3.2.2. FRAP and 5-LOX results

After the plant collection and extraction steps, 32 finalized extracts were obtained and tested on the FRAP test. The FRAP test was used to measure the antioxidant potential of all the extracts obtained while the 5-LOX assay was tested on plant parts having a traditional use implying their anti-inflammatory potential. These two preliminary tests were conducted in order to select the most active extracts and pursue relevant *in cellulo* tests in accordance with their targeted cosmetic development axes.

In our antioxidant assay (Table 4), the best antioxidant activities are displayed by the ethyl acetate extracts of *A. moluccanus* bark, *B. pilosa* the whole plant, the leaves of *C. inophyllum* and the bark of *T. purpurea* var. *purpurea* as well as *C. inophyllum* leaves aqueous extract. Their activities are 1331.58 ± 24.18, 1123.61 ± 83.11, 1683.04 ± 138.68, 1262.49 ± 24.03 and 1044.40 ± 58.40 µmol Trolox equivalent/g of dry matter respectively. Comparatively, some plant parts showed very low antioxidant activity such as *A. pavonina* seeds ethyl acetate extract with 38.71 ± 7.19 µmol Trolox equivalent/g. The best faring extracts are considered mild antioxidant. Indeed, our standard, a green tea extract has very strong antioxidant potential and a value of 15348.23 ± 521.02 µmol Trolox equivalent/g of dry matter.

Table 4 : Antioxidant potential of the 32 tested extracts

Plant species	Plant part	Extraction solvent[1]	Extract dry mass (g)	Yield (%)	Trolox equivalent (µmol/g of DM)	SD
A. pavonina	Seeds	EtOAc	41.22	13.74	38.71	7.19
A. moluccanus	leaves	EHO	3.66	3.14	134.76	35.15
		H2O	1.69	1.45	253.72	18.68
	bark	EtOAc	0.51	0.11	1331.58	24.18
		EHO	3.66	0.69	225.45	91.69
B. monnieri	whole plant	EtOAc	4.44	3.01	127.15	9.95
		EHO	4.35	2.95	216.23	6.94
		H2O	9.78	6.63	305.36	36.02
B. pilosa	whole plant	EtOAc	0.99	0.20	1123.61	83.11
		EHO	16.78	3.36	711.05	46.59
		H2O	8.80	1.76	253.38	84.93
C. inophyllum	leaves	EtOAc	5.92	5.33	1683.04	138.69
		H2O	6.44	5.8	1262.5	24.03

	fruits	EtOAc	81.65	34.02	159.62	18.90
		EHO	24.77	10.32	309.53	25.94
		EtOH	28.74	11.98	562.81	43.45
		H2O	1.83	0.76	338.13	161.38
C. fruticosa	leaves	EHO	4.32	5.84	309.88	26.72
		H2O	3.20	4.32	262.84	11.86
F. berteroana	leaves	EtOAc	8.49	1.67	128.23	19.14
		EHO	19.89	3.92	312.76	19.12
	fruits	EtOAc	18.75	4.17	130.01	18.40
		EHO	22.25	4.94	332.67	11.24
		H2O	14.93	3.32	219.87	21.77
G. taitensis	flowers	EtOAc	2.49	3.11	173.78	23.93
		H2O	4.79	5.99	193.01	24.74
M. citrifolia	leaves	EtOAc	6.10	5.17	295.09	116.2
		EHO	14.66	12.43	440.06	23.48
T. purpurea var. *purpurea*	bark	EtOAc	4.82	5.95	1044.4	58.40
	roots	EtOAc	3.03	2.90	553.55	158.38
	leaves	EtOAc	5.04	1.68	675.20	22.09
		H2O	11.24	3.75	383.20	15.05
Green tea extract (900017 internal reference)					15348.23	521.02

[1] EHO = ethanol: water (1 :1) extract

In the 5-LOX assay (Table 5), several compounds fared well compared to our standard *Primula veris* L., extract (IC 50 = 0,018% dry mass). The IC 50 values of the extracts' range between 0.015% of dry mass and 0.206% dry mass. The most potent anti-inflammatory extracts are the aqueous ethanolic extract of the bark of *A. moluccanus* (IC 50 = 0,015 %), the aqueous extract of *C. inophyllum* leaves (IC 50 = 0.016 %) as well as the ethanolic extract of its fruits (0,021%). The ethyl acetate extracts of *B. pilosa* and *A. moluccanus* bark, *T. purpurea* var. *purpurea*'s bark and the fruits of *F. berteroana* also show interesting anti-inflammatory activities.

Table 5 : The anti-inflammatory activities of the plant extracts

Plant species	Plant part	Extraction solvent[1]	5-LOX IC 50 % dry mass
A. pavonina	seeds	EtOAc	0.205
A. moluccanus	leaves	EHO	0.055
	bark	EtOAc	0.029
		EHO	0.015
B. monnieri	whole plant	EtOAc	0.065

		EHO	0.102
		H_2O	0.073
B. pilosa	whole plant	EtOAc	0.024
		EHO	0.055
C. inophyllum	leaves	H_2O	0.016
	fruits	EtOH	0.020
C. fruticosa	leaves	EHO	0.134
F. berteroana	fruits	EtOAc	0.041
		EHO	0.040
M. citrifolia	leaves	EHO	0.072
T. purpurea var. purpurea	bark	EtOAc	0.031
Primula veris referenced extract			0.018

[1] EHO = ethanol: water (1 :1) extract

From the preliminary obtained results (Tables 4 & 5), a few extracts stood out, such as the aqueous extract of *C. inophyllum* leaves that possess both antioxidant as well as anti-inflammatory activities. The ethyl acetate extract was only tested on the FRAP assay and already demonstrated antioxidant potential similar to that of the aqueous extract. The leaves are not the only interesting plant part as the fruits also showed a potent anti-inflammatory activity. *A. moluccanus* activities mainly concern the bark and its ethyl acetate extract that mediates both good anti-inflammatory and antioxidant activities, although the EHO extract has better anti-inflammatory potential. The leaves present a mild anti-inflammatory activity. *B. pilosa* gave more interesting antioxidant and anti-inflammatory results more so than the EHO extract. Every *F. berteroana* whether leaves or fruits revealed very low antioxidant potential, but the fruits extract recorded mild to good anti-inflammatory activities. *T. purpurea*, ethyl acetate bark extract not only proved to be a source of antioxidants but also an anti-inflammatory extract. The results of performed assays confirmed the antioxidant and anti-inflammatory potential of *C. inophyllum*, *A. moluccanus*, *B. pilosa, F. berteroana* as well as *T. purpurea*. A limited number of assays were performed on the extracts but nevertheless gave preliminary insight on those most active for further study. This preliminary screening was a step towards determining which extracts would be further studied. Thus, the overall cosmetic potential of the four plants, as well as *S. orientialis* are hereby discussed according to results from table 3.

3.2.3. Asteraceae

Bidens pilosa

The flowers and leaves showed interesting DPPH activity compared to stems and roots (Cortés-Rojas *et al.,* 2013). The butanol fraction of the plant also shows good antioxidant activity in DPPH, antiradical and to inhibit NO (Chiang *et al.,* 2004). The aqueous extract of the aerial part

inhibited cyclooxygenase and consequently PGE2 (Yoshida *et al.,* 2006). A plant extract antioxidant activity was shown by inhibition of the production of ROS and activation of NO in endothelial cells of the derma (Kohda *et al.,* 2013). A formulation of *B. pilosa*/ *Curcuma longa* L. (125 mg/kg and 15 mg/kg) (Bastos *et al.,* 2015) displayed anti-mucositis activities. The petroleum ether extract of the aerial parts exhibits antimicrobial activity (Geissberger & Séquin, 1991). The butanol fraction of the whole plant is immunomodulatory (Chang *et al.,* 2007). A combination of antioxidant, anti-inflammatory and anti-microbial activities explains its ethnobotanical use to heal knife cut wounds. Furthermore, the ethanol extract of aerial parts inhibits renin and the enzyme converting angiotensin (Chen *et al.,* 2016) which could have a role in alleviating bleeding caused by wounding. This underlines *B. pilosa* potential for development as an effective anti-aging product. This activity was already found in the supercritical CO_2 extract of the aerial parts and more specifically phytol (Dieamant *et al.,* 2015). *B. pilosa* extract has already been patented as a whitening agent (US PATENT: US 2015/0359734 A1). According to this patent, *B. pilosa* acts as a degrading agent of melanin and affects melanin transport. This mode of action is attributed to its high antioxidant activity and retinoid-like activity (Diemant *et al.,* 2015; Roberts *et al.,* 2015). Its whitening activity seems to be a result of compounds such as caffeic and ferulic acids (Chen *et al.,* 2016) and derivatives, as they are a potent source of anti-tyrosinase compounds (Okombi, 2005).

Sigesbeckia orientalis

The aerial parts exert an anticancer effect (Chang *et al.,* 2014). They also possess an anti-inflammatory activity topically *in vivo* on carrageenan-induced inflammation in rats (Wang *et al.,* 2011) and through the inhibition of NO production, TNF-α, IL-6 production, reduction of iNOS, suppression of I??B-?? and NF??B phosphorylation in a dose-dependent manner. Also, the *S. orientalis* extract reduced the expression of JNK, p38 and ERK 1 and ERK 2 (Hong *et al.,* 2014). All of these factors are included in the process of skin-ageing. This comforts its traditional use in wound-healing. It is further confirmed by the antimicrobial activity also of kirenol from the hairy roots against Gram-positive bacteria such as *Bacillus subtilis, Streptococcus oralis* and *Staphylococcus aureus* (Wang *et al.,* 2012). The anti-inflammatory and antimicrobial activity of *S. orientalis* aerial parts in line with its traditional use to cure sores, heal wounds and hydrate skin highlights its potential to be developed as an anti-ageing product as well as an anti-blemish agent. The whole plant was found to inhibit the production of Immunoglobulin E (IgE) and thus exert an anti-allergy combined to an anti-inflammatory activity (Hwang *et al.,* 2001), while the ethanol extract of the aerial parts was found to be immunosuppressive (Sun *et al.,* 2006). High levels of IgE influence sensitive skin making it prone to inflammation and leading along with eosinophils (Liu *et al.,* 2011) to atopic dermatitis (Yatagai *et al.,* 2018, Ham *et al.,* 2019).

S. orientalis also has depigmenting traditional uses (Handy, 1923). The efficiency of *S. orientalis* as a whitening agent would be interesting to investigate thoroughly. Furthermore, testing its retinoid-like activity could potentially show a similar pattern or mode of action as *B. pilosa*. Indeed, *S. orientalis* and *B. pilosa* both belong to the *Asteraceae* family. The whitening activity of *B. pilosa* could give some insight into *S. orientalis* potential, although these two plants species have a distinct chemical composition. Constituents responsible for the whitening potential of *S. orientalis* could be flavonoids (Loizzo *et al.,* 2012).

Thus *S. orientalis* presents potential development as a whitening, anti-blemish and an anti-ageing ingredient.

3.2.4. Calophyllaceae

Calophyllum inophyllum

The acetonides and neoflavonoids synthesized from the nut oil showed anti-bacterial activity against *E. coli, Salmonella typhi* and *Pseudomonas aeruginosa* while the oil extract was active against *B. subtilis* and *S. aureus.* (Adewuyi *et al.,* 2014). A further antibacterial activity against *Proponium acnes* was also observed (Léguillier *et al.,* 2015) thus corresponding to an anti-acne or anti-blemish potential. Léguillier *et al.* (2015) as well as Ansel *et al.* (2016b) also demonstrated a wound-healing activity of the nut oil further observed along with an anti-inflammatory activity of calophyllolides of the seeds by decreasing IL-1β, IL-6, TNF-α expression levels in serum of mice (Nguyen *et al.,* 2017). Inophinnin from the dichloromethane extract of the stem bark showed a mild anti-inflammatory activity in the nitric oxide assay on raw cells (Ee *et al.,* 2011). The barks stem is anti-arthritic (Perumal *et al.,* 2017). While the wound-healing properties of tamanu nut oil has been studied, the leaves have garnered less interest, yet they have been used in other parts of Polynesia for similar ailments as the oil. Also, the nut oil is already used by some to promote hair growth, but its mode of action has yet to be fully assessed.

3.2.5. Euphorbiaceae

Aleurites moluccanus

Flavonoids such as swertisin and 2''-O-rhamnosylswertisin are the molecules deemed responsible for the cutaneous anti-inflammatory activity of *A. moluccanus* (Cesca *et al.,* 2012; Hoepers *et al.,* 2015). The latter, 2''-O-rhamnosylswertisin, also possesses an antinociceptive activity (Cesca *et al.,* 2012; Quintao *et al.,* 2011 & 2012). β-sitosterol, stigmasterol, campesterol, α- et β- amyrin as well as n-hentriacontane are analgesic (Meyre-Silva *et al.,* 1998). The seed oil is antioxidant and has hydrating properties (Athar & Nasir, 2005; Ako *et al.,* 2005). The methanol extract of the leaves

completely inhibited the porcine pancreatic lipase (Ado *et al.,* 2013). The methanol and aqueous extracts of the nut inhibit *Proteus mirabilis*, exhibiting a potential anti-rheumatic arthritis activity (Cock *et al.,* 2015). Furthermore, polyphenols are compounds that have been very effective to inhibit elastase and collagenase (Zillich *et al.,* 2015). Along with "tamanu" *(C. inophyllum)*, *A. moluccanus* nut oil or kukui nut oil are already commercialized as massage and anti-aging oils. Nevertheless, its mode of action has not yet been clearly studied and identified to our knowledge. The bark could also be interesting for its anti-aging potential according to its traditional use, although in this case, collecting such a plant part could be very destructive for the tree and serve as a limiting factor to its sustainable use.

3.2.6. Fabaceae

Tephrosia purpurea* var. *purpurea

The biological activities discussed here correspond to *T. purpurea* and to its synonym *T. piscatoria*. Along with other plants from this genus*, T. purpurea* has a high rotenoid content that is responsible for its ichtyotoxic activity. Lanceolatins, found as constituents of *T. purpurea* stems, were also formerly extracted from *Cephalotaxus lanceolate* and were shown having both an anti-inflammatory activity by inhibiting NO in macrophages and an anti-tumoral activity through cytotoxicity against several tumoral cell lines (He *et al.,* 2015). An ethanolic extract of *T. purpurea* aerial parts showed wound-healing properties by enabling proper collagen and fibroblast formation, as well as epithelization, increasing tensile strength after incision and in the dead space wound model on rats (Lodhi *et al.,* 2006). According to our literature review of traditional uses and biological activities, *T. purpurea* is most suited for a potential anti-aging development.

3.2.7. Gentianaceae

Fagraea berteroana

The chemical composition of *F. berteroana* is not extensively studied apart from its flowers and their volatile compounds (Hayashi *et al.,* 1995). Thus, very little is known of the chemical composition of the fruits. Several other plants of the genus *Fagraea* have been studied and a diverse range of compounds have been isolated from several parts and compiled (Guezennec *et al.,* 2005). According to other plants of the Fagraea genus, the fruits could contain monoterpenes alkaloids. Hence, the lack of knowledge of the chemical composition of *F. berteroana* and little research that has been conducted on the plant, proposes it as an original candidate for further study in hair care. This activity might be supported by compounds such as 3,4-dimethoxycinnamic acid, as sinapic acid (3,5-dimethoxy-4-hydroxycinnamic acid) has shown a hair growth activity by activating the Wnt pathway

through phosphorylating GSK3β and stimulating the production of β-catenin as well as boosting cell cycle progression of HFDPC by upregulating factors IGF and VEGF (Woo *et al.,* 2017).

4. Conclusion

Eleven plants were selected, both native (indigenous) and introduced ones (Polynesian and modern) of the French Polynesian flora, that show promise to be further studied and developed as cosmetic ingredients. Although we did not investigate the endemic potential of the flora of French Polynesia, we were still able to find active extracts and knowledge to increase our limited grasp of ethnocosmetopoeia in this region. The chosen plants have traditional Polynesian uses that are relevant in determining their cosmetic development potential. Literature review and preliminary biochemical screenings were the first steps to determine which plants and plant parts were most active and what cosmetic applications were most relevant when refered to the identified traditional uses. Several extracts stood out for future bioassays and deeper studies. The ethyl acetate and aqueous ethanol extracts of *F. berteroana* fruits, the ethyl acetate extracts of *B. pilosa* and *T. purpurea, C. inophyllum* extracts and *S. orientalis* deserve more investigation for their anti-ageing potential, hair growth promotion and skin whitening. The bark extracts of *A. moluccanus* should not be considered as they are not renewable plant parts. Further studies will be necessary to propose pertinent natural and effective cosmetic ingredients with minimal, to no side effects. Finding active compounds from the Polynesian cosmetopoeia would be a rewarding form of cosmetic ingredient sourcing because hair and skin maintenace is an important aspect of Polynesian culture.

Focusing on folk cosmetics is an attractive aspect of plant sourcing as only 15% - 20% of plants around the world have been phytochemically assessed. Yet, many countries abound with plant resources and combined traditional cosmetic knowledge with no prior scientific assessment or study. Preservation of this traditional knowledge of cosmetopoeia and new findings of modern pertinent cosmetic applications of the related plants could be a promising sector of sustainable development and bring new income for these countries.

Declaration of interest

The authors declare that there are no conflicts of interest.

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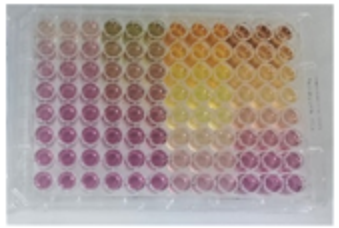
11 plants

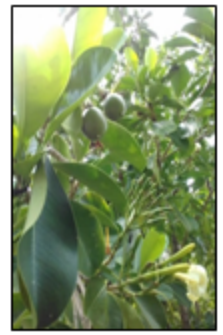
Plant extracts

5 - LOX FRAP



Preliminary bioassays

Fagraea berteroana



Bidens pilosa

Sigesbeckia orientalis

Tephrosia purpurea var. *purpurea*

French Polynesian Cosmetopoeia

Polynesian ethnobotanical studies :
Pharmacopoeia and Cosmetopoeia

+

Phytochemistry literature

Hair care Depigmentation Skin-aging

Potential cosmetic developments