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Medicinal plants used to treat infectious diseases in French Polynesia: an ethnobotanical survey and antibacterial evaluation

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ABSTRACT

Ethnopharmacological relevance: In French Polynesia, traditional medicine remains an important component of primary healthcare and relies on nearly 300 medicinal plants, including species used against infectious diseases that are prevalent in the territory. However, anti-infective medicinal plants remain insufficiently documented and scientifically evaluated.

Aim of the study: This study aimed to document medicinal plants used for common infectious disorders in the Society Islands and to assess, in their traditional forms, the antibacterial activity and cytotoxicity.

Materials and methods: A semi-structured survey was conducted with 85 participants across five Society Islands. Data were collected on 11 infectious disorders. Eight species and one traditional remedy were then selected and prepared according to field-documented practices. Antibacterial activity was evaluated by broth microdilution against nine bacterial strains, and cytotoxicity was assessed by MTT assay on Vero, hIEC-6, and HaCaT cells.

Results: The survey documented 626 remedies involving 84 species from 49 families, mostly administered as oral fresh plant juices. Cutaneous and respiratory infections, together with leucorrhea (*he'a*), were the conditions most frequently treated with medicinal plants. Among the preparations tested, *Thespesia populnea* fruit exudate and *Calophyllum inophyllum* leaves showed the strongest antibacterial activity (MIC 8–512 μg/mL), supporting their traditional use. The *he'a* remedy was more active than *Syzygium malaccense* leaves alone. None of the tested preparations was cytotoxic according to the $CC_{50} < 20$ μg/mL threshold.

Conclusion: This study documents Polynesian anti-infective remedies, supports testing traditional preparations, and provides ethnopharmacological validation for *Thespesia populnea*, *Calophyllum inophyllum*, and *Syzygium malaccense* as Polynesian anti-infective medicinal plants.

1. Introduction

French Polynesia, located in the South Pacific Ocean, is an extensive insular territory distinguished by a rich traditional knowledge. Its traditions have been preserved over centuries, from the settlement of the islands by the Polynesian navigators to the European contact in the 18th century and the French colonization the following century (Conte, 2019). This culture, shaped by navigation, arts, and social customs, integrates traditional medicine as one of its major pillars (Grand, 2021). Practiced for generations, Polynesian traditional medicine relies on approximately three hundred medicinal plants (Hittinger et al., 2025) originating from a flora influenced by human migrations and historical exchanges. The Polynesian pharmacopoeia therefore includes indigenous and endemic species naturally occurring on the territory, as well as plants introduced by the first Polynesian navigators and later by Europeans (Florence, 1997).

Today, although biomedical healthcare is available in French Polynesia through public primary healthcare services and hospital facilities, access remains geographically uneven due to the wide dispersion and large number of islands (118 in total) and the concentration of specialized medical services on Tahiti Island (Santos and Servy, 2026). In this context, traditional medicine may continue to play an important role as locally available primary healthcare resources, as illustrated by

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List of abbreviations

ANR–	French National Research Agency
ATCC–	American Type Culture Collection
CC_{50}–	50% Cytotoxic Concentration
CLSI–	Clinical and Laboratory Standards Institute
DMSO–	Dimethyl Sulfoxide
ENT–	Ear, Nose and Throat infection
EUCAST–	European Committee on Antimicrobial Susceptibility Testing
HaCaT	– Human immortalized keratinocyte cell line
HepG2–	Human hepatocellular carcinoma cell line
hIEC-6–	Human intestinal epithelial cell line
HIV–	Human Immunodeficiency Virus
HSF–	Human skin fibroblasts
ICPC-3–	International Classification of Primary Care (3rd edition)
INT–	*p*-Iodonitrotetrazolium violet
IRD–	French National Research Institute for Sustainable Development
IUCN–	International Union for Conservation of Nature
LPS–	Lipopolysaccharide
MIC–	Minimum Inhibitory Concentration
MTT–	3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide
OD–	Optical Density
RAW 264.7–	Murine macrophage cell line
SDS–	Sodium Dodecyl Sulfate
SI–	Selectivity Index
UR–	Use-Reports
Vero–	Kidney epithelial cell line from African green monkey (*Chlorocebus sabaeus*)
WHO–	World Health Organization

recent ethnobotanical studies (Chassagne et al., 2022, 2023; Girardi et al., 2015; Quenon et al., 2022).

Infectious diseases remain an important public health concern in French Polynesia, encompassing skin infections, arboviral diseases, leptospirosis, tuberculosis, leprosy, lymphatic filariasis, hepatitis B, influenza, and sexually transmitted infections (Oehler et al., 2025). Their persistence and circulation are favoured by the humid tropical climate, high population density on some islands, and insularity. In this context, documenting traditional remedies used for infectious conditions is particularly relevant, as these practices remain part of the local therapeutic landscape. However, scientific knowledge documenting these uses remains limited. To date, only two studies have reported data on medicinal plants used for infectious conditions in the Society Archipelago. Chassagne et al. (2023) documented traditional medical practices used for children, including remedies for some infectious conditions, whereas Quenon et al. (2022), in a survey involving 18 participants, identified around sixty medicinal plants used against infectious diseases on two islands (Tahaa and Raiatea). Together, these studies indicate that, despite recent advances, the ethnobotanical richness of anti-infective practices in the Society Archipelago remains largely underexplored.

The present study aims to further document medicinal plants traditionally used to treat infectious diseases in French Polynesia, while experimentally assessing their efficacy and safety. For this purpose, an ethnobotanical survey, specifically targeting a subset of conditions, was conducted across five islands of the Society Archipelago, including both the Windward and Leeward Islands. The most relevant plants were then selected based on ethnobotanical criteria. Plant material was extracted according to the traditional practices documented during interviews. The resulting "traditional" extracts were evaluated *in vitro* for their antibacterial activity against a panel of pathogenic strains, as well as for their cytotoxicity. As a final outcome, this study is intended to contribute to the preservation and valorization of Polynesian traditional medicine, which remains a living but threatened heritage.

2. Materials and methods

2.1. Study site

The ethnobotanical study was conducted in French Polynesia, a French overseas collectivity. This territory consists of five archipelagos: Society, Marquesas, Tuamotu, Gambier, and Austral, covering a terrestrial area of 3793 km^2 (Ministère de l'Intérieur et des Outres-mer, 2024). The inhabitants of each archipelago exhibit distinct cultural practices, linguistic variations, and environmental adaptations, shaped by geography and historical interactions. The survey was conducted in the Society Islands, which hold a central place in the cultural and linguistic identity of French Polynesia (Charpentier and François, 2015). These islands are the most populous, with 249,000 of the 283,000 inhabitants of French Polynesia (Borne, 2022), and are distinguished by their rich flora, including 545 native taxa (Guezennec et al., 2006). The Society Archipelago is divided into two subgroups: the Windward Islands and the Leeward Islands. Five islands were selected from these subgroups to gather data from diverse geographical locations. In the Windward Islands, the study targeted Tahiti, the political, economic, and cultural hub of French Polynesia and Moorea, located 17 km northwest of Tahiti. The study area of the Leeward Islands includes Raiatea, Tahaa, and Huahine islands (Fig. 1). French Polynesia's population is predominantly constituted of Polynesian descent alongside smaller communities of European (mainly French), Chinese, and mixed-heritage individuals (Merceron, 2005). While French is the official language, Tahitian (*reo tahiti*) is widely spoken, particularly in the Society Archipelago (Charpentier and François, 2015). The Society Archipelago has a tropical climate characterized by warm and stable temperatures averaging 25 °C and humidity near 80% (Météo France, 2025). Two distinct seasons are observed, a wet and warm season extending from November to April with abundant rainfall, and a drier and colder season from May to October (Laurent et al., 2017).

2.2. Ethnobotanical data collection

The survey was conducted between February and April 2024 on the five islands of the Society archipelago to document the medicinal plants used by Polynesian people in the treatment of infectious diseases. Participants were recruited through guided encounters (via local associations, recommendations from district administrators, professional networks, and snowball sampling) and random selection (at public gatherings, markets, cultural events, and through door-to-door visits). Data were collected through semi-structured interviews structured into three sections. The first section gathered sociodemographic information, including age, gender, place of residence and birth, occupation, and educational background. The second section assessed participants' expertise in traditional medicine, based on three criteria established by Chassagne et al. (2022): (i) the ability to treat a broad range of disorders, (ii) the capacity to heal different types of patients (e.g., children, adults), and (iii) recognition within the community as a healer. Participants were then classified as experts (meeting all three criteria), knowledgeable practitioners (meeting two criteria), or non-experts (meeting only one criterion). The third section focused on the use of herbal remedies for a predefined list of 11 infectious diseases (Table 1). This list was established according to three sources: (i) the prevalence of infectious diseases in French Polynesia as documented in the Guide to Infectious

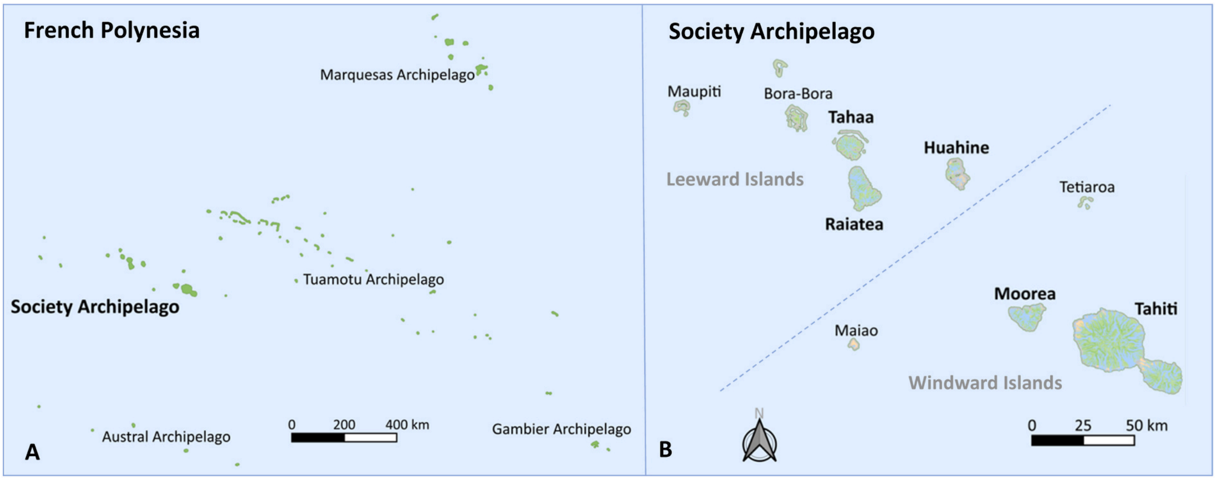

Fig. 1. Study area. (A) French Polynesia in the South Pacific. (B) Detailed map of the Society Islands. Bolded geographic names indicate locations where ethnobotanical interviews were conducted.

Table 1
Infectious diseases investigated during the ethnobotanical survey.

ICPC-3 classification	Disorders (English translation)	Disorders (Tahitian names)
General symptoms		
	Fever	*fiva*
Respiratory system		
	Angina, sore throat	*ma'i 'arapo'a, 'oromo'o*
	Sinusitis	*nanu*
	Nasopharyngitis, cold	*hūpē*
	Bronchitis, cough	*tūto'o, ma'i 'ōuma pē, ma'i mahaha, hota*
Skin		
	Skin infections, furuncles, abscess	*tūtu'a, fēfē, tui*
Genital system		
	Leucorrhoea	*he'a*
Urinary system		
	Cystitis	*'ōpī, 'ōpītapu*
Digestive system		
	Gastroenteritis	*hī, piha'e*
Eyes		
	Conjunctivitis	*ma'i 'ura mata*
Ear		
	Otitis	*tui*

Diseases in French Polynesia (Direction de la santé, 2022); (ii) infectious diseases previously reported in regional ethnobotanical surveys (Chassagne et al., 2023; Girardi et al., 2015; Quenon et al., 2022); and (iii) the categories of infectious diseases defined by the International Classification of Primary Care, 3rd Edition (ICPC-3, https://flyer.icpc-3.info/). Disease names, based on biomedical terminology, were translated into Tahitian and integrated into the concepts of traditional medicine in French Polynesia. Although the interview focused on this predefined list, additional conditions such as influenza, COVID-19, and chickenpox were occasionally reported by participants, and ethnobotanical data were collected for these as well. For each herbal remedy cited, data were collected including vernacular plant names, plant parts used, methods of preparation and administration, and posology. A Use Report (UR) was generated for each mention of a plant used for a specific therapeutic purpose. Vernacular names provided in Tahitian were systematically cross-checked using the Tahitian Academy Dictionary (Fare Vāna'a, http://www.farevanaa.pf/dictionnaire.php).

2.3. Ethical considerations

To preserve, support, and valorize the traditional medical knowledge of French Polynesia, this research incorporated ethical considerations at three complementary levels. At the governmental level, the management of natural resources and traditional knowledge in French Polynesia is regulated by the Polynesian government. Authorization for this study was granted by the Environmental Direction of French Polynesia (DIREN) (authorization no. 012024/VP/DIREN, December 5, 2023) and published in the *Official Journal of French Polynesia*. At the local level, research activities were carried out in collaboration with community leaders, associations, and Polynesian institutions through official meetings and formal correspondence. Finally, at the participant level, Prior Informed Consent (PIC) was obtained from all participants after providing a clear explanation of the study objectives, methods, and participant rights, including confidentiality and voluntary participation.

2.4. Botanical identification

The plants mentioned during the interviews (except common cultivated plants) were collected as herbarium specimens (two duplicates) following the methodology outlined by Chassagne and Quave (2021). Plant photographs were taken and information on their characteristics, location, and habitat was recorded. The specimens were then pressed, dried, and assigned unique labels consisting of the first author's initials (DT) followed by a number. Identifications were conducted by the botanist Dr. J.F Butaud, co-author of this study and cross-checked for the valid scientific names using the international database Plants of the World Online (https://powo.science.kew.org/) and French Polynesia database *Nadeaud* (https://nadeaud.ilm.pf/). Herbarium specimens were deposited at the *Herbier de Polynésie française* (PAP) in the *Musée de Tahiti et des Îles*, Puna'auia, Tahiti, French Polynesia, and duplicate specimens were stored in the herbarium of the *Jardin Botanique Henri Gaussen* (TL) at *Muséum d'Histoire Naturelle*, Toulouse, France.

2.5. Plants selection for scientific evaluation

Among the 84 plant species documented during the ethnobotanical survey, eight were selected for the evaluation of their efficacy and safety. In addition, one traditional remedy composed of a mixture of three plant species was also included (Table 2). The selection was based, first, on the frequency of citation during the ethnobotanical survey, with the most frequently mentioned species and remedies. Second, the biogeographical status of each plant was considered, with priority given to indigenous species and those introduced by Polynesians, rather than to modern introductions. Third, the availability of scientific literature on the antibacterial properties and toxicity of the species was evaluated; plants with limited data were prioritized, to address existing knowledge

Table 2
Plants and remedy selected from ethnobotanical surveys for biological investigation.

Plant species	Botanical family	Part of the plant	Voucher No	Number of citations	Biogeographic status	Collection locality (GPS)	Administration route	Traditional preparation methods reproduced in the laboratory	Plant material quantity used for traditional extract preparation [a]
Plants selected									
Spondias dulcis Parkinson	Anacardiaceae	Green fruits	DT016	47	Polynesian introduction	– 17.76033 – 149.508434	Oral	Fruit grated and the pulp pressed through a cloth to extract the juice	30 fruits
Syzygium malaccense (L.) Merr. & L. M.Perry	Myrtaceae	Leaves	DT021	44	Polynesian introduction	– 17.76033 – 149.508434	Oral	Leaves crushed and the mixture pressed through a cloth to extract the juice	60 leaves
Thespesia populnea (L.) Sol. ex Corrêa	Malvaceae	Young fruits	DT008	31	Indigenous	– 17.76033 – 149.508434	Cutaneous	Fruit cut and macerated in water	60 fruits
Microsorum grossum (Langsd. & Fisch.) S.B.Andrews	Polypodiaceae	Rhizomes	DT004	30	Indigenous	– 17.5748633 – 149.5209686	Oral	Rhizomes crushed and the mixture pressed through a cloth to extract the juice	20 rhizomes
Calophyllum inophyllum L.	Calophyllaceae	Leaves	DT022	19	Indigenous	– 17.5747444 – 149.3119112	Cutaneous	Leaves cut and macerated in water	50 leaves
Davallia solida (Forst.) Sw. var. *solida*	Davalliaceae	Rhizomes	DT012	18	Indigenous	– 17.5748633 – 149.5209686	Oral	Rhizomes crushed and the mixture pressed through a cloth to extract the juice	20 rhizomes
Heliotropium arboreum (Blanco) Mabb.	Boraginaceae	Leaf buds	DT043	13	Indigenous	– 17.5747444 – 149.3119112	Oral	Leaf buds crushed and the mixture pressed through a cloth to extract the juice	40 leafbuds
Leucas decemdentata (Willd.) Sm	Lamiaceae	Aerial parts	DT011	10	Polynesian introduction	– 17.543623 – 149.541208	Oral	Plant crushed and the mixture pressed through a cloth to extract the juice	15 handful
Remedy selected									
"*He'a*" remedy: *Syzygium malaccense* (L.) Merr. & L.M.Perry	Myrtaceae	Leaves	DT021	69	Polynesian introduction	– 17.76033 – 149.508434	Oral	Plant crushed together and the mixture pressed through a cloth to extract the juice	36 leaves
Citrus × *aurantiifolia* (Christm.) Swingle	Rutaceae	Juice fruit	ND		Modern introduction	Papeete food market			18 fruits
Curcuma longa L.	Zingiberaceae	Rhizome	ND		Polynesian introduction				9 rhizomes

[a] During the ethnobotanical surveys, the quantities of plant material used were reported qualitatively (e.g., number of leaves, fruits, a handful or, the length of a phalanx). To remain faithful to traditional practices, the laboratory preparation of extracts followed these same empirical measures, adjusting the quantities proportionally to obtain sufficient material for analysis. Consequently, the amounts are not expressed in grams but correspond to the traditional units of reference documented in the field.

gaps through this study. Finally, the conservation status of each species was verified, and plants classified as threatened on the International Union for Conservation of Nature Red List (UICN, 2015) were excluded to ensure the ethical and sustainable conduct of the research.

2.6. Plant collection and traditional preparation

The selected species were prepared according to the traditional methods most frequently reported by participants (Table 2). All plant material was collected on the island of Tahiti in May 2025, then washed and cut into small pieces (Fig. 2A). Oral preparations consisted of the expression of fresh plant juice: the plant material was crushed using a mortar and pestle (Fig. 2B) and manually pressed through a locally used cloth (Fig. 2C). Cutaneous preparations consisted of medicinal baths: the freshly cut plant material was left to macerate in water at ambient temperature for 30 min. The resulting juices and maceration aqueous extracts were immediately frozen (Fig. 2D) and subsequently lyophilized (Martin Christ Beta 2–8 LSCbasic, Osterode am Harz, Germany) (Fig. 2E) to obtain dry extracts suitable for transport and laboratory analyses (Fig. 2F).

2.7. Evaluation of the antibacterial activity of traditional polynesian medicinal plant preparations

2.7.1. Bacterial strain and growth conditions

A total of nine bacterial strains, including four Gram-negative and five Gram-positive species, were selected. These strains are considered reference standards by CLSI and EUCAST and represent pathogens associated with infections reported during the ethnobotanical survey. The panel included *Escherichia coli* ATCC® 25,922, *Pseudomonas aeruginosa* ATCC® 27,853, *Klebsiella pneumoniae* ATCC® 10 031, *Salmonella enterica* subsp. *enterica* serovar Enteritidis ATCC® 13 076, *Staphylococcus aureus* ATCC® 25,923, *Staphylococcus epidermidis* ATCC® 12,228, *Enterococcus faecalis* ATCC® 29,212, *Streptococcus pyogenes* ATCC® 19,615, and *Bacillus cereus* ATCC® 11,778. All strains were obtained from the Pasteur Institute and stored in glycerol at −70 °C. Appropriate culture media and reference antibiotics were used for subsequent assays.

2.7.2. Determination of the minimal inhibitory concentration

The minimum inhibitory concentration (MIC) of traditional preparations was determined using the 96-well microdilution method as described by Chassagne and Quave (2021). Bacterial strains, cultured in Mueller-Hinton broth, were adjusted to 5×10^5 CFU/mL based on their optical density (OD_{600}). Extracts were solubilized in DMSO and tested at concentrations ranging from 4 to 1024 µg/mL by serial dilution, in parallel with a reference antibiotic (2–64 µg/mL, dissolved in water). Controls included untreated bacterial cultures, medium without inoculum, and solvent-only wells. All conditions were performed in triplicate. After 18 h of incubation at 37 °C, bacterial viability was assessed visually by adding 40 µL of iodonitrotetrazolium chloride (INT, 0.2 mg/mL), as developed by Eloff (1998), incubating for 1 h at 37 °C. The formation of pink formazan indicated bacterial growth, while its absence reflected inhibition. MIC value was determined visually as the lowest well showing no pink coloration. As the present study evaluated crude traditional preparations obtained by fresh plant juice expression, rather than enriched organic extracts, 1024 µg/mL was retained as the highest tested concentration. MIC values were then interpreted according to literature-based thresholds for crude plant extracts: <100 µg/mL as significant, 100–625 µg/mL as moderate, and >625 µg/mL as weak activity, following Kuete (2010).

2.8. Evaluation of the cytotoxicity of traditional polynesian medicinal plant preparations

2.8.1. Cell lines

Cytotoxicity assays were conducted on healthy mammalian cell lines. Extracts traditionally administered orally were tested on Vero CCL-81 (primate kidney epithelial cells) and hIEC-6 CRL-3266 (human intestinal epithelial cells), while extracts used topically were also tested on the human keratinocyte cell line HaCaT CVCL_0038.

2.8.2. MTT cell viability assay

Cell viability was evaluated using the colorimetric 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay as previously described (Mosmann, 1983). Cells were seeded in 96-well plates at densities of 6×10^4 cells/mL for hIEC-6, 5×10^4 cells/mL for Vero,

Fig. 2. Traditional preparation of plants in the laboratory. (2. A) Fresh plants collected, washed and cut into small pieces (2. B) Fresh plants crushed with a mortar and pestle (2. C) Crushed plants manually pressed through a locally used cloth (2. D) Traditional preparation frozen (2. E) Lyophilization of the frozen traditional preparation (2. F) Dry traditional preparation of plants.

and 1×10^5 cells/mL for HaCaT in appropriate culture medium and incubated for 24 h in standard conditions (37 °C, 5% CO_2). Traditional preparations, dissolved in DMSO, were applied in serial dilutions ranging from 1250 to 9.76 μg/mL (final DMSO concentration of 0.5%). Controls included untreated cells, vehicle-only wells, SDS, and doxorubicin as a positive control. All conditions were performed in triplicate. After 72 h of incubation, the medium was aspirated and 100 μL of MTT solution (0.5 mg/mL in complete Minimum Essential Medium) was added to each well and incubated for 1 h at 37 °C. The supernatant was then replaced with 100 μL of DMSO to solubilize the formazan crystals formed by metabolically active cells. After shaking, absorbance was recorded at 570 nm using the microplate reader BIOTEK Eon. CC_{50} values were determined by nonlinear regression of dose–response curves using TableCurve 2D v5. A traditional preparation was considered cytotoxic when its CC_{50} value was below 20 μg/mL (Elisha et al., 2017; Indrayanto et al., 2021). Selectivity indices (SI) were calculated by dividing the CC_{50} value by the previously determined MIC for each reference bacterial strain (SI = CC_{50}/MIC). An SI > 1 suggests that the extract's activity is more likely attributable to specific antibacterial compounds rather than to nonspecific cytotoxicity.

2.9. Data analysis and visualization

The study maps were created using the open-source software QGIS (version 3.36.1). Basemaps and geographic layers were extracted from the OpenStreetMap database using the QuickOSM plugin. Vector features were manually styled (relief, contours, and place names). The cartographic layout, including the addition of scale bars, compass rose, and geographic annotations, was completed in QGIS using the Layout Manager tool.

A targeted literature review of preclinical data was carried out for plant species investigated in the study, aiming to compile data on ethnobotanical uses, antimicrobial activity, and toxicity. Searches were conducted via Google Scholar electronic database, and only peer-reviewed articles published in journals with an impact factor greater than 1 and indexed in the Scimago Journal (https://www.scimagojr.com/) were considered. Search terms were tailored to each topic as follows.

- Ethnobotanical uses: [scientific name of the plant] AND ("traditional medicine" OR "medicinal plant" OR "ethnobotany" OR "field survey") AND ("French Polynesia" OR "Pacific");
- Antimicrobial activity: [scientific name of the plant] AND ("infection" OR "infectious disease" OR "antibacterial" OR "antimicrobial");
- Cytotoxicity: [scientific name of the plant] AND ("cytotoxicity" OR "toxicity" OR "case report").

3. Results

3.1. Ethnobotanical data

3.1.1. Socio-demographic data and classification of healers

A total of 85 participants were interviewed across the five studied islands (**Additional file 1:** Table S1), with the following distribution: 21 participants in Tahiti (24%), 19 in Moorea (22%), 13 in Raiatea (15%), 11 in Tahaa (13%), and 21 in Huahine (25%). The participants consisted mostly of women (67 participants, 79%) and ranged in age from 26 to 83 years, with a mean age of 58 years. Regarding educational background, 55% of participants have completed only primary education. Most were retirees (41%), followed by farmers and manual workers (15%), employees (14%), and artisans, retailers, or business owners (12%); 13% were unemployed, and only 5% held executive or intellectual positions. Based on the previously described classification of Polynesian healers, 35 participants (41%) were identified as experts in traditional medicine. Most experts were women (86%), mostly aged between 61 and 70 years (34%), with most having completed only elementary education (80%). An additional 13 participants (15%) were classified as having an intermediate level of knowledge and practice, while 37 (44%) were considered non-experts with limited familiarity with herbal remedies.

3.1.2. Overview of traditional herbal remedies used for infectious diseases in French Polynesia

A total of 626 traditional herbal remedies, known as *rā'au tahiti*, were documented during the survey to treat infectious diseases, with an average of 8 remedies reported per participant. Remedies sharing the same used plant species, methods of preparation, administration, and therapeutic indications were grouped together. As a result, 334 of the 626 recorded remedies were identified as distinct formulations, hereafter referred to as "unique remedies". Each unique remedy comprises between 1 and 14 plants, with an average of 2.3 plants per formulation. Most remedies consist of a single plant (145 remedies, 43%), followed by those containing two (82 remedies, 25%) and three plants (53 remedies, 16%). Remedies composed of four to six plants represent 14% (46 remedies) of cases, whereas complex formulations with more than seven plants are less common (8 remedies, 2%).

Most traditional remedies documented in this study are administered orally (203 out of 334 unique remedies, 61%). Oral preparations predominantly consisted of plant juice from fresh plants (169 remedies, 83% of oral remedies) (Fig. 3. A, D), obtained after crushing the plant material in a traditional wooden bowl called *'ūmete* (Fig. 3. B, C). Other oral forms include decoctions (26 remedies, 13% of oral remedies) or direct mastication of plant material (8 remedies, 4% of oral remedies). Cutaneous application represented the second most common route of administration (92 remedies, 27.5%), primarily through medicinal baths (33 remedies, 36% of cutaneous preparations). In 24% of these cases (8 out of 33 baths), a portion of the bathwater is also ingested orally, reflecting a dual route of administration. Other cutaneous applications include herbal poultices (30 remedies, 32% of cutaneous preparations) and massages using oil macerates of medicinal plants (24 remedies, 26% of cutaneous preparations). Additional routes are employed for specific infections with the pulmonary administration (16 remedies, 5%) through medicinal steam baths, the ocular administration (14 remedies, 4%) via eye baths made from plants or eye drops derived from fresh plant juice and the auricular administration (9 remedies, 3%), involving massage around the ear with an oil macerate followed by instillation of a few drops into the ear canal.

The dosage and quantity of traditional remedies are empirical and vary according to the practitioner and the condition treated. Among the 626 remedies documented, most were administered for three days (398 remedies, 64%) or until the symptoms were resolved (157 remedies, 25%). Others were taken once daily until the preparation was finished (40 remedies, 6%), while a few were given as a single dose (28 remedies, 4%) or over the course of one week (3 remedies, 0.5%). Ingredient quantities are similarly based on experiential and culturally embedded measurement systems, often derived from bodily references. For instance, rhizomes are measured in *'initi* (a phalanx length), tree barks in *pa'a* (the size of a hand), and herbaceous plants in *'apu rima* (a handful). For liquids such as water or coconut water, a gallon (an Anglo-Saxon unit equivalent to approximately 5 L) is commonly used.

3.1.3. Overview of medicinal plants used in traditional anti-infective remedies

A total of 84 plant species, accounting for 1086 individual use reports, were documented during the survey for the treatment of infectious diseases (Table 3). All species are consistently used in their fresh form. Of these, 39 were identified as herbaceous plants (46%), 29 as trees (35%), 11 as shrubs (13%), and 5 as ferns (6%). The ten most frequently cited plant species are *Cocos nucifera* (101 UR), *Citrus* x *aurantiifolia* (66 UR), *Cordia subcordata* (58 UR), *Curcuma longa* (52 UR), *Gardenia taitensis* (52 UR), *Saccharum officinarum* (52 UR), *Spondias dulcis* (47 UR), *Syzygium malaccense* (44 UR), *Morinda citrifolia* (33 UR), and *Thespesia populnea* (31 UR) (Fig. 4).

Fig. 3. Preparation of a traditional remedy through plant juice expression. (3. A) Fresh plants selected for the remedy preparation (3. B) Traditional wooden bowl (*'ūmete*) used to prepare the remedy (3. C) Manual crushing of plants inside the *'ūmete* (3. D) Juice extraction using a filtering cloth.

The 84 plant species documented in this study belong to 49 distinct botanical families, with Lamiaceae being the most represented (78 UR, 7 species), followed by Poaceae and Rubiaceae (71 UR, 5 species) and Asteraceae (21 UR, 4 species). At the genus level, *Coleus* is the most represented with 3 species (39 UR), followed by *Citrus* (78 UR), *Hibiscus* (28 UR), *Ficus* (23 UR), *Musa* (20 UR), and *Ipomoea* (2 UR) each comprising 2 species.

Among the plant parts used, leaves were the most frequently cited (217 UR, 39 species). They were followed by fruits (182 UR, 17 species) and aerial parts (154 UR, 20 species). Rhizomes were cited 119 times (8 species), mainly among ferns and members of the Zingiberaceae family. Leaf buds were also commonly reported, cited for 101 (36 species). Other frequently used parts included the inner bark of trees (88 UR, 18 species) and stems (56 UR, 6 species), with *Saccharum officinarum* being the most representative example. Finally, flowers (52 UR, 9 species) were also used, while floral buds were specifically cited for 5 species (35 UR), particularly *Gardenia taitensis*.

Regarding biogeographical origin, 32 species (38%) are modern introductions, introduced following European contact in the late 18th century. Then, 28 species (33%) are considered as indigenous, meaning they are native to the region and arrived naturally, prior to any human intervention. Finally, 24 species (29%) are classified as Polynesian introductions, brought by the first Polynesian navigators and so called "canoe plants" for their nutritional, medicinal, or cultural importance, during their transoceanic migrations.

3.1.4. Medicinal plants used for infectious diseases

Among the infectious diseases targeted during the survey, the most frequently treated conditions are skin infections (149 citations, 24% of the total disease citations), angina and sore throat (97 citations, 15.5%), leucorrhea (69 citations, 11%) and fever (68 citations, 11%). In contrast, gastroenteritis is the least treated, with only 18 citations (2.9%) (**Additional file 2:** Table S2). The following section presents the plant species most frequently used to treat each condition, listed in descending order of citation. Detailed information on the corresponding remedies is provided in the supplementary material (**Additional file 3**).

3.1.4.1. Cutaneous infections. Skin infections, including wounds and abscesses, are among the conditions most frequently treated in Polynesian traditional medicine, with 65 unique remedies documented (149 UR). These treatments are predominantly single-ingredient formulations (106 UR, 71%), with an average of 1.6 ingredients per remedy. Most remedies for skin infections are applied topically, through direct application, massage, or poultices (48 unique remedies, 75%). Herbal baths represent the second most common mode of administration (14 unique remedies, 22%), while only two remedies (3%) are taken orally. A total of 49 plant species were identified for skin treatments, the most frequently cited being *Musa* × *paradisiaca* [pseudostem sap] (18 UR), *Morinda citrifolia* [ripe fruit] (16 UR), *Capsicum frutescens* [fruit or leaf bud] (15 UR), *Cocos nucifera* [coconut water or coconut milk] (15 UR), *Hibiscus tiliaceus* [flower or root] (9 UR), and *Calophyllum inophyllum* [oil, fruit, or leaf] (8 UR).

3.1.4.2. Angina, sore throat – 'oromo'o. In Polynesian traditional medicine, both sore throat and angina are treated in the same way, with 31 unique remedies (97 UR) using 13 plant species. Among these remedies, 87% (84 UR) are mono ingredient. On average, each remedy contains 1.7 ingredients, with the most complex remedy involving up to 4 medicinal plants. Almost all remedies for this condition are administered orally (30 unique remedies, 97%) and gargle (8 unique remedies, 26%). The most frequently cited species is *Spondias dulcis* [green fruit] (41 UR), followed by *Rorippa sarmentosa* [aerial part] (15 UR), *Heliotropium arboreum* [leafbud] (13 UR), *Morinda citrifolia* [flower or ripe fruit] (6 UR), and *Oxalis corniculata* [aerial part] (6 UR). Notably, *Heliotropium arboreum* is specifically used for treating angina.

3.1.4.3. Leucorrhea – he'a. The treatment of the traditional Polynesian disease concept *he'a*, interpreted in this study as corresponding to leucorrhea, involves 41 plant species incorporated into 45 distinct remedies (69 use reports). It constitutes the most complex treatment documented in this study, with up to 14 ingredients per remedy and an average of 4.6 species per preparation. The majority of remedies (96%, 66 UR) consist of multi-plant formulations and are administered orally (44 unique remedies, 97%). The most frequently cited species in *he'a* treatments include *Curcuma longa* [rhizome] (38 UR), *Citrus* × *aurantiifolia* [fruit juice] (37 UR), and *Syzygium malaccense* [leaf or bark] (33 UR), often used in combination. These are followed by *Cordia subcordata* [bark or leafbud or leaf or flower] (30 UR), *Cocos nucifera* [coconut water or

Table 3
Ethnobotanical data of 84 medicinal plant species used for treating infectious diseases in the Society archipelago.

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
Achyranthes aspera L. var. *aspera*	*'Āerofai*	Amaranthaceae	DT041	Pol.	2	Angina, sore throat	Leafbud	Crush, filter	Oral	2
Adenostemma viscosum J.R. Forst. & G.Forst.	*Vaianu*	Asteraceae	DT065	Ind.	9	Leucorrhea (*he'a*)	Aerial part	Crush, filter, fermentation	Oral	5
						Conjunctivitis	Aerial part	Crush in water	Eye bath	2
						Angina, sore throat	Aerial part	Crush, filter	Oral	1
						Sinusitis	Aerial part	Crush, filter	Oral	1
Aleurites moluccanus (L.) Willd.	*Ti'airi, 'Ama* (Marquesan)	Euphorbiaceae	DT042	Pol.	23	Leucorrhea (*he'a*)	Bark/Fruit	Crush, filter, fermentation	Oral	7
						Skin infection	Bark/Flower	Crush	Local application, oral	5
						Cystitis	Bark/Fruit	Crush, filter	Oral	4
						Angina, sore throat	Bark	Crush, filter	Gargle	3
						Nasopharyngitis, cold	Fruit	Crush, filter	Oral, bath	1
						Conjunctivitis	Flower	Press in water	Eye bath	1
						Otitis	Fruit	Crush, filter	Oral, cutaneous, auricular	1
						Sinusitis	Flowerbud	Crush, filter	Oral	1
Aloe vera (L.) Burm.f	Aloé (French)	Asphodelaceae	DT082	Mod.	8	Skin infection	Leaf (inner gel)	None	Local application	6
						Covid	Leaf (inner gel)	Crush, filter	Oral	1
						Sore throat	Leaf (inner gel)	Crush, filter	Oral	1
Alpinia zerumbet (Pers.) B.L.Burtt & R.M.Sm.	*'Ōpuhi*	Zingiberaceae	DT084	Mod.	1	Fever	Leaf	Boil	Bath, oral	1
Amaranthus viridis L.	*Vahineāra'a*	Amaranthaceae	NC	Pol.	2	Leucorrhea (*he'a*)	Aerial part	Crush, filter	Oral	1
						Sinusitis	Aerial part	Crush	Massage	1
Ananas comosus (L.) Merr.	*Painapo*	Bromeliaceae	NC	Mod.	2	Leucorrhea (*he'a*)	Fruit	Grate, boil, filter/Crush, filter	Oral	2
Angiopteris evecta (G.Forst.) Hoffm.	*Nahe*	Marattiaceae	DT024	Ind.	2	Fever	Leafbud/ Leaf	Press on tissue/Crush, filter	Cutaneous (forehead)/ Oral	2
Annona muricata L.	Corossol (French)	Annonaceae	DT033	Mod.	12	Skin infection	Leaf	Boil/ Maceration	Bath/Local application	6
						Leucorrhea (*he'a*)	Leaf	Crush, filter/ Boil	Oral	2
						Nasopharyngitis, cold	Leaf	Boil	Inhalation, bath	1
						Fever	Leaf	Boil	Bath, oral	1
						Influenza	Leaf	Crush, filter	Oral	1
						Cystitis	Leaf	Boil	Oral	1
Artocarpus altilis (Parkinson) Fosberg	*'Uru pae'a*	Moraceae	DT071	Pol.	14	Bronchitis	Bark/ Leafbud	Crush, filter	Oral	5
						Angina, sore throat	Leafbud	Crush, filter	Oral, gargle	3
						Gastroenteritis	Leafbud	Crush, filter	Oral	1
						Fever	Leafbud	Crush, filter	Oral	1
						Influenza	Leafbud	Crush, filter	Oral	1
						Otitis	Leafbud	Crush	Cutaneous, auricular	1
						Furuncles, abscess	Leafbud	Boil	Local application	1
						Cystitis	Leafbud	Crush, filter	Oral	1
Bauhinia monandra Kurz	*Pine*	Fabaceae	DT057	Mod.	2	Otitis	Leaf	Crush, mix with monoi	Cutaneous, auricular	1
						Skin infection	Leafbud	Crush, mix with monoi	Local application	1
Broussonetia papyrifera (L.) Vent.	*Aute*	Moraceae	DT085	Pol.	1	Skin infection	Leaf	Crush	Local application	1
Calophyllum inophyllum L.	*Tāmanu*	Calophyllaceae	DT022	Ind.	19	Leucorrhea (*he'a*), Cystitis	Bark	Crush, boil/ Crush, filter, fermentation	Oral	8

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Table 3 (*continued*)

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
						Skin infection	Seed (oil)/ Leaf	Press/Boil	Local application/ Bath	8
						Conjunctivitis	Leaf	Crush	Eye bath	2
						Otitis	Fruit	Boil	Cutaneous, auricular	1
Capsicum frutescens L.	*'Ōporo*	Solanaceae	DT032	Mod.	16	Skin infection	Fruit/Leaf/ Leafbud/ Stem	Crush, mix with monoi/ Crush, filter, boil	Local application/ Oral, local application	15
						Covid	Fruit	Crush, filter	Oral	1
Casuarina equisetifolia L. subsp. *equisetifolia*	*'Aito*	Casuarinaceae	DT053	Ind.	2	Leucorrhea (*he'a*)	Bark	Crush, filter	Oral	1
						Cystitis	Leaf	Crush, filter	Oral	1
Catharanthus roseus (L.) G. Don	Pervenche de Madagascar (French)	Apocynaceae	DT045	Mod.	2	Leucorrhea (*he'a*)	Flower	Chew	Oral	1
						Gastroenteritis	Flower	Boil	Oral	1
Cenchrus caliculatus Cav.	*Piripiri*	Poaceae	DT060	Ind.	5	Leucorrhea (*he'a*)	Aerial part/ Leafbud	Crush, filter	Oral	4
						Skin infection	Leafbud	Crush	Local application	1
Centotheca lappacea (L.) Desv.	*'Ofe'ofe*	Poaceae	DT062	Ind.	2	Bronchitis	Leafbud	Crush, filter	Oral	1
						Nasopharyngitis, cold	Aerial part	Crush, filter	Oral	1
Citrus × *aurantiifolia* (Christm.) Swingle *	*Tāporo*	Rutaceae	DT035	Mod.	66	Leucorrhea (*he'a*)	Fruit (juice)/ Leafbud/ Bark	Crush, filter, fermentation	Oral	37
						Fever	Fruit (juice)/ Leaf/ Leafbud	Crush, filter/ Boil	Oral/Oral, bath	6
						Bronchitis	Fruit (juice)	Press	Oral	5
						Gastroenteritis	Fruit (juice)/ Leafbud	Crush, filter	Oral	4
						Skin infection	Fruit (juice)	Press	Local application	4
						Cystitis	Fruit (juice)/ Leafbud	Crush, filter/ Boil	Oral	4
						Nasopharyngitis, cold	Leaf	Boil	Inhalation	2
						Sinusitis	Fruit (juice)	Boil/Crush, filter	Oral	2
						Sore thoart, cough	Fruit (juice)	Crush, filter/ Boil	Oral	2
						Influenza	Fruit (juice)	Crush, filter	Oral	1
Citrus × *sinensis* (L.) Osbeck	*'Anani*	Rutaceae	DT029	Mod.	6	Sinusitis	Fruit	Crush, filter	Oral	2
						Bronchitis	Fruit	Crush, filter	Oral	1
						Fever	Leafbud	Boil	Bath, oral	1
						Leucorrhea (*he'a*)	Leafbud	Crush, filter	Oral	1
						Skin infection	Fruit	Crush, filter, fermentation	Oral	1
Cocos nucifera L. *	*Ha'ari*	Arecaceae	NC	Pol.	101	Fever	Water/Oil/ Leafbud/ Root	Put on a tissue/None/ Crush, filter	Cutaneous (forehead)/ Cutaneous (forehead), oral/Oral/ Massage	22
						Sinusitis	Water/ Milk/Oil	Crush, filter, fermentation/ Crush, filter/ Boil	Oral/Oral, massage/ Inhalation	18
						Leucorrhea (*he'a*)	Water/ Milk/ Coconut sprout/Root	Crush, filter, fermentation	Oral	15
						Skin infection	Water/ Coconut sprout/ Flesh/Milk/ Oil	Crush, filter, fermentation/ Crush/Boil	Oral/Local application	15

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Table 3 (*continued*)

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
						Bronchitis	Water/ Coconut sprout	Crush, filter/ Boil	Oral	11
						Cystitis	Water	Crush, filter	Oral	7
						Angina, sore throat	Water/Leaf/ Milk	Crush, filter/ Chew/None	Oral, gargle/ Oral	7
						Conjunctivitis	Water	None	Eye bath	3
						Nasopharyngitis, cold	Milk	Crush, filter	Oral	1
						Genital infection	Fruit	Crush, boil	Oral	1
						Otitis	Milk	Crush, filter	Oral, cutaneous, auricular	1
Codiaeum variegatum (L.) A.Juss	Croton (French)	Euphorbiaceae	DT068	Mod.	1	Conjunctivitis	Leaf	Crush in water	Eyes bath	1
Coleus amboinicus Lour.	*Niauri*	Lamiaceae	DT076	Mod.	13	Nasopharyngitis, cold	Leaf/ Leafbud	Boil	Inhalation/ Bath	8
						Fever	Leaf/ Leafbud	Boil	Oral/ Inhalation	4
						Otitis	Leaf	Crush, mix with monoi	Cutaneous, auricular	1
Coleus barbatus (Andrews) Benth. ex G. Don	Sauge doliprane (French)	Lamiaceae	DT018	Mod.	17	Fever	Leaf	Boil	Oral/ Inhalation/ Bath	11
						Nasopharyngitis, cold	Leaf	Boil	Bath/ Inhalation/ Bath, oral	3
						Skin infection	Leaf	Crush, mix with monoi	Local application	2
						Sinusitis	Leaf	Boil	Bath	1
Coleus scutellarioides (L.) Benth.	*Terevete*	Lamiaceae	DT017	Mod.	8	Skin infection	Leaf	Crush/Boil	Local application/ Bath	7
						Conjunctivitis	Leaf	Crush in water	Eye bath	1
Cordia subcordata Lam.	*Tou*	Boraginaceae	DT001	Ind.	58	Leucorrhea (*he'a*)	Leaf/ Leafbud/ Flower/Bark	Crush, filter/ Crush, filter, fermentation	Oral	30
						Bronchitis	Bark/Leaf	Crush, filter	Oral	16
						Conjunctivitis	Leaf	Crush in water	Eyes bath	4
						Skin infection	Leaf	Crush in water	Bath	3
						Angina, sore throat	Bark/Leaf	Crush, filter	Oral	2
						Fever	Leaf	Boil/Crush, filter	Bath, oral/ Cutaneous (forehead)	2
						Cystitis	Bark	Crush, boil	Oral	1
Cordyline fruticosa (L.) A.Chev	*'Autī*	Asparagaceae	DT003	Pol.	11	Gastroenteritis	Leafbud	Crush, filter	Local application (navel)/Oral	3
						Fever	Leaf	Crush	Cutaneous (forehead)	2
						Bronchitis	Leaf	Crush in water	Bath	1
						Conjunctivitis	Leafbud	Boil	Eyes bath	1
						Fever	Leafbud	Crush, filter	Oral	1
						Sinusitis	Leaf	Crush, boil	Oral	1
						Cystitis	Leaf	Crush, filter	Oral	1
						Chickenpox	Leaf	Boil	Bath	1
Curcuma longa L.	*Re'a tahiti*	Zingiberaceae	DT019	Pol.	52	Leucorrhea (*he'a*)	Rhizome	Crush, filter, fermentation	Oral	38
						Cystitis	Rhizome	Crush, filter	Oral	3
						Bronchitis	Rhizome	Crush, filter	Oral	2
						Furuncles, abscess	Rhizome	Crush	Local application	2
						Sinusitis	Rhizome	Crush, filter/ Boil	Oral/Massage	2
						Angina, sore throat	Rhizome	Crush, boil	Oral	1
						Angina, sore throat	Rhizome	Crush, filter	Oral	1

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Table 3 (*continued*)

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
						Nasopharyngitis, cold	Rhizome	Crush, boil	Inhalation	1
						Fever	Rhizome	Crush, filter	Oral	1
						Influenza	Rhizome	Crush, filter	Oral	1
Cyathula prostrata (L.) Blume	*Toro'ura*	Amaranthaceae	DT044	Pol.	4	Leucorrhea (*he'a*)	Aerial part	Crush, filter, fermentation	Oral	2
						Sinusitis	Aerial part	Crush	Oral	1
						Cystitis	Aerial part	Crush, filter	Oral	1
Cyperus mindorensis (Steud.) Huygh	*Mōʻu upo'o*	Cyperaceae	DT013	Pol.	8	Bronchitis	Aerial part	Crush, filter	Oral	2
						Gastroenteritis	Aerial part	Crush, filter	Oral	1
						Influenza	Aerial part	Crush, boil	Oral	1
						Leucorrhea (*he'a*)	Aerial part	Crush, filter	Oral	1
						Sinusitis	Aerial part	Crush, filter, fermentation	Oral	1
						Cystitis	Aerial part	Crush, filter	Oral	1
						Skin infection	Aerial part	Crush, filter	Oral	1
Davallia solida (Forst.) Sw. var. *solida*	*Ti'ati'amou'a*	Davalliaceae	DT012	Ind.	18	Bronchitis	Rhizome	Crush, filter	Oral	7
						Leucorrhea (*he'a*)	Rhizome	Crush, filter	Oral	4
						Fever	Rhizome	Crush, filter	Oral	3
						Nasopharyngitis, cold	Leaf	Boil	Inhalation, bath	1
						Influenza	Rhizome	Crush, filter	Oral	1
						Otitis	Rhizome	Crush, boil	Oral	1
						Cystitis	Rhizome	Crush, filter	Oral	1
Dichrocephala integrifolia (L.f.) Kuntze	*Ta'ata'ahiara*	Asteraceae	DT066	Pol.	8	Leucorrhea (*he'a*)	Aerial part	Crush, filter, fermentation	Oral	3
						Angina, sore throat	Aerial part	Crush, filter	Oral	1
						Bronchitis	Aerial part	Crush, filter	Oral	1
						Fever	Aerial part	Crush, filter	Oral	1
						Sinusitis	Aerial part	Crush, filter	Oral	1
						Cystitis	Aerial part	Crush, filter	Oral	1
Emilia fosbergii Nicolson	*Ma'a rapiti*	Asteraceae	DT049	Mod.	1	Skin infection	Aerial part	Crush	Local application	1
Erythrina variegata L.	*'Atae*	Fabaceae	NC	Pol.	1	Leucorrhea (*he'a*)	Bark	Crush, filter, fermentation	Oral	1
Ficus prolixa G. Forst.	*'Ōrā*	Moraceae	DT014	Ind.	13	Leucorrhea (*he'a*)	Aerial Root	Crush, filter, fermentation	Oral	5
						Bronchitis	Aerial Root	Crush, filter	Oral	2
						Gastroenteritis	Aerial Root	Crush, filter	Oral	1
						Fever	Aerial Root	Crush in water	Oral	1
						Influenza	Aerial Root	Crush, boil	Oral	1
						Skin infection	Aerial Root	Crush, filter	Oral	1
						Skin infection	Leaf	Boil	Bath	1
						Cystitis	Aerial Root	Crush, filter	Oral	1
Ficus tinctoria G. Forst. subsp. *tinctoria*	*Mati*	Moraceae	DT040	Pol.	9	Leucorrhea (*he'a*)	Fruit (sap)/ Bark/Leaf	Crush, filter	Oral	9
Gardenia taitensis DC.	*Tiare tahiti*	Rubiaceae	DT027	Pol.	52	Bronchitis	Flower/ Flowerbud	Crush, filter	Oral	21
						Leucorrhea (*he'a*)	Flower/ Flowerbud	Crush, filter, fermentation	Oral	12
						Fever	Flower/ Flowerbud/ Leaf	Crush, filter/ Boil	Oral/ Inhalation/ Bath, oral	5
						Sinusitis	Flower/ Flowerbud	Crush, filter	Oral	3
						Nasopharyngitis, cold	Flower/ Flowerbud	Crush, filter	Oral	2
						Otitis	Flowerbud	Crush/Boil	Cutaneous, auricular/Oral	2
						Furuncles, abscess	Leaf/ Leafbud	Crush	Local application	2
						Skin infection	Flower	Crush, mix with monoi	Local application/ Oral, bath	2
						Cystitis	Flower/ Flowerbud	Crush, filter	Oral	2
						Gastroenteritis	Flowerbud	Crush, filter	Oral	1
Geophila herbacea (Jacq.) K. Schum.	*Tōhetupou*	Rubiaceae	NC	Ind.	1	Skin infection	Aerial part	Crush, filter	Oral	1

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Table 3 (*continued*)

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
Heliotropium arboreum (Blanco) Mabb.	*Tāhinu*	Boraginaceae	DT043	Ind.	13	Angina, sore throat, cough	Leafbud	Crush, filter	Oral, gargle	13
Hibiscus x *rosa sinensis* L. *"Carnation"*	*'Aute 'ū'umu*	Malvaceae	DT039	Mod.	8	Skin infection	Flower	Crush	Local application	5
						Gastroenteritis	Leaf	Crush, filter	Oral	1
						Fever	Leaf	Boil	Bath, oral	1
						Leucorrhea (*he'a*)	Flower	Boil	Oral	1
Hibiscus tiliaceus L. subsp. *tiliaceus*	*Pūrau*	Malvaceae	DT015	Ind.	18	Skin infection	Flower/ Root (sap)	Crush, mix with monoi/ Boil/Blow	Local application/ Bath	9
						Conjunctivitis	Root (sap)	Blow inside	Ocular	5
						Sinusitis	Leafbud/ Stem	Crush, filter	Oral	2
						Angina, sore throat	Leaf	Crush, filter	Oral	1
						Cystitis	Bark	Crush, boil	Oral	1
Inocarpus fagifer (Parkinson) Fosberg	*Māpē*	Fabaceae	DT074	Pol.	1	Leucorrhea (*he'a*)	Leaf	Crush, filter	Oral	1
Ipomoea batatas (L.) Lam.	*Kuma'a* (Marquesan), *'uma'a*	Convolvulaceae	NC	Pol.	1	Furuncles, abscess	Leaf	None	Local application	1
Ipomoea pes-caprae (L.) R.Br.	*Pōhue miti*	Convolvulaceae	DT064	Ind.	1	Leucorrhea (*he'a*)	Aerial part	Crush, filter	Oral	1
Lantana camara L.	Lantana (French)	Verbenaceae	DT051	Mod.	1	Skin infection	Aerial part	Crush	Local application	1
Leucas decemdentata (Willd.) Sm	*Niu*	Lamiaceae	DT011	Pol.	10	Leucorrhea (*he'a*)	Aerial part	Crush, filter, fermentation	Oral	3
						Angina, sore throat	Aerial part	Crush, filter	Oral	2
						Bronchitis	Aerial part	Crush, filter	Oral	2
						Sinusitis	Aerial part	Crush, filter	Oral	2
						Otitis	Leafbud	Crush, boil	Oral	1
Mangifera indica L.	*Vī popa'ā*	Anacardiaceae	NC	Mod.	1	Fever	Fruit (green)	Grate, press	Oral	1
Mentha sp.	*'Ōtime*	Lamiaceae	DT083	Mod.	14	Sinusitis	Leaf	Crush/Boil	Oral/Massage	9
						Nasopharyngitis, cold	Leaf	Boil	Oral/ Inhalation	2
						Bronchitis	Leafbud	Crush, filter	Oral	1
						Gastroenteritis	Leaf	Crush, filter	Oral	1
Microsorum grossum (Langsd. & Fisch.) S.B. Andrews	*Metuapua'a*	Polypodiaceae	DT004	Ind.	30	Bronchitis	Leafbud/ Leaf/ Rhizome	Crush, filter	Oral	13
						Leucorrhea (*he'a*)	Rhizome	Crush, filter, fermentation	Oral	6
						Fever	Leaf/ Rhizome	Crush, filter	Bath/Oral	4
						Nasopharyngitis, cold	Leaf	Crush, filter/ Boil	Oral, bath/ Inhlation	2
						Conjunctivitis	Leafbud	Crush	Occular	1
						Gastroenteritis	Leaf	Crush, filter	Oral	1
						Otitis	Rhizome	Crush, boil	Oral	1
						Skin infection	Rhizome	Crush, filter, fermentation	Oral	1
						Cystitis	Rhizome	Crush, filter	Oral	1
Miscanthus floridulus (Labill.) Warb. ex K.Schum. & Lauterb.	*'Ā'eho*	Poaceae	DT047	Ind.	3	Sinusitis	Leafbud	Crush, filter	Oral	2
						Bronchitis	Stem	Crush, filter	Oral	1
Morinda citrifolia L.	*Nono*	Rubiaceae	DT007	Ind.	33	Skin infection	Fruit (ripe)/ Leaf/ Leafbud/ Flower	Crush/Mix with monoi	Local application	16
						Angina, sore throat	Flower/ Flowerbud/ Fruit (ripe)	Crush, filter	Oral, gargle	6
						Bronchitis	Leaf/ Flower/ Fruit	Boil/Crush, filter	Inhalation/ Oral	3
						Cystitis	Leaf/Fruit/ Flower	Crush, filter	Oral	3
						Conjunctivitis	Fruit	Press in water	Eye bath	1
						Covid-19	Fruit	Crush, filter	Oral	1

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Table 3 (*continued*)

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
						Leucorrhea (*he'a*)	Bark	Crush, filter, fermentation	Oral	1
						Otitis	Root	Crush, mix with monoi	Cutaneous, auricular	1
						Sinusitis	Leaf	Boil	Inhalation	1
Moringa oleifera Lam.	Moringa (French)	Rubiaceae	DT080	Mod.	3	Fever	Leaf/Flower	Boil	Oral	2
						Nasopharyngitis, cold	Leaf	Boil	Oral	1
Musa troglodytarum L.	*Fē'ī*	Musaceae	NC	Pol.	1	Skin infection	Fruit	None	Local application	1
Musa x paradisiaca L.	*Mei'a*	Musaceae	NC	Mod.	19	Skin infection	Leafbud/ Pseudostem sap	Crush/None	Local application	18
						Bronchitis	Fruit (skin)	Chew	Gargle	1
Neonauclea forsteri (Seem. ex Havil.) Merr.	*Mara*	Rubiaceae	NC	Ind.	1	Leucorrhea (*he'a*)	Bark	Crush, filter, fermentation	Oral	1
Nephrolepis hirsutula (G. Forst.) C.Presl	*'Āmo'a*	Nephrolepidaceae	DT052	Ind.	1	Skin infection	Stem (hairs)	Crush	Local application	1
Ocimum basilicum L.	*Miri*	Lamiaceae	DT002	Mod.	12	Nasopharyngitis, cold	Aerial part	Boil	Bath/Oral/ Inhalation	5
						Skin infection	Aerial part	Crush	Local application	4
						Conjunctivitis	Aerial part	Boil/None	Eyes bath/ Ocular	2
						Fever	Aerial part	Boil	Inhalation	1
Ophioglossum reticulatum L.	*Ti'apito*	Ophioglossaceae	DT056	Ind.	8	Leucorrhea (*he'a*)	Aerial part	Crush, filter, fermentation	Oral	3
						Sinusitis	Aerial part	Crush, filter, fermentation	Oral	2
						Fever	Aerial part	Crush, filter	Oral	1
						Skin infection	Aerial part	Crush, filter	Local application	1
						Cystitis	Aerial part	Crush, filter	Oral	1
Oxalis corniculata L.	*Pātoa'ava'ava*	Oxalidaceae	DT048	Ind.	7	Angina, sore throat, cough	Aerial part	Crush, filter	Gargle, oral	6
						Skin infection	Aerial part	Crush, mix with monoi	Local application	1
Pandanus tectorius Parkinson var. *tectorius*	*Fara*	Pandanaceae	DT025	Ind.	7	Angina, sore throat	Aerial Root	Crush, filter	Oral, gargle	2
						Leucorrhea (*he'a*)	Aerial Root	Crush, filter	Oral	2
						Bronchitis	Leafbud	Crush, filter	Oral	1
						Fever	Aerial Root	Crush, filter	Oral	1
						Skin infection	Aerial Root	Crush, mix with monoi	Local application	1
Paspalum vaginatum Sw.	*Matie tātahi*	Poaceae	DT063	Ind.	6	Bronchitis	Aerial part	Crush, filter	Oral	2
						Skin infection	Aerial part	Crush	Local application/ Bath, oral	2
						Fever	Aerial part	Crush, filter	Bath, oral	1
						Sinusitis	Aerial part	Crush, filter, fermentation	Oral	1
Persicaria glabra (Willd.) M. Gómez	*Tamore, pītorea*	Polygonaceae	DT072	Ind.	3	Bronchitis	Leafbud	Boil	Oral	1
						Leucorrhea (*he'a*)	Leaf	Crush, filter	Oral	1
						Skin infection	Leaf	Crush	Local application, oral	1
Phyllanthus amarus Schumach. & Thonn.	*Moemoe*	Phyllanthaceae	DT005	Mod.	25	Otitis	Aerial part	Crush, mix with monoi	Cutaneous, auricular	25
Physalis angulata L.	*Tāmaru ha'ari*	Solanaceae	DT037	Pol.	1	Angina, sore throat	Leaf	Crush, filter	Oral	1
Polyscias guilfoylei (W.Bull) L.H. Bailey	Faux-caféier (French)	Araliaceae	DT081	Mod.	3	Fever	Leaf	Boil	Bath/ Inhalation	2
						Skin infection	Leaf	Crush	Local application	1
Premna serratifolia L.	*'Āvaro*	Lamiaceae	DT054	Ind.	1	Skin infection	Leaf	Boil	Bath	1
Pseudelephantopus spicatus (B.Juss. ex Aubl.) C.F. Baker	*Fikitu* (Marquesan)	Asteraceae	DT036	Mod.	1	Skin infection	Leaf	Boil	Bath	1
Psidium guajava L.	*Tuvava*	Myrtaceae	DT034	Mod.	25	Gastroenteritis	Bark/ Leafbud	Crush/Boil	Oral	8

(*continued on next page*)

Table 3 (*continued*)

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
						Skin infection	Leaf/ Leafbud	Crush	Local application	7
						Angina, sore throat	Leaf/ Leafbud	Boil/Crush, filter	Bath/Oral	3
						Leucorrhea (*he'a*)	Bark/ Leafbud	Crush, filter, fermentation/ Boil	Oral	2
						Angina, sore throat	Stem	Chew	Oral	1
						Bronchitis	Leafbud	Boil	Oral	1
						Conjunctivitis	Fruit	Press	Ocular	1
						Influenza	Leaf	Crush, filter	Oral	1
						Cystitis	Leafbud	Boil	Oral	1
Rorippa sarmentosa (G.Forst. ex DC.) J.F.Macbr.	*Pātoa pūrahi, Moahau'a'ino*	Brassicaceae	DT006	Ind.	30	Angina, sore throat	Aerial part	Crush, filter	Oral	15
						Leucorrhea (*he'a*)	Aerial part	Crush, filter, fermentation	Oral	7
						Bronchitis	Aerial part	Crush, filter	Oral	3
						Sinusitis	Aerial part	Crush, filter	Oral/ Inhalation	2
						Skin infection	Aerial part	Crush, mix with monoi	Local application	2
						Fever	Aerial part	Crush, filter	Oral	1
Rosa sp.	*Roti fautau'a*	Rosaceae	DT058	Mod.	10	Sinusitis	Flower	Chew	Oral	7
						Conjunctivitis	Flower	Crush in water	Eye bath	3
Saccharum officinarum L. *	*Tō*	Poaceae	DT026	Pol.	52	Sinusitis	Stem/ Leafbud/ Root	Crush, filter/ Boil	Oral	25
						Bronchitis	Stem	Crush, filter	Oral	11
						Angina, sore throat	Stem	Crush, filter	Oral	3
						Leucorrhea (*he'a*)	Stem	Crush, filter	Oral	3
						Cystitis	Stem	Crush, filter	Oral	3
						Nasopharyngitis, cold	Stem	Crush, filter/ Boil	Oral	2
						Gastroenteritis	Stem	Crush, filter	Oral	2
						Fever	Stem	Crush, filter	Oral	1
						Otitis	Stem	Crush, boil	Oral	1
						Skin infection	Stem	Crush, filter	Oral	1
Salix babylonica L.	Saule pleureur (French)	Salicaceae	NC	Mod.	1	Fever	Leaf	Boil	Inhalation, bath	1
Santalum insulare Bertero ex A.DC.	*Ahi,* Santal (French)	Santalaceae	NC	Ind.	2	Otitis	Bark	Maceration	Cutaneous, auricular	1
						Sinusitis	Bark	Crush	Inhalation	1
Scaevola taccada (Gaertn.) Roxb.	*Naupata*	Goodeniaceae	DT023	Ind.	13	Conjunctivitis	Fruit	Press	Ocular	11
						Otitis	Fruit	Press	Cutaneous, auricular	2
Sphagneticola trilobata (L.) Pruski	*Wedelia*	Asteraceae	DT030	Mod.	1	Skin infection	Aerial part	Crush	Local application	1
Spondias dulcis Parkinson	*Vī tahiti*	Anacardiaceae	DT016	Pol.	47	Angina, sore throat, cough	Fruit (green)/ Flowerbud	Grate, press/ Crush	Gargle, oral	41
						Bronchitis	Leaf	Boil/Crush, filter	Bath/Oral	2
						Fever	Fruit (green)/Leaf	Grate, press/ Boil	Oral/Bath	2
						Leucorrhea (*he'a*)	Leafbud/ Bark	Crush, filter	Oral	2
Stachytarpheta cayennensis (Rich.) Vahl	Verveine bleue (French)	Verbenaceae	DT067	Mod.	1	Fever	Flowerbud	Boil	Oral	1
Syzygium cumini (L.) Skeels	*Pistas*	Myrtaceae	DT059	Mod.	3	Leucorrhea (*he'a*)	Bark	Fermentation	Oral	1
						Skin infection	Bark	Boil	Bath	1
						Cystitis	Bark	Crush, filter	Oral	1
Syzygium malaccense (L.) Merr. & L.M. Perry	*'Ahi'a*	Myrtaceae	DT021	Pol.	44	Leucorrhea (*he'a*)	Leaf/Bark	Crush, filter, fermentation	Oral	33
						Angina, sore throat	Leaf	Crush, filter	Oral/Gargle	3
						Cystitis	Leaf	Crush, filter	Oral	3
						Gastroenteritis	Fruit/Leaf	None/Crush, filter	Oral	2

(*continued on next page*)

Table 3 (*continued*)

Scientific name	Vernacular name	Botanical family	Voucher No	Origin	UR per species	Disease treated	Part of plant	Method of preparation	Method of administration	UR per disease
						Nasopharyngitis, cold	Bark	Crush, filter	Oral	1
						Influenza	Leaf	Crush, filter	Oral	1
						Sinusitis	Leaf	Boil	Oral	1
Terminalia catappa L.	*'Aua, 'Autara'a*	Combretaceae	DT078	Mod.	1	Skin infection	Leafbud	Crush, filter	Oral, bath	1
Thespesia populnea (L.) Sol. ex Corrêa	*Miro*	Malvaceae	DT008	Ind.	31	Leucorrhea (*he'a*)	Bark/ Leafbud	Crush, filter, fermentation	Oral	13
						Fever	Fruit (exudate)	Press/Crush, filter	Bath/Oral	11
						Skin infection	Fruit (exudate)	Press	Bath/Local application	3
						Bronchitis	Leafbud/ Fruit	Crush, filter	Oral	2
						Cystitis	Bark	Crush, boil	Oral	1
Torenia crustacea (L.) Cham. & Schltdl.	*Piri'ate, Ha'eha'a*	Linderniaceae	DT010	Pol.	14	Leucorrhea (*he'a*)	Aerial part	Crush, filter, fermentation	Oral	3
						Bronchitis	Aerial part	Crush, filter	Oral	2
						Nasopharyngitis, cold	Aerial part	Crush, boil	Oral	2
						Otitis	Aerial part	Crush, filter/ Boil	Oral/ Cutaneous, auricular	2
						Sinusitis	Aerial part	Crush, filter	Oral	2
						Angina, sore throat	Aerial part	Crush, filter	Oral	1
						Fever	Aerial part	Crush, filter	Oral	1
						Cystitis	Aerial part	Crush, filter	Oral	1
Wikstroemia coriacea Seem.	*'Āvao*	Thymelaeaceae	NC	Ind.	1	Cystitis	Leaf	Crush, filter	Oral	1
Zingiber officinale Roscoe	*Re'a tinitō*	Zingiberaceae	DT020	Mod.	5	Angina, sore throat, cough	Rhizome	Boil/Crush, filter	Oral	2
						Nasopharyngitis, cold	Rhizome	Boil	Inhalation	1
						Covid	Rhizome	Crush, filter	Oral	1
						Leucorrhea (*he'a*)	Rhizome	Crush, filter	Oral	1

A slash ("/") indicates alternatives ("or"); a comma (",") indicates combination ("and"). Ind. = Indigenous; Pol. = Polynesian introduction; Mod. = Modern introduction; NC = Not Collected.
* These plant species are not used alone but are combined with other plant species in traditional polyherbal preparations.

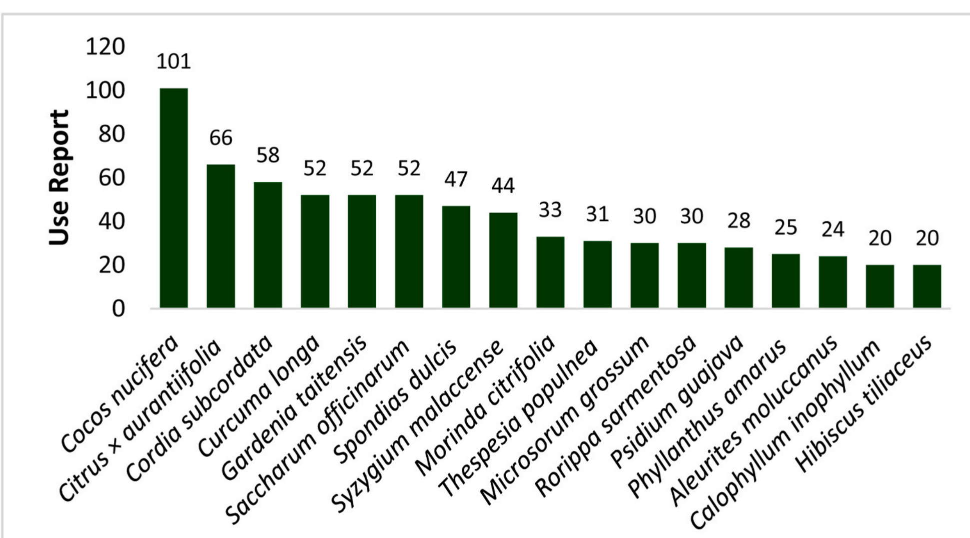

Fig. 4. Medicinal plant species most frequently cited for the treatment of infectious diseases in the ethnobotanical survey.

coconut milk] (15 UR), *Thespesia populnea* [bark or leafbud] (13 UR), *Gardenia taitensis* [flower or flowerbud] (12 UR), *Ficus tinctoria* [fruit] (9 UR), and *Calophyllum inophyllum* [bark] (8 UR). Notably, *Ficus tinctoria* was cited exclusively for *he'a*, highlighting a specific use for this disease.

3.1.4.4. Fever – fiva. Fever is treated using 32 plant species, incorporated into 35 unique remedies (68 UR). These remedies contain between 1 and 6 ingredients, with an average of 1.7 ingredients per preparation. Most remedies are mono ingredient (84%, 57 UR). This condition is treated through various routes of administration, including oral (16 unique remedies, 46%), bathing (9 unique remedies, 26%), cutaneous (6 remedies, 17%), and pulmonary routes (4 remedies, 11%). The most frequently cited species are *Cocos nucifera* [coconut water] (22 UR), *Coleus barbatus* [leaf] (11 UR), *Thespesia populnea* [fruit exudate] (11 UR), *Citrus* × *aurantiifolia* (6 UR) [fruit juice], *Gardenia taitensis* [flower or flowerbud] (5 UR), and *Microsorum grossum* [rhizome or leaf] (4 UR).

3.1.4.5. Sinusitis – nanu. The term *nanu* literally refers to mucus or phlegm in newborns and may extend to adult respiratory conditions such as sinusitis. During the study, this condition was widely treated by traditional medicine in French Polynesia for babies and children. Nearly 30 distinct remedies (49 UR) have been documented, utilizing 26 plant species. These preparations contain an average of 2.2 ingredients, with a maximum of 6. The remedies are generally balanced between mono-ingredient formulations (23 UR, 47%) and plant combinations (26 UR, 53%) and are mainly administered orally (20 unique remedies, 67%). Given that the target population is primarily children, some remedies are specifically prepared to be chewed (3 unique remedies, 10%). Additionally, 3 remedies are administered either through massage (10%) or inhalation (10%), and 1 remedy is delivered via bathing. The most frequently cited species are *Saccharum officinarum* [stem or leafbud or root] (25 UR), *Cocos nucifera* [coconut milk] (18 UR), *Mentha* sp. [leaf] (9 UR), *Rosa* sp. [flower] (7 UR), and *Gardenia taitensis* [flower or flowerbud] (3 UR).

3.1.4.6. Bronchitis, cough – ʻōuma pē, hota. A total of 45 unique remedies (48 UR) were recorded for the treatment of bronchitis and cough, involving 27 different plant species. Bronchitis is mainly treated with polyherbal preparations (39 UR, 81%), containing an average of 2.6 ingredients and up to 7 medicinal plants per remedy. Nearly all remedies are administered orally (41 unique remedies, 91%). The most frequently cited species are *Gardenia taitensis* [flower or flowerbud] (21 UR), *Cordia subcordata* [bark or leaf] (16 UR), *Microsorum grossum* [rhizome or leaf or leafbud] (13 UR), *Saccharum officinarum* [stem] (11 UR), *Cocos nucifera* [coconut water or coconut sprout] (11 UR), *Davallia solida* [rhizome] (7 UR), *Artocarpus altilis* [bark or leafbud] (5 UR), and *Citrus* × *aurantiifolia* [fruit juice] (5 UR). Regarding *Artocarpus altilis*, known as *ʻuru* in Tahitian, a specific cultivar referred to as *ʻuru pae'a* is traditionally used.

3.1.4.7. Conjunctivitis – ma'i ʻura mata. Fifteen unique remedies (39 UR) were documented for the treatment of conjunctivitis, involving the use of 15 plant species. All these remedies are exclusively single-ingredient formulations (39 UR, 100%) and involve ocular administration, either as eye baths (11 unique remedies, 73%) or via direct instillation into the eyes (4 unique remedies, 27%). *Scaevola taccada* [fruit] is the most frequently cited species (11 UR), followed by *Hibiscus tiliaceus* [root sap] (5 UR) and *Cordia subcordata* [leaf] (4 UR).

3.1.4.8. Otitis – tui. Otitis is treated with 12 unique remedies (35 UR) involving the use of 16 plant species. On average, these remedies consist of two ingredients, typically a plant mixed with monoi oil (6 unique remedies, 50%), and are applied topically (11 unique remedies, 92%). Among the listed plants, *Phyllanthus amarus* [aerial part] is the most frequently cited for this condition, with nearly 25 mentions and its use appears to be specific to this ailment. Other species, although less represented, include *Gardenia taitensis* [flowerbud] (2 UR), *Torenia crustacea* [aerial part] (2 UR), and *Scaevola taccada* [fruit] (2 UR).

3.1.4.9. Nasopharyngitis – hūpē. Twenty unique remedies (29 UR) were reported for treating common cold, each comprising an average of 1.9 ingredient. These preparations are generally simple, with 69% (20 UR) consisting of a single ingredient. The common cold is primarily treated through inhalation (8 unique remedies, 40%) or oral administration (8 unique remedies, 40%), and occasionally through baths (4 unique remedies, 20%). In total, 18 plant species were mentioned. The most frequently cited species were *Coleus amboinicus* [leaf] (8 UR), *Ocimum basilicum* [aerial part] (5 UR), and *Coleus barbatus* [leaf] (3 UR).

3.1.4.10. Cystitis – 'ōpītāpū. Several participants in the survey (11 UR) specified that the remedy for *he'an* also treated urinary infections, thus making it a remedy for uro-genital infections. However, 19 participants identified remedies for urinary infections, corresponding to 18 unique formulations. These remedies are also complex, involving the use of 26 plant species, with an average of 2.6 plants per preparation. The most frequently cited species are similar to those used for *he'a*, included *Cocos nucifera* [coconut water] (7 UR), *Citrus* × *aurantiifolia* [fruit juice] (4 UR), *Aleurites moluccanus* [bark or fruit] (4 UR), *Curcuma longa* [rhizome] (3 UR), *Morinda citrifolia* [leaf or fruit or flower] (3 UR), *Syzygium malaccense* [leaf] (3 UR), and *Saccharum officinarum* [stem] (3 UR).

3.1.4.11. Gastroenteritis. Gastroenteritis is less frequently treated in Polynesian traditional medicine, and many of the reported remedies rely on the use of processed food ingredients. Nevertheless, 13 unique plant-based remedies (18 UR) were documented. These remedies contain an average of 1.6 ingredients, with the majority (12 UR, 68%) consisting of single-ingredient formulations, and are mainly oral preparation (12 unique remedies, 92%). In total, 13 plant species are employed, with *Psidium guajava* [leafbud or bark] (8 UR), *Citrus* × *aurantiifolia* [fruit juice] (4 UR), and *Cordyline fruticosa* [leafbud] (3 UR) cited as the most frequently used.

3.2. Biological screening of the nine traditional preparations

3.2.1. Antibacterial activity

Among the nine traditional preparations evaluated, four exhibited antibacterial activity under the tested conditions (Table 4). The fruit exudate preparation of *Thespesia populnea* exhibited the strongest activity, with MIC values ranging from 8 to 256 μg/mL against all tested bacterial strains, including both Gram-positive and Gram-negative species. The leaves of *Calophyllum inophyllum* showed moderate activity against five strains, predominantly Gram-positive, with MIC values between 256 and 512 μg/mL. The polyherbal remedy *he'a* showed moderate to weak activity against *Pseudomonas aeruginosa, Streptococcus pyogenes*, and *Bacillus cereus*, with MICs ranging from 512 to 1024 μg/mL. Among its constituents, the leaves of *Syzygium malaccense* also demonstrated weak activity against *S. pyogenes* and *B. cereus* (MIC of 1024 μg/mL). In contrast, the other traditional preparations, although frequently reported during ethnobotanical surveys for the treatment of infectious diseases (*Leucas decemdentata, Davallia solida* var. *solida, Microsorum grossum, Spondias dulcis, and Heliotropium arboreum*), did not exhibit antibacterial activity *in vitro* at 1024 μg/mL against the tested strains.

3.2.2. Cytotoxicity

Cytotoxicity tests of the traditional preparations (Table 5) revealed that none of the samples exhibited toxicity according to the cytotoxicity threshold of 20 μg/mL. However, the fruits of *Thespesia populnea*, the most active antibacterial preparation, showed the strongest activity on cells, with CC_{50} values ranging from 37.5 to 67 μg/mL across all three tested cell lines. Despite this point, it achieved the highest selectivity indices, particularly against *Klebsiella pneumoniae* and *Streptococcus pyogenes* (SI up to 8.4 on HIEC6). The leaves of *Calophyllum inophyllum* also showed activity on cells ($CC_{50} < 100$ μg/mL), but its limited antibacterial effects resulted in low selectivity indices ($SI < 1$). The polyherbal remedy *he'a* and the leaves of *Syzygium malaccense* exhibited minimal activity on cells ($CC_{50} > 800$ μg/mL) and only weak antibacterial activity, yielding low SI values ($SI < 2$). Unexpectedly, the rhizome of *Microsorum grossum* displayed moderate activity on cells

Table 4
MIC values (µg/ml) of traditional preparations from Polynesian medicinal plants against nine bacterial strains relevant to infectious diseases.

MIC (µg/mL)		Gram -				Gram +				
Plant extract (traditional preparation)	Plant part	*Escherichia coli O6* ATCC 25922	*Salmonella enterica* ATCC 13076	*Pseudomonas aeruginosa* ATCC 27853	*Klebsiella pneumoniae* ATCC 10031	*Staphylococcus aureus* ATCC 25923	*Staphylococcus epidermidis* ATCC 12228	*Enterococcus faecalis* ATCC 29212	*Streptococcus pyogenes* ATCC 19615	*Bacillus cereus* ATCC 11778
Thespesia populnea	Fruit exudate	256	256	16	8	32	32	32	8	32
Calophyllum inophyllum	Leaf	-	-	256	256	-	512	-	512	512
he'a remedy		-	-	512	-	-	-	-	1024	1024
Syzygium malaccense	Leaf	-	-	-	-	-	-	-	1024	1024
Microsorum grossum	Rhizome	-	-	-	-	-	-	-	-	-
Leucas decemdentata	Aerial part	-	-	-	-	-	-	-	-	-
Davallia solida var. solida	Rhizome	-	-	-	-	-	-	-	-	-
Heliotropium arboreum	Leaf	-	-	-	-	-	-	-	-	-
Spondias dulcis	Green fruit	-	-	-	-	-	-	-	-	-
Ampicillin		64	16	ND	16	1	ND	8	<0,5	ND
Erythromycin		ND	ND	ND	ND	ND	<0,5	ND	ND	ND
Ciprofloxacin		ND	ND	ND	ND	ND	ND	ND	ND	<0,5
Gentamicin		ND	ND	<0,5	ND	ND	ND	ND	ND	ND

Table 5
CC_{50} values (µg/ml) and selectivity indices of traditional preparations from selected Polynesian medicinal plants on three mammalian cell lines.

Plant extract (traditional preparation)	CC50 (µg/mL)			SI											
				E.coli			*S.enterica*			*P.aeruginosa*			*K.pneumoniae*		
	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT
Thespesia populnea fruit exudate	37,5 ± 0,7	67 ± 3,8	52 ± 4,2	0,1	0,3	0,2	0,1	0,03	0,2	2,4	4,2	3,1	4,8	8,4	6,1
Calophyllum inophyllum leaf	59,5 ± 3,5	101 ± 8,5	76 ± 2,8	-	-	-	-	-	-	0,2	0,4	0,3	0,2	0,4	0,3
he'a remedy	843 ±11,3	972 ± 4.7	-	-	-	-	-	-	-	1,6	1,9	-	-	-	-
Syzygium malaccense leaf	>1250	>1250	-	-	-	-	-	-	-	-	-	-	-	-	-
Microsorum grossum rhizome	193,5 ± 34,9	250 ± 1 ,1	-	-	-	-	-	-	-	-	-	-	-	-	-
Leucas decemdentata aerial part	611 ± 31	>1250	-	-	-	-	-	-	-	-	-	-	-	-	-
Davallia solida rhizome	>1250	>1250	-	-	-	-	-	-	-	-	-	-	-	-	-
Heliotropium arboreum leaf	>1250	>1250	-	-	-	-	-	-	-	-	-	-	-	-	-
Spondias dulcis fruit	>1250	>1250	-	-	-	-	-	-	-	-	-	-	-	-	-
Doxorubicin	3,8 ± 1,6	16,6 ± 1,7	5,2 ±1.3												

Plant extract (traditional preparation)	SI														
	S.aureus			*S.epidermidis*			*E.faecalis*			*S.pyogenes*			*B.cereus*		
	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT	Vero	HIEC-6	HaCaT
Thespesia populnea fruit exudate	1,2	1,2	1,5	1,2	2,1	1,5	1,2	2,1	1,5	4,8	8,4	6,1	1,2	2,1	1,5
Calophyllum inophyllum leaf	-	-	-	0,1	0,2	0,1	-	-	-	0,1	0,2	0,1	0,1	0,2	0,1
he'a remedy	-	-	-	-	-	-	-	-	-	0,8	0,9	-	0,8	0,9	-
Syzygium malaccense leaf	-	-	-	-	-	-	-	-	-	1,2	1,2	-	1,2	1,2	-
Microsorum grossum rhizome	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leucas decemdentata aerial part	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Davallia solida rhizome	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heliotropium arboreum leaf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spondias dulcis fruit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Doxorubicin															

SI > 3, SI 1-3, SI <1, (-) = Not documented

(CC_{50} < 200 µg/mL) despite showing no antibacterial effects.

4. Discussion

4.1. Ethnomedical and epidemiological perspectives on infectious diseases reported in the survey

To our knowledge, this is the first ethnobotanical investigation to focus specifically on a defined set of infectious conditions in French Polynesia, encompassing both the Windward and Leeward Islands of the Society Archipelago, and enrolling participants with complementary expertise profiles.

The conditions most frequently treated with traditional medicine were skin infections followed by respiratory ailments, febrile states, and the traditional disease concept of *he'a*. This predominance is consistent with local epidemiological data. Indeed, skin infections are among the most common bacterial diseases in French Polynesia. In 2014, the annual incidence of erysipelas was estimated at 287 cases per 100,000 inhabitants, compared with 10–100 per 100,000 in mainland France (Oehler et al., 2025). Abscesses and furuncles (*fēfē*) are also highly prevalent, although precise epidemiological data remain limited. A recent community-based survey conducted in Tahiti and Moorea reported a scabies prevalence of 11.9% and a bacterial skin infection prevalence of 5.5% among 1770 participants (Walker et al., 2025). Several factors contribute to this high prevalence, including obesity, diabetes and lifestyle habits that promote minor skin trauma. The main pathogens identified are *Streptococcus* spp. and *Staphylococcus aureus* (Oehler et al., 2025).

In addition, respiratory infections represent one of the leading causes of medical consultation in French Polynesia. They encompass both seasonal viral illnesses, such as influenza, bronchitis, and pharyngitis, and bacterial infections, notably pneumonia caused by *Streptococcus pneumoniae* or *Haemophilus influenzae* (Health Department of French Polynesia, 2021a). In parallel, tuberculosis remains endemic in the territory, with an average incidence of around 20 new cases per 100,000 inhabitants per year, nearly three times higher than that observed in mainland France (Direction de la santé de Polynésie française, 2018). This epidemiological context is further aggravated by the high prevalence of non-communicable diseases and various socio-environmental factors.

Another frequently treated condition is known as *he'a*, a key Polynesian concept describing an internal disorder caused by the accumulation of bodily "impurities" that must be expelled through natural secretions, particularly from the genito-urinary tract. Primarily reported among women, *he'a* is classified in this study under urogenital infections, and specifically referred to as leucorrhea, although its meaning extends well beyond this biomedical classification. *He'a* represents a fundamental concept of Polynesian traditional medicine, alongside two other major nosological frameworks, *ira* and *fati*, which explains its high frequency of citation in this survey (Grand, 2021; Grépin and Grépin, 1984). Remedies known as *rā'au he'a* are used by Polynesian women throughout their lives, from childhood to adulthood, to purify the body and regulate vaginal discharge. From a biomedical standpoint, the strong prevalence of *he'a*-related treatments may also reflect the underlying burden of urogenital and sexually transmitted infections in French Polynesia. Although epidemiological data remain limited, the territory continues to report bacterial vaginosis, vulvovaginal candidiasis, trichomoniasis, chlamydial and gonococcal infections (Oehler et al., 2025), all of which can clinically manifest as abnormal vaginal discharge, a symptom culturally interpreted through the lens of *he'a*.

Conversely, although gastroenteritis is common in the archipelago (Health Department of French Polynesia, 2021b), few participants reported the use of plant-based remedies for this condition. Instead, responses mainly referred to popular practices (sweetened hot drinks, lemon juice, starch-based preparations), also documented in a previous study on the subject (Chassagne et al., 2022). These remedies effectively address primary needs related to diarrhea and reflect practical recommendations widely disseminated within the population.

Besides, this study suggests that several major infectious diseases in French Polynesia, such as hepatitis B, leptospirosis, and arboviral infections (dengue, Zika, chikungunya), do not appear to be specifically managed within traditional medicine. This pattern may partly reflect the relatively recent introduction of these diseases in the territory, which may have limited the time available for their integration into traditional medical knowledge and practices. This observation can also be explained by fundamental differences between the therapeutic frameworks of biomedicine and Polynesian traditional medicine. The latter is primarily oriented toward the restoration of balance and the relief of symptoms rather than toward defined microbial targets. Moreover, several of these infections do not manifest through specific or recognizable signs within local nosological systems, making their identification, and consequently their traditional therapeutic targeting, unlikely. Plant-based remedies therefore pursue transversal functions that align poorly with the etiological treatments (targeted antibiotic therapy, antivirals) required for such infections. Finally, historical and structural factors, including longstanding regulatory restrictions on traditional practice, public health messaging, and the accessibility of an organized biomedical healthcare system, promote early referral to medical services at the onset of warning signs, thereby confining the role of traditional medicine largely to preventive, familial, and first-line care (Misaki, 2021).

4.2. A core therapeutic framework in polynesian traditional medicine

The treatment of infectious diseases in traditional Polynesian medicine follows principles well documented in the literature (Chassagne et al., 2022, 2023; Girardi et al., 2015; Hittinger et al., 2025; Lemaître, 1978; Panoff, 1966; Pétard, 2019; Quenon et al., 2022), supporting the existence of a common foundation specific to this pharmacopoeia, regardless of the archipelago or type of conditions. It is predominantly practiced by elderly women, often with limited formal education, who play a central role in knowledge transmission.

A hallmark feature across ethnobotanical surveys is the exclusive use of fresh plant material. The most frequently reported preparation method, both in this study and prior work, involves crushing and pressing the plant to obtain its juice, typically administered orally. In contrast to other pharmacopoeias that preferentially use decoctions of dried plants, the Polynesian practice of employing fresh, unheated plants may help to preserve volatile compounds such as aromatic terpenes and thermolabile polyphenols (Babaei Rad et al., 2025; ElGamal et al., 2023; Oliveira-Alves et al., 2021), both recognized for their antibacterial activity, thus making this method particularly relevant for anti-infective use.

Another cornerstone of traditional practice is the consistent use of a three-day administration cycle, also documented in this study and earlier reports. This temporal pattern may reflect cultural symbolism (e.g., lunar cycles, the Christian Trinity) as well as empirical knowledge, given that many diseases, comprising mild infections (e.g., fevers, respiratory conditions) typically resolve within a few days.

Additionally, most preparations involve two to three plant species. This reliance on polyherbal formulations, also widely documented in the literature, reflects the principle of synergy, whereby combining multiple species can enhance therapeutic efficacy (Moretti and Butaud, 2023). Recent studies support this concept, demonstrating that combinations of plant extracts can yield increased antimicrobial activity at lower concentrations than individual extracts alone (Choudhury, 2022; Donkor et al., 2023; Vaou et al., 2022).

Among the medicinal plants most frequently used to treat infectious diseases in this survey, *Gardenia taitensis*, *Cocos nucifera*, and *Microsorum grossum* also stand out as major species in Polynesian traditional medicine, as highlighted in the review from Hittinger et al. (2025). This convergence underscores the existence of a shared pharmacopoeia structured around versatile species. Moreover, several of these plants, notably *Cocos nucifera*, *Saccharum officinarum*, and *Citrus* × *aurantiifolia*, frequently serve functions analogous to pharmaceutical excipients in anti-infective remedies, facilitating administration and improving the texture or taste of preparations.

4.3. Plant-based specificities in the treatment of infectious diseases and their ethnopharmacological validation

Although Polynesian traditional medicine relies on broadly shared therapeutic principles for the treatment of both infectious and non-infectious conditions, differences primarily lie in the medicinal plant species that are employed. In total, 84 species were recorded in the Society Islands during this study. Comparison with the inventory of Quenon et al. (2022) indicates that 50 species are common to both studies for the treatment of infectious disorders, whereas an additional 34 species were documented exclusively in the present survey (**Additional file 4:** Table S3). Moreover, four species identified here, *Pseudelephantopus spicatus* and *Sphagneticola trilobata* (used for skin infections), as well as *Alpinia zerumbet* and *Salix babylonica* (employed for fever), do not appear in the review of medicinal plants used in Polynesian traditional medicine compiled by Hittinger et al. (2025), and can therefore be considered as newly reported in the context of Polynesian ethnomedicine. Their absence from previous inventories likely reflects their status as recently introduced species in French Polynesia, highlighting the dynamic nature of local medicinal practices and the emergence of therapeutic syncretism.

Among the documented species, eight plants, *Thespesia populnea*, *Calophyllum inophyllum*, *Syzygium malaccense*, *Microsorum grossum*, *Spondias dulcis*, *Davallia solida*, *Leucas decemdentata*, and *Heliotropium arboreum*, along with the *he'a* remedy, were selected for further investigation. To the best of our knowledge, this study is the first to integrate field-derived ethnobotanical data with the scientific validation of medicinal plants in French Polynesia in their traditional preparation forms. Thus, prepared according to traditional practices, these species were subjected to antibacterial and cytotoxicity assays. Their ethnobotanical relevance, biological activity, and safety are examined in the following sections and summarized in **Additional file 5:** Table S4 **(Excel spreadsheet).**

4.3.1. Thespesia populnea

4.3.1.1. Ethnobotanical relevance. *Thespesia populnea*, commonly known as *miro* in Tahitian, is a tree belonging to the Malvaceae family. It is indigenous to French Polynesia, where it is widespread across tropical coastal areas. This study highlights the broad therapeutic use of the species in the management of infectious diseases, as its different parts (bark, leaves, and fruits exudate) are widely employed orally and topically to treat conditions such as urogenital disorders (13 UR) fever (11

UR) and skin infections (3 UR). These uses are consistent with previous ethnobotanical records from French Polynesia, where fruit, bark and leaves of *T. populnea* are mainly employed in the treatment of skin infections (Chassagne et al., 2023; Davin, 2021; Girardi et al., 2015; Pétard, 2019; Quenon et al., 2022), followed by urogenital conditions such as leucorrhea (Grépin and Grépin, 1984; Pétard, 2019; Quenon et al., 2022), vaginal mycoses (Quenon et al., 2022), and gonorrhea (Grépin and Grépin, 1984). The fruit exudate of the species is also reported for the treatment of fever in another survey (Chassagne et al., 2023). Beyond French Polynesia, the use of *T. populnea* is widely documented across the Pacific, where it is employed for similar indications as well as for other ailments such as stomatitis and gastroenteritis (O'Rourke George, 1995; Pétard, 2019; Singh et al., 1984; Weiner, 1971; Whistler, 1985, 1991, 2006). At a global scale, the plant is also part of traditional Indian medicine, where it is used for the treatment of inflammation, infections, and liver disorders (Savithramma et al., 2017), confirming the broad recognition of its therapeutic properties across worldwide cultures.

4.3.1.2. Antibacterial activity and pharmacological interpretation. This study specifically evaluated the antibacterial and cytotoxic activities of traditionally prepared fruit exudate of *T. populnea*, a plant part that is frequently used yet remains poorly documented in the current literature. The fruit exudate demonstrated a significative to moderate activity against all nine tested bacterial strains, with MIC values ranging from 8 μg/mL to 256 μg/mL. On one hand, inhibition of *Staphylococcus aureus*, *Streptococcus pyogenes* and *Pseudomonas aeruginosa,* major pathogens involved in skin and soft tissue infections, supports the traditional use of *T. populnea* for cutaneous infections. On the other hand, the sensitivity of *Escherichia coli*, *Klebsiella pneumoniae*, and *Enterococcus faecalis* is directly relevant to urogenital infections such as cystitis and urethritis, aligning with vernacular indications. Furthermore, the febrifuge properties attributed to the fruit exudate of *T. populnea* may be partly explained by its direct action on bacterial load, thereby contributing to a reduction of infection. In addition, its traditional use in the management of fever may also involve other well-documented mechanisms, including anti-inflammatory, antipyretic, and analgesic activities (Ilavarasan et al., 2012; Mika and Guruvayoorappan, 2013; Shah and Alagawadi, 2011; Vasudevan et al., 2007). Beyond these uses, the broad antimicrobial spectrum of the *T. populnea* fruit suggests potential applications for other clinical contexts, including bacterial gastroenteritis (due to the activity on *E. coli*, *Salmonella enterica*, *E. faecalis*) and respiratory infections (due to the activity on *P. aeruginosa*, *K. pneumoniae*). To date, few reliable studies have assessed the antibacterial properties of *T. populnea* fruits exudate, limiting direct comparisons. However, MIC determinations of extracts from other plant parts consistently confirm the species' broad-spectrum antibacterial activity. For example, root extracts (aqueous and ethanolic) exhibit MICs ranging from 10 to 2000 μg/mL against a panel of seven strains (Senthil-Rajan et al., 2013); leaf extracts (methanolic) show MICs between 125 and 500 μg/mL against *K. pneumoniae*, *S. aureus*, *E. coli*, *E. faecalis*, and *P. aeruginosa* (Prakash et al., 2016); and nonpolar organic bark extracts display MICs of 50 to 200 μg/mL against *E. coli* and *S. aureus* (Nguyen et al., 2022). Thus, based on MIC values, the fruit exudate extract of *T. populnea* prepared by traditional methods demonstrates higher antibacterial activity than previously reported extracts from other plant parts. Although methodological differences limit direct comparisons, these findings suggest that (1) the fruit exudate is likely among the most active organs of the species, and (2) traditional preparation methods may enhance the extraction or bioavailability of active compounds.

4.3.1.3. Mechanisms of action and bioactive compounds. This relevant antibacterial activity may be attributed to the sesquiterpene quinones present in the species, particularly the mansonones, as well as to gossypol, both of which exhibit activity against *Bacillus subtilis*, *Staphylococcus aureus*, and *Enterococcus faecalis* (Boonsri et al., 2008). Their mechanisms are complementary: quinones irreversibly alkylate bacterial proteins, leading to their inactivation and bacterial death (Cowan, 1999), whereas gossypol inhibits the polymerization of the FtsZ protein, thereby blocking cell division (Du et al., 2022).

4.3.1.4. Safety considerations. However, the mechanisms of action of mansonones and gossypol are not restricted to bacteria; these compounds can also interfere with eukaryotic cells, which accounts for the cytotoxic profile reported in the literature (Boonsri et al., 2008; Johnson Inbaraj et al., 1999; Yu, 1987).

An isolated case of contact dermatitis associated with exposure to *T. populnea* wood has also been documented (Hausen et al., 1997). These observations are consistent with the relatively low CC_{50} values obtained in our study, particularly for the Vero cell line ($CC_{50} = 37.5$ μg/mL). Nevertheless, available general toxicity assays do not indicate major acute toxicity for methanolic leaf extracts of *T. populnea* (Prakash et al., 2016). Moreover, the traditionally prepared fruit exudate extract exhibited a high selectivity index ($SI > 8$), suggesting that its antibacterial efficacy outweighs its cytotoxic potential.

4.3.1.5. Ethnopharmacological interpretation. Thus, the use of the fruit exudate of *T. populnea* for treating skin infections, fever, and urogenital conditions is supported by strong ethnopharmacological evidence. Its traditional use is worldwide documented, and its extracts exhibit marked, broad-spectrum antibacterial activity involving complementary mechanisms of action. However, further *in vivo* toxicological investigations are required, particularly given the presence of potentially toxic compounds in the plant.

4.3.2. *Calophyllum inophyllum*

4.3.2.1. Ethnobotanical relevance. Calophyllum inophyllum, commonly known as *tāmanu* in French Polynesia, is a coastal tree of the Calophyllaceae family widely distributed throughout the Indo-Pacific region and indigenous to French Polynesia. Formerly regarded as a sacred species (Pétard, 2019), it continues to occupy a central place in the traditional pharmacopoeia. Its leaves, bark, fruits, and the tamanu oil extracted from the kernel of the seed, are commonly used in traditional medicine. In the present survey, both the leaves and the oil were among the most frequently cited remedies for cutaneous infections (8 UR), consistently applied topically to manage a wide range of conditions (wounds, abscesses, infectious dermatoses). This convergence of use aligns with previous ethnobotanical reports: Chassagne et al. (2023) documented the use of leaves for chickenpox, measles, and various purulent or fungal skin infections, while Girardi et al. (2015) described their application in the treatment of *pu'eva* in the Marquesas Islands, a syndrome encompassing pruritus, skin allergies, burns, superficial wounds, scabies, and warts. Similarly, Pétard (2019) noted the use of leaves for dermatoses, urticaria, eczema, and other skin disorders, and Quenon et al. (2022) reported their application, alongside the oil, for skin symptoms, wounds, and abscesses. This pattern is consistent across the Pacific: in the Cook Islands and Samoa, leaves are likewise used to treat wounds and skin eruptions (Whistler, 1985; Harrington, 2001). At a broader scale, throughout South and Southeast Asia and the Indian Ocean region, the species is recognized for its healing, antiseptic, and anti-inflammatory properties (Dweck and Meadows, 2002; Gupta and Gupta, 2020; Lim, 2012).

4.3.2.2. Antibacterial activity and pharmacological interpretation. While the wound-healing and antibacterial properties of tamanu oil are now well established, the leaves of *C. inophyllum* remain comparatively understudied, particularly in their traditional form of preparation. Thus, the traditional leaf extract exhibited moderate activity against the Gram-negative bacteria *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*

(MIC: 256 μg/mL), and against the Gram-positive species *Staphylococcus epidermidis*, *Streptococcus pyogenes*, and *Bacillus cereus* (MIC: 512 μg/mL). This activity profile is consistent with the documented traditional uses, as these species are common etiological agents of skin infections. Moreover, the contribution of *C. inophyllum* leaves to the treatment of cutaneous infections may also stem from their demonstrated anti-inflammatory activity (Van Thanh et al., 2019). Beyond cutaneous applications, the sensitivity of *P. aeruginosa* and *K. pneumoniae* highlight by this study also points to a broader pharmacological potential, including possible relevance for respiratory infections. The stronger activity against Gram-negative bacteria, an uncommon feature among plant extracts, suggests that the traditional preparation may promote the extraction of amphiphilic compounds capable of disrupting or permeating the outer membrane of Gram-negative pathogens, such as certain prenylated xanthones and coumarins (Cushnie and Lamb, 2011). The leaves further display biological activities beyond antibacterial effects: several pyranocoumarins have shown inhibitory activity against HIV-1 reverse transcriptase (Laure et al., 2008; Patil et al., 1993).

4.3.2.3. Bioactive compounds. The antibacterial activity is most likely driven primarily by pyranocoumarins such as inophyllums C and E and by coumarins such as calophyllolide, with additional contributions from xanthones and other phenolic compounds reported in this species (Hapsari et al., 2022; Susanto et al., 2017; Yimdjo et al., 2004).

4.3.2.4. Safety considerations. Regarding safety, the traditional leaf extract exhibited no cytotoxicity according to the predefined threshold; however, the CC_{50} measured on the HaCaT keratinocyte cell line, the most relevant model for topical applications, remained relatively low (<100 μg/mL). The resulting selectivity indices (SI < 1) indicate a narrow therapeutic window *in vitro*, with antibacterial concentrations approaching cytotoxic levels.

4.3.2.5. Ethnopharmacological interpretation. Taken together, these findings suggest that the leaves of *C. inophyllum* rely on a coherent pharmacological basis, combining antibacterial and anti-inflammatory properties, that supports their traditional use in Polynesia for the treatment of cutaneous infections. Nevertheless, further investigations are required to confirm their safety under realistic conditions of traditional use.

4.3.3. Syzygium malaccense and the polyherbal he'a remedy

4.3.3.1. Ethnobotanical relevance. Syzygium malaccense is a tree of the Myrtaceae family native to the Malay region, and now widely naturalized in French Polynesia where it is known as *'ahi'a*. In the present study, its leaves and bark were primarily used to treat urogenital disorders encompassed within the traditional concept of *he'a* (33 UR), most commonly through the oral administration of fresh juice obtained from the crushed plant parts. These observations are consistent with previous ethnobotanical records: in French Polynesia, the leaves and bark of *S. malaccense* are traditionally employed to treat various ailments such as cystitis, vaginal mycoses, vulvitis, *he'a*, vaginal discharge, gonorrhea, urethritis, and leucorrhea (Chassagne et al., 2023; Dunn, 2005; Girardi et al., 2015; Grépin and Grépin, 1984; Pétard, 2019; Quenon et al., 2022). In the Pacific, bark and leaves of *S. malaccense* are also cited in Tonga for the treatment of *kahi*, a concept of internal illness comparable to the Polynesian *he'a* (O'Rourke George, 1995; Singh et al., 1984). In the same region, the plant is additionally used to treat oral infections such as thrush and stomatitis (Holdsworth, 1990; Whistler, 1985, 1991, 2006). Thus, *S. malaccense* emerges as a widely recognized species throughout the Pacific, traditionally used for the treatment of female urogenital disorders.

4.3.3.2. Antibacterial activity and pharmacological interpretation. However, few pharmacological studies have been conducted on this species, and none on the *he'a* remedy itself, to scientifically validate the traditional use. The remedy used for the treatment of *he'a* relies primarily on the leaves of *Syzygium malaccense*, to which turmeric rhizomes and lemon juice are added. In our study, the complete traditional preparation exhibited moderate to weak antibacterial activity against three species: *Pseudomonas aeruginosa*, *Streptococcus pyogenes*, and *Bacillus cereus* (MIC: 512–1024 μg/mL). When the leaves of *S. malaccense* were evaluated individually, weak activity was only observed against *S. pyogenes* and *B. cereus* (MIC = 1024 μg/mL), whereas no inhibition of *P. aeruginosa* was observed at the concentrations tested. This profile indicates that the antibacterial activity of the *he'a* remedy is partly driven by the intrinsic properties of *S. malaccense* leaves against Gram-positive bacteria, while the addition of turmeric and lemon juice appears necessary to extend the spectrum to *P. aeruginosa*. Thus, although the antibacterial activity identified in this study targets non-urogenital species, these findings nonetheless provide pharmacological support for the traditional use of *S. malaccense* in the management of respiratory infections across the Pacific. Furthermore, two studies investigating aqueous and methanolic extracts of *S. malaccense* leaves and bark confirmed antibacterial activity against *S. pyogenes*, while also demonstrating broader antibacterial and antifungal effects against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans* (Locher et al., 1995; Quenon et al., 2022). Notably, the microorganisms inhibited by these extracts are frequently implicated in urogenital infections, such as vaginitis, cystitis, urethritis, and leucorrhea, which aligns with the ethnomedicinal indications documented for this species.

4.3.3.3. Mechanisms and bioactive compounds. These activities were attributed to a series of alkyl-salicylic acids (C15:0, C15:1, C17:0, C17:1, C17:2, C17:3, C19:1) (Quenon et al., 2022). The antibacterial mechanism of these compounds involves a combination of complementary cellular targets. Their long alkyl chain facilitates insertion into bacterial membranes (such as ampihilic systems), leading to increased permeability, disruption of ionic homeostasis, and ultimately loss of membrane integrity. In parallel, these compounds can inhibit key bacterial metabolic enzymes, thereby impairing vital biochemical pathways. They also reduce biofilm formation and may interfere with quorum-sensing signaling systems, limiting pathogen virulence and persistence (Gómez et al., 2019; Hollands et al., 2016; Nugrahani et al., 2025; Wen et al., 2022). Moreover, aqueous bark extracts exhibited significant antiviral activity against *Herpes simplex virus* types 1 and 2 and *HIV-1* (Locher et al., 1995, 1996), two sexually transmitted viruses known to alter the genital mucosa and increasing susceptibility to opportunistic infections. In addition, the plant's anti-inflammatory, antioxidant, and astringent properties (Batista et al., 2017; Pazzini et al., 2021) may contribute to relieving irritation, inflammation, and excessive secretions.

4.3.3.4. Safety considerations. Furthermore, *S. malaccense* leaves exhibits an excellent safety profile: no cytotoxicity was observed on renal (Vero), and intestinal (HIEC6) cell lines tested in the present study, nor on hepatic (HepG2) and human fibroblast (HSF) cell lines in previous works (Quenon et al., 2022; Rocchetti et al., 2019). These results are further supported by *in vivo* assays confirming the absence of toxicity in murine splenocyte cultures (Figueirôa et al., 2013). However, alkyl-salicylic acids, although responsible for part of the antibacterial activity of *S. malaccense*, possess a well-documented cytotoxic and irritant potential at higher concentrations. These compounds can disrupt eukaryotic cell membranes, induce oxidative stress, and act as skin sensitizers (Berg et al., 2015; Boateng, 2022; Lepoittevin et al., 1989; Liu and Zeng, 2009; Shao et al., 2025). Their toxicity is dose-dependent and generally moderate at levels compatible with traditional use, but prolonged or high-dose exposure warrants caution.

4.3.3.5. Ethnopharmacological interpretation. Overall, these findings provide evidence of a synergistic effect among medicinal plants in remedies used for the treatment of *he'a* and highlights their favorable safety profile compatible with oral use. Moreover, the literature consistently reports broad-spectrum antimicrobial properties for *S. malaccense*, largely attributed to the bioactivity of its alkyl-salicylic acids, which supports the pharmacological relevance of its traditional use in infectious diseases. Given that the *he'a* syndrome is a culturally specific condition in the Pacific region, further investigations on *S. malaccense* would be valuable to better understand, and ultimately validate, its ethnobotanical application.

4.3.4. *Microsorum grossum*

4.3.4.1. Ethnobotanical relevance. *Microsorum grossum*, known as *metuapua'a* in Tahitian, is an indigenous fern of French Polynesia belonging to the Polypodiaceae. It is regarded as one of the most polyvalent and emblematic medicinal species of the Polynesian pharmacopoeia (Ho et al., 2010). Its uses, which include the treatment of respiratory disorders, dermatological conditions, musculoskeletal pain, and various febrile or gynecological ailments, extend beyond French Polynesia, as the species is also employed throughout the Pacific (Baltrushes, 2006) and even in Madagascar (Ramanitrahasimbola et al., 2005). In the present survey, freshly pressed rhizomes of *M. grossum*, taken orally, were frequently cited for the management of respiratory infections, particularly bronchitis (13 UR). This therapeutic pattern is consistent with some previous ethnobotanical reports: Quenon et al. (2022) similarly documented the use of rhizomes for conditions described as "crumpled lung" and pneumonias, while other studies have also reported their use in bronchitis and tuberculosis (Dunn, 2005; Grépin and Grépin, 1984; Pétard, 2019).

4.3.4.2. Antibacterial activity and pharmacological interpretation. From a pharmacological perspective, the traditionally prepared rhizome extract, tested in this study, exhibited no antibacterial activity against the nine bacterial strains assessed, including *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, two possible agents of respiratory infections. A similar absence of direct antibacterial activity was previously reported by Balada et al. (2022) for hexane extracts of leaves and rhizomes against *Staphylococcus aureus* and *S. epidermidis*. However, these authors reported an inhibition of biofilm formation, suggesting that the species may modulate bacterial virulence rather than exert a direct bactericidal effect. In addition, because bronchitis is predominantly viral, *M. grossum* may provide antiviral benefits that remain to be investigated. Beyond antimicrobial pathways, several non-antibiotic mechanisms could further account for its traditional use. Notably, experimental data obtained from aerial part of *Phymatodes scolopendria* (a closely allied species to *M. grossum*) demonstrate a bronchodilator effect on guinea pig trachea attributed to the coumarin 1,2-benzopyrone, which supports the relevance of this species in the traditional management of bronchitis (Ramanitrahasimbola et al., 2005). Furthermore, recent work by Balada et al. (2025) reported anti-inflammatory activity of *M. grossum* rhizomes and leaves, mediated through selective COX-2 inhibition and attenuation of oxidative stress. These findings are consistent with the species' high polyphenol content and may contribute to its traditional use in bronchitis and other respiratory conditions. Several studies have also reported the presence of ecdysteroids (Ho et al., 2007, 2012; Snogan et al., 2007) in *M. grossum*, multifunctional molecules exhibiting anabolic, hypoglycemic, hypocholesterolemic, tonic, hepatoprotective, and antidepressant properties, which may contribute to the plant's therapeutic profile and provide additional benefits.

4.3.4.3. Safety considerations. Regarding safety, the traditionally prepared rhizome extract did not show significant cytotoxicity under the tested conditions ($CC_{50} \approx 200$ µg/mL on Vero and hIEC-6 cell lines). However, compared with the other evaluated preparations, *Microsorum grossum* showed a relatively higher impact on cell viability despite the absence of detectable antibacterial activity. Interestingly, intoxication cases involving infants have been reported in French Polynesia following oral administration of preparations containing *M. grossum* (Pétard, 2019), and recent ethnobotanical data indicate that many local participants consider the plant potentially dangerous (Chassagne et al., 2022). Together, these observations suggest that caution may still be warranted regarding its traditional use.

4.3.4.4. Ethnopharmacological interpretation. Overall, although pharmacological data on *M. grossum* remain limited, the species exhibits a potentially valuable profile owing to its richness in polyphenols, coumarins, and ecdysteroids, which may explain its diverse traditional uses and its relevance for respiratory conditions. Nevertheless, rigorous *in vivo* toxicological investigations are required to ensure safe therapeutic use and to reconcile traditional practices with modern safety standards, particularly for vulnerable populations such as infants and young children.

4.3.5. *Spondias dulcis*

4.3.5.1. Ethnobotanical relevance. Finally, *Spondias dulcis* is a Polynesian-introduced tree belonging to the Anacardiaceae family, widely cultivated in French Polynesia where it is known as *vī tahiti*. In this study, unripe fruits of *S. dulcis* were almost exclusively used to treat conditions characterized by sore throat, cough, and pharyngitis (41 UR), through ingestion of juice extracted from the grated pulp. This indication is supported by several ethnobotanical investigations conducted in French Polynesia. Chassagne et al. (2023) similarly identified sore throat and cough as the primary indications associated with fruit use. Girardi et al. (2015) and Pétard (2019) reported the use of leaves and bark for upper respiratory ailments, while Quenon et al. (2022) documented the use of leaves in the treatment of oral fungal infections. Beyond Polynesia, comparable uses are recorded elsewhere in the Pacific: in the Cook Islands, the leaves are administered to children with thrush (Whistler, 1985), and in Samoa and Tonga, the bark is used for stomatitis (Whistler, 1991, 2006). Together, these data underscore the integration of *S. dulcis* into traditional medicinal practices for managing mild infections of the upper respiratory and oral tract.

4.3.5.2. Antibacterial activity and pharmacological interpretation. The traditional fruit extract tested in this study showed no antibacterial activity against the nine bacterial strains evaluated, including *Streptococcus pyogenes*, a key pharyngitis pathogen. However, Islam et al. (2013) reported moderate inhibition of 13 microbial strains using methanolic fruit extracts in a disc diffusion assay, and Zofou et al. (2019) demonstrated significant activity of fruit-derived pectins against *Salmonella enterica*. These discrepancies may partly stem from differences in testing methods, as inhibition zones in agar diffusion assays depend on compound diffusion, solubility, and extract concentration, and may therefore not directly correspond to MIC values obtained by broth microdilution (Balouiri et al., 2016; Eloff, 2019). They may also reflect differences in extraction procedures, which yield more concentrated preparations than the traditional aqueous juice, and possible chemotypic and cultivar variation between fruits from French Polynesia, Bangladesh, and Cameroon. Overall, these studies consistently report a lack of activity against *Streptococcus pyogenes*, suggesting that the traditional use of *Spondias dulcis* for sore throat relief may rely on non-antibacterial mechanisms. Several studies have demonstrated the anti-inflammatory, antioxidant, and astringent properties of *S. dulcis* extracts (Sameh et al., 2018; Santos et al., 2023; Sinan et al., 2021), which could contribute to pharyngeal symptom relief and mucosal healing.

4.3.5.3. Safety considerations. Moreover, the traditional extract tested showed no cytotoxicity ($CC_{50} > 1250$ µg/mL) on human intestinal and renal cell lines used in this study. This aligns with earlier findings: Islam et al. (2013) reported low toxicity of the fruit in the *Artemia salina* model, and Fernandes et al. (2024) observed no adverse effects in mice at doses up to 2000 mg/kg.

4.3.5.4. Ethnopharmacological interpretation. Together, these *in vitro*, cellular, and *in vivo* data support both the favorable safety profile of orally administered *S. dulcis* fruit and its potential to provide symptomatic relief in mild upper respiratory tract infections.

4.3.6. Overall ethnopharmacological interpretation of the evaluated species

Taken together, among the plants tested, these findings indicate that two species are consistently supported across ethnobotanical, pharmacological, and toxicological dimensions: *Thespesia populnea* and *Calophyllum inophyllum*. Their traditional uses to treat infectious diseases are widely reported in French Polynesia, across the Pacific, and globally, and both species exhibit well-documented antimicrobial activity in various experimental models. A second group, *Syzygium malaccense* and *Spondias dulcis*, occupies an intermediate position. Their ethnobotanical uses for infectious conditions are well supported in French Polynesia and, to a lesser extent, in the broader Pacific. Existing pharmacological studies provide preliminary but encouraging evidence of antimicrobial activity, although not always sufficient to fully validate the traditional indications. Importantly, both species exhibit favorable safety profiles, supporting the validation of their ethnomedicinal use. Finally, for *Microsorum grossum*, *Davallia solida*, *Heliotropium arboreum*, and *Leucas decemdentata*, although they remain widely used in local traditional medicine to treat infectious diseases, their broader ethnobotanical use is limited, and pharmacological and toxicological data are scarce. The current evidence base is therefore insufficient to confirm or refute their traditional anti-infective uses, highlighting the need for targeted investigations.

5. Conclusion

This study provides ethnobotanical and pharmacological investigation of medicinal plants used to treat infectious diseases in the Society Islands of French Polynesia. By documenting 626 traditional remedies shared by 85 participants, and 84 plant species associated with a predefined set of infectious conditions, it shows that skin, respiratory, and urogenital disorders are strongly addressed within local traditional medicine. Moreover, despite the existence of a shared core of therapeutic practices and commonly used species, specific plants appear to be preferentially used for infectious indications. The experimental evaluation of nine traditional preparations, reproduced according to local practices, provides scientific support for the use of *Thespesia populnea* fruit exudate and *Calophyllum inophyllum* leaves in the treatment of skin infections, fever, and leucorrhea, and highlights the superior antibacterial activity of the polyherbal *he'a* remedy compared with *Syzygium malaccense* leaves alone. Conversely, the other species did not inhibit the selected bacterial strains, suggesting that their perceived efficacy may rely on non-bacterial anti-infective mechanisms (e.g., antiviral, antifungal, antiparasitic), as well as anti-inflammatory or symptomatic effects. These findings highlight the high value of testing traditional preparations themselves, rather than conventional laboratory extracts, to more accurately assess the pharmacological basis of local medical practices. At the same time, 76 of the 84 anti-infective species documented in this study remain untested, including *Pseudelephantopus spicatus*, *Sphagneticola trilobata*, *Alpinia zerumbet*, and *Salix babylonica*, which are reported for the first time in Polynesian herbal medicine, thereby representing a substantial reservoir for future ethnopharmacological research. By documenting contemporary practices of Polynesian traditional medicine, this work contributes to the preservation and valorization of traditional medical knowledge. It also identifies priority species for further phytochemical, pharmacological, and toxicological investigations (*Microsorum grossum, Davallia solida, Heliotropium arboreum,* and *Leucas decemdentata*), and represents a significant step toward the ethnopharmacological validation of *Thespesia populnea, Calophyllum inophyllum,* and *Syzygium malaccense* as Polynesian anti-infective plants.

CRediT authorship contribution statement

Doriane Titton: Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft. **Jean-François Butaud:** Investigation, Validation, Writing – review & editing. **Raimana Ho:** Investigation, Methodology, Resources, Writing – review & editing. **Sandra Bourgeade-Delmas:** Investigation, Writing – review & editing. **Phila Raharivelomanana:** Conceptualization, Methodology, Project administration, Resources, Supervision, Writing – review & editing. **François Chassagne:** Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Given his role as an editor for Journal of Ethnopharmacology, François Chassagne had no involvement in the peer review of this article and had no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to another journal editor. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jep.2026.122101.

Data availability

Data will be made available on request.

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