



A comparative ethnopharmacological analysis of traditional medicine used against respiratory tract diseases in Mauritius



Shanoo Suroowan, M. Fawzi Mahomoodally*

Department of Health Sciences, Faculty of Science, University of Mauritius, 230 Réduit, Mauritius

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ABSTRACT

Ethnopharmacological relevance: Despite laudable advances in conventional medicine, respiratory tract diseases (RTD) induced morbidity and mortality continue to inflict a substantial burden on healthcare systems worldwide. Similarly, in the tropical island of Mauritius, 13,320 hospital admissions and 8.2% mortality rates were attributed to RTD solely in the year 2013. Consequently, the therapeutic benefits and relief experienced with traditional medicine (TM) against RTD by the local inhabitants cannot be underestimated. The present study aims to report and quantitatively determine the extent of utilization of plant based therapies and other miscellaneous TM preparations concocted against RTD over the island. Additionally, a similarity index was generated which is indicative of the extent of harmonisation of individual plant species against RTD when the uses mentioned in the study are compared to previous ethnobotanical studies.

Materials and methods: Data was compiled using a semi-structured questionnaire via face-to-face interviews with TM users and practitioners ($n=384$). Three quantitative ethnopharmacological indices (the use value (UV), informant consensus factor (ICF), and ethnobotanicity index (EI)) were calculated. We also calculated the similarity ratio, similarity percentage, new uses for each plant species and percentage of new use against RTD to compare primary data collected in the present study.

Results: Fifty five plants were documented to be in use against 18 RTD. The most used plant species belonged to the following taxa; Lamiaceae (9%), Fabaceae (7%) and Rutaceae (7%). Thirty two plants recorded in this study have been reported to be used against RTD in previous ethnobotanical studies, of which 22 of these plants have been attributed new uses against RTD based on the results of the present study. The remaining 23 plants species have been recorded for the first time to be used traditionally against RTD. Altogether, 81 different recipes were concocted from the medicinal plants and the most common route of administration was oral intake. Common methods of obtaining medicinal plants were from the wild, cultivation and as imported herbal products. Cough was the most common RTD managed by plant species. The largest proportion of plants were employed against cold. The preference ranking both for UV placed *Curcuma longa* L., *Zingiber officinale* Roscoe, *Citrus × limonia* Osbeck and *Cymbopogon citratus* (DC.) Stapf as the most useful plant species. Only a small proportion of the indigenous plants (7.73%) proved to be useful in TM.

Conclusion: This study provides empirical primary ethnopharmacological data on the use of TM to manage and/or treat RTD and can contribute in preserving indigenous knowledge in Mauritius. It is anticipated that these primary data will open new avenues to identify novel drugs that can help to alleviate sufferings.

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Abbreviations: CSO, central statistics office; EI, ethnobotanicity index; IPNI, International Plant Name Index; IUCN, International Union for Conservation of Nature; UV, use value; MOHQL, Ministry of Health and Quality of Life; RTD, respiratory tract disorders; TM, traditional medicines; WHO, World Health Organization

* Corresponding author.

E-mail address: f.mahomoodally@uom.ac.mu (M.F. Mahomoodally).

1. Introduction

Respiratory tract diseases (RTD) amalgamate a varied proportion of mild to chronic pathological conditions which upset the airways, nasal passages, bronchi and lungs (WHO, 2015). RTD account for up to 4 million cases of premature deaths resulting in 25% of all lethality figures worldwide every year (York et al., 2011) and remains the prominent cause of decease in underdeveloped

nations (York et al., 2011; Ferkol and Schraufnagel, 2014).

A medley of RTD including allergy, asthma, lung cancer, cough, chronic obstructive pulmonary disease (COPD), rhinitis, pneumonia, sinusitis and tuberculosis induce billions of dollars out pocket costs on both prescription and over the counter drugs (OTC) round the globe (Rigat et al., 2013; Lopes, 2014). Besides, the burden on healthcare systems posed by RTD is staggering at an expeditious rate (Ferkol and Schraufnagel, 2014). Accordingly, asthma; a devastating RTD accounts for more than 235 million sufferers and 180,000 deaths every year (Ferkol and Schraufnagel, 2014). Additionally, 3.5 million premature mortality results from chronic RTD including chronic obstructive pulmonary disease (COPD) and lung cancer (Yach et al., 2004; Ferkol and Schraufnagel, 2014). Due to this upsurge of mortality and morbidity from RTD, the World Health Organisation (WHO) foresees COPD to become the leading cause of death worldwide by 2030 (WHO, 2014a).

Interestingly, panoply of conventional drugs have been developed that can offer a wide array of therapeutic benefits to RTD patients (Zanasi et al., 2014). Patients suffering from asthma have recourse to an inhaled corticosteroid and employ a bronchodilator to mitigate the disease. For cough management an antitussive or a protussive agent is administered for symptomatic relief while for COPD the use of bronchodilators remains the mainstay (Zanasi et al., 2014; Bourdet and Williams, 2014; Kelly and Sorkness, 2014).

Nonetheless, the use of conventional drugs for RTD management have been associated with a plethora of side and/or lethal effects such as death, altered consciousness and arrhythmias (Lopes, 2014). Similarly, failure of asthma therapy remains a significant risk for morbidity and reduced quality of life. In addition, evidence exists that patients having recourse to conventional medications for allergy management are not satisfactorily relieved despite adhering completely to their drug regimens (Sibbrit et al., 2014).

Given this need to seek relief, a major resurgence in traditional medicine (TM) to benefit once again from nature's invigorating powers has been witnessed in recent years (Maregesi et al., 2007; Fomogne-Fodjo et al., 2014; Kayani et al., 2014). Indeed, a panoply of ethnopharmacological studies tend to show that RTD sufferers still rely to a great extent on phytomedicines to assuage their suffering (Alzweiri et al., 2011; Tangjanga et al., 2011; Sadeghi et al., 2014; Fomogne-Fodjo et al., 2014; Kayani et al., 2014).

Interestingly, the local inhabitants of Mauritius hold an inherent use of TM emanating from their ancestors for decades (Sussman, 1980; Gurib-Fakim and Brendler, 2004; Suroowan and Mahomoodally, 2013). Additionally, the island is home to a vast array of plant species that are employed to a significant extent in TM (Sreekeesoon and Mahomoodally, 2014; Mootosamy and Mahomoodally, 2014).

Notoriously, RTD prevail as a consequent cause of morbidity and mortality over the island as depicted by the 2013 health report; 13,320 hospital admissions were due to upper respiratory tract infections, bronchitis, pneumonia, COPD, emphysema and asthma combined (Ministry of Health and Quality of Life (MOHQL), 2013). Concurrently, mortality rates from the year 2012 to 2013 resulting from RTD have increased by 0.4% rising from 8.2% to 8.6% (MOHQL, 2013).

Given the burden that RTD pose over the island and the fact that no single study has assessed the use of TM, particularly herbal remedies for RTD, it is relevant to bring into the scientific limelight the multiplicity of TM concocted by the indigenous people in defiance to the disease. The present study aims to report and quantitatively determine the extent of utilization of plant based preparations as well as cultural healing practices and other miscellaneous TM preparations concocted against RTD over the island. Additionally, a similarity index was generated which is indicative of the extent of harmonisation of individual plant species against RTD when the uses mentioned in the study are compared to previous ethnobotanical studies. It is anticipated that the present study will help to safeguard primary data that could generate a multiplicity of avenues with motives of developing better alternative therapeutic regimens as well as actuating the goal of discovering novel drug agents that can spark enhanced management and treatment of RTD.

2. Materials and methods

2.1. Study area

The tropical island of Mauritius forms part of the African continent and lies in the southwest Indian Ocean bearing coordinates with latitude and longitude 20.1625°S, 58.2903°E covering a total land area of 1864.8 km² (Fig. 1). The climate is dominated by 2 seasons; summer lasts from November to April and winter extends from June to September (Sreekeesoon and Mahomoodally, 2014).

The people of Mauritius are multi-ethnic and multi-cultural. The various ethnic groups that make up the whole of the populace include; Indo-Mauritian 68%, Creole 27%, Sino-Mauritian 3% and Franco-Mauritian 2% (Anonymous, 2014). Mauritians are multi-lingual and commonly spoken languages include; Mauritian creole, English, French, Bhojpuri and other Asian dialects.

As at 01st July 2014 the population of the island stood at 1,219,265 individuals with 603,473 males and 615,792 females (Central Statistics Office (CSO), 2014). Interestingly, due to its volcanic origin Mauritius has a diverse flora and has been

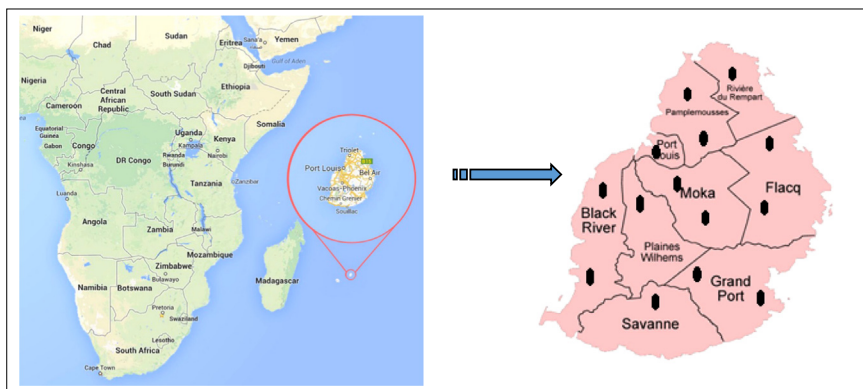


Fig. 1. (Political-Districts Map of Mauritius, 2015) Location map of Mauritius and study areas represented by black dots (Adapted from Mauritius attractions, 2013 and Pearl Beach Hotel: Climate and Map of Mauritius, 2014).

endorsed by the International Union for Conservation of Nature (IUCN) as a centre for plant diversity (Ministry of Environment and Sustainable Development of Mauritius, 2010). Indeed, the island embodies panoply of plant species expressed as 711 in number out of which 246 are endemic (Ministry of Environment and Sustainable Development of Mauritius, 2010; Gurib-Fakim and Brendler, 2004). Nonetheless, during the recent years the island has undergone a consequent extent of land clearing, invasion by alien species and an increasing level of land pollution. There is no denying to the fact that these factors are a major threat to the local flora/fauna and directly threatens 89% of the endemic plant species for extinction. Consequently, the endemic plants are conserved, protected and managed by the Mauritian government at legally proclaimed protected areas on the mainland; National Parks and Nature Reserves (Ministry of Environment and Sustainable Development of Mauritius, 2010).

2.2. Data collection

This project has been approved by the Department of Health Sciences, Faculty of Science, University of Mauritius, Mauritius. We attempted to follow the best field practice in the present ethnopharmacological survey as described by Heinrich and Verpoorte (2014) and as per the code of ethics stipulated by the International Society of Ethnobiology Code of Ethics (<http://ethnobiology.net/code-of-ethics/>) to amass primary data from key informants and TM practitioners.

Key informants ($n=384$) were selected through 'purposeful' or 'criterion-based' sampling, which consists of choosing key participants according to predefined criteria (e.g. medicinal plants users and traditional medicine practitioner) to get specific information to answer key questions. Data has been gathered via face-to-face interviews using a semi-structured questionnaire. The interviews were held in both urban and rural settings spread over 9 districts (Fig. 1) in 2014. Many of the local people helped in locating potential participants. Prior to participation, each participant read and signed a consent form describing the study and ensuring their confidentiality. Some of the interviews were performed during busy hours of common areas such as the traditional 'bazaars'. Personal visits were also made to homes, herbalists and indigenous health centers. Interviews, group discussion with knowledgeable persons and individual meetings with TM practitioners were also organized in order to collect precise data on common medicinal plants in use. In addition, respondents were assured that this study does not hold any commercial purpose and serves the sole goal of information documentation, preservation and dissemination of traditional knowledge pertaining to the use of TM against RTD.

As far as possible, the vernacular languages (Mauritian Creole and Bhojpuri) were employed to collect accurate data from the participants when interviews, informal meetings, open and group discussions, and overt observations were performed with the semi-structured questionnaire (Nunkoo and Mahomoodally, 2012; Mootoosamy and Mahomoodally, 2014).

During field survey, whenever a plant species was mentioned by the participant, where possible, the participant was encouraged to show a sample of the plant species which was collected and photographed immediately. The collected sample was then identified with the help of their vernacular names and by a local expert. Often photographs of plant were shown to informants to confirm claims or to stimulate memory and gather further information.

Data obtained during the survey was cross-checked (local/scientific names) according to locally published books (Gurib-Fakim and Gueho, 1995; Gurib-Fakim and Brendler, 2004). The Plant List (www.plantlist.org), International Plant Name index (www.ipni.org), (IPNI) and Kew Botanical Garden Plant name databases were used to validate plant scientific names as well as confirm author names (Heinrich and Verpoorte, 2014; Rivera et al., 2014). Our local repository database was updated whereby plant samples were assigned a collection number for future reference and data mining as suggested by Verpoorte (2008).

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2.3. Questionnaire design

A semi-structured questionnaire was adapted from previous studies carried out by Kayani et al. (2014), Maregesi et al. (2007) and York et al. (2011) to amass primary data. It consisted of 4 sections; A, B, C, and D and included structured open-ended and close-ended questions. Section A consisted of demographic details including age, gender, area of residence, level of education, religion and occupation. The second section (B) of the questionnaire consisted of specifications on plants employed for specified respiratory ailments. In addition section B and C contained key ethnopharmacological information including; local names of the plant, parts used, method of preparation, frequency of intake, duration of use and the dose of the medicine administered. Section C was an open-ended part related to the use of any other natural/traditional therapies excluding plants employed. Section D focused on the sources of information regarding TM use and focussed on the concomitant use of TM with conventional medicine.

As far as possible the respondents were asked to give explicit details about the type of RTD they have experienced and were encouraged to indicate any symptoms to the interviewer. Voluntary assistance from a medical practitioner was sought to confirm medical conditions and to establish comparisons between the local/vernacular descriptions and standard medical terms.

Eighteen use-categories were used to classify RTD managed and/or treated by TM in the present study as reported by Kayani et al. (2014). These included (1) asthma, (2) bronchitis, (3) bronchial problems, (4) chest problems, (5) cold, (6) cough, (7) flu, (8) influenza, (9) lung infections, (10) mucous discharge, (11) nose infection, (12) pneumonia, (13) respiratory disorders, (14) sinusitis, (15) sore throat, (16) throat infection (17) tonsillitis and (18) whooping cough.

2.4. Ethnopharmacological indices

A total of 3 different ethnopharmacological indices were employed to evaluate the importance of plant and animal species:

2.4.1. Use value

The UV of species employed was determined using the following formula (Phillips et al., 1994): $UV = Um/n$, where UV is the use value of species, "Um" is the total number of use reports per species, and "n" represents the total number of informants interrogated for a given plant. A high UV value for a given species corresponds to a major use of that species while a near to zero indicates a negligible use (Savikin et al., 2013).

2.4.2. Informant consensus factor

The informant consensus factor (ICF) is calculated with the following formula (Heinrich et al., 1998): $ICF = (Nur - Nt)/(Nur - 1)$, where Nur mentions the number of use reports for a particular ailment category and Nt refers to the number of taxa used for a particular ailment category. When using this index ailment conditions are classified into broad categories. It is used to determine the level of homogeneity of the information regarding particular types of ailment categories. The values calculated from this consensus ranges from zero to 1. A high value (close to 1) indicates that a high proportion of respondents employ medicinal species to manage that ailment category. Conversely, a low value (close to 0)

indicates that informants did not exchange information pertaining to the use of plants for that given ailment category (Yaseen et al., 2015).

2.4.3. The ethnobotanicity index

The ethnobotanicity index (EI) was calculated using the following formula (Porteres, 1970): $EI = (Nm/Nt) \times 100$; where, Nm is the number of useful medicinal species reported; Nt is the total flora in the area (Porteres, 1970). This index was used to verify the proportion of species considered useful in TM against RTD by the Mauritian population in relation to the total flora of the island. EI gives a very clear idea of the importance of the medicinal plant species in a region (Leto et al., 2012).

2.4.4. The similarity ratio and similarity percentage

The similarity ratio (SR) was adapted from a similar study carried out by Kayani et al. (2014). In this study, this ratio is used to calculate the percentage similarity which is indicative of the extent of harmonisation of individual plant species against RTD when the uses mentioned in this study are compared with other ethnobotanical studies carried in other countries. The $SR = \text{ratio of } (SU:DU)$; where SU for a given species represents the frequency of similar uses obtained for this species in this study against RTD reported in other ethnobotanical studies, and DU represents the species uses against RTD mentioned in other ethnobotanical studies but not recorded in this study. The percentage similarity was calculated as follows: $(SU/SU+DU) \times 100$.

2.4.5. New uses for each plant species and percentage of new use against RTD

New uses (NU) for each plant species were identified when all uses against RTD for a given plant species reported in this study were compared with its uses recorded against RTD in previous ethnobotanical studies investigated in different countries. The percentage of new uses for plant species was then calculated as: $(NU/NU+SU+DU) \times 100$.

2.5. Statistical analysis

Data obtained was tabulated and analyzed using Microsoft Office Excel 2007. Pharmacological and chemical data of different remedies were collected by probing scientific databases (Pubmed, Scopus, and Google Scholar), local university dissertations/books and other web sources such as records from Plant Resources from Tropical Africa (PROTA) and Association Prevents Extinction of Rare Plants in Southeast Asia (PROSEA).

3. Results

3.1. Demographic characteristics of respondents

The demographic characteristics of the TM users and practitioners ($n=384$) are summarized in Table 1, extracted from the raw data (Supplementary file).

As depicted in Table 1, the majority of the respondents were retired and above 60 years of age. There was a preponderance of TM use among women (54%) and inhabitants of rural areas (55%). The majority of respondents (71%) had attained at least primary schooling. Most of the respondents were self-employed (31%) and the majority found themselves to be very religious (34%).

3.2. Herbal therapies

Altogether 55 plants distributed within 32 families were reported by informants and recorded in Table 2, and extracted from

Table 1
Demographic characteristics of TM users.

Demographic features	Number of people	TM users frequency (%)
Age	21–30	32 (8)
	31–40	49 (13)
	41–50	79 (21)
	51–60	92 (24)
	> 60	132 (34)
Gender	Male	178 (46)
	Female	206 (54)
Area of residence	Rural	212(55)
	Urban	172 (45)
Level of education	None	110 (29)
	Primary	127 (33)
	Secondary	112 (29)
	Tertiary	35 (9)
Occupation	Unemployed	79 (21)
	Self-employed	119 (31)
	Government officer	53 (14)
	Non-government officer	112 (29)
	Traditional medicine practitioner	21 (5)
Ethnicity	Hindu	261 (68)
	Creole	103 (28)
	Sino-Mauritian	12 (2)
	Franco-Mauritian	8 (2)
Religiosity	Extremely religious	69 (18)
	Very religious	133 (34)
	Religious	82 (21)
	Not really religious	49 (13)
	No religious ideas	51 (14)

the raw data (Supplementary file). The best represented used families in terms of the number of species are Lamiaceae (5 species), Fabaceae and Rutaceae (with 4 species each) (Fig. 2). Plants are often used as decoction (34%) and a small proportion is also used raw, infused and extracted (Fig. 3). The most common parts of the plants used are their leaves (40%), fruit (13%), and rhizome (11%) (Fig. 4). Highest plants species are used in the treatment of cold (24 species). Moreover a single plant is used for more than one disease for example, *Citrus × limonia* (cough, cold, flu), *Zingiber officinale* (cough, cold, flu, sore throat, throat infection, influenza), and *Camellia sinensis* (sinusitis, cold, cough, flu). The highest UV was reported for *Curcuma longa* (0.14).

Table 3 shows that only 32 plants mentioned in this study have been reported to be used against RTD in previous ethnobotanical surveys carried in various countries worldwide. There is complete similarity in the use of 10 plant species against RTD mentioned in this study with their uses reported in other surveys. Out of the 32 plant species listed in the Table 3, 22 plant species bear new uses based on the findings of this study.

As depicted in Table 4, the highest number of taxa was used for the management of lung infections, pneumonia, tonsillitis and whooping cough had total consensus (ICF=1.00). The ailment category holding the lowest consensus was the bronchial problems category (ICF=0.50).

Table 2

Plant species used for medicinal application against RTD.

Family plant species (collection number)	Source	VN/CEN	Indication (codes of informants) ^a	Part used	Therapeutic mode of utilization	Um = number of informant who cited a given plant species	UV = Um/n, where n is the total number of informants (384)	Previous recorded literature uses
Amaryllidaceae								
<i>Allium cepa</i> L. (SSA1501)	C	Zoiyuon/Onion	Cough: CP001, HP005, FMRR026, HPL052, cold: HP145, HGR244, HGP245, flu: HBR146, SMBR147, HRR246, tonsillitis: HP144, CGP247, HRR248	Bu	Crush the bulb of and administer it orally until symptoms disappear.	19	0.05	Dental infections, Cancer, antihypertensive ^b
			Mucous discharge: CS255, HS256, chest problems: HGP257, HGP258	Bu	Crush the bulb, squeeze it to remove the juice with the addition of honey. Administer once orally daily until symptoms disappear.			
			Nose infection: CP002, CS259	Bu	Prepare a hot water infusion by crushing 1 bulb in 1 l of water, cover the head with a towel holding the preparation beneath and inhale once daily. Repeat frequent times until symptoms disappear.			
<i>Allium sativum</i> L. (SSA1502)	C	Aile/Garlic	Sinusitis: HP143, CF260, HF261	Bu	Prepare a decoction of 2 bulbs and 1 in. length crushed rhizome of <i>Zingiber officinale</i> Roscoe in 1 l of water. Administer 3 times orally daily until symptoms disappear.	24	0.06	Anti-carcinogenic, anti-atherosclerotic, antithrombotic, antimicrobial, anti-inflammatory and antioxidant ^c
			Cold: HS262, HF263, HF264, HS265, HF266, flu: CS267, HF268, HF269	Bu	Crush 1 bulb with around 1 quarter inch of <i>Zingiber officinale</i> Roscoe rhizome in a glass of milk. Administer once orally daily until symptoms disappear.			
			Asthma: CPW113, HBR142, CF270, bronchitis: HGP114, HGP122, chest problems: FMGP123	Bu	An infusion of 2 bulbs is prepared in 1 cup of hot water to which sugar is added. Administer twice orally daily for 3–5 days.			
			Asthma: HGP124, HGP127, pneumonia: HP148, SMGP178, respiratory disorders: HPW177	Bu	1 bulb is consumed raw orally 3 times daily until symptoms disappear.			
			Cold: HP141, flu: HGP174	Bu	Make a chain from 2 bulbs and tie it around the neck just before bedtime for 1 single day.			
Araliaceae								
<i>Panax ginseng</i> C.A. Mey. (SSA1503)	P	Ginseng/Ginseng	Whooping cough: CGP166, HGP171, HPL236	R	Prepare a decoction of the root. Administer 3 times orally daily until symptoms subside.	3	0.01	Antioxidant, anti-inflammatory ^d
Asteraceae								
<i>Ayapana triplinervis</i> (Vahl) R. M.King & H.Rob. (SSA1504)	C	Ayapana/Water Hemp	Cold: HPW163, HRR235, CF271, flu: HRR027, FMP028, HP161, CS275	L	Prepare a decoction of 5–6 leaves in 7 half litre of water. Administer 1 cup orally 3 times daily for 3–5 days.	7	0.02	Antimicrobial, anti-inflammatory ^e
			Asthma: HPW162, chest problems: CP003, bronchitis:	Fl	Prepare a decoction of a shoot of the plant containing approximately 3–5	3	0.01	Antitumour, anti-inflammatory, anti-diabetic, antihyperglycemic,

Table 2 (continued)

Family plant species (collection number)	Source	VN/CEN	Indication (codes of informants) ^a	Part used	Therapeutic mode of utilization	Um = number of informant who cited a given plant species	UV = Um/n, where n is the total number of informants (384)	Previous recorded literature uses
			HP160		flowers in half a litre of water. Administer twice orally daily for 3 days.			antioxidant ^f
<i>Cynara scolymus</i> L. (SSA1506)	P	Artichaut/ Artichoke	Cold: HP154, HP155, CS273, CF274, CF276, Flu: HP025, HGP130, HP131, CF272	L	Prepare an infusion by soaking a few leaves in water for 24 h. Administer half cup orally 2–3 times daily for 2–3 days until symptoms disappear.	9	0.02	Hepatoprotective, antioxidative, anti-hyperlipidemic ^g
Brassicaceae								
<i>Nasturtium officinale</i> R.Br. (SSB1507)	C	Cresson/ Watercress	Cough: HP029, HGP132, CP133, WP asthma: HGP134, HP135, bronchial problems: HGP136, HP137	WP	Extract the juice by crushing the whole plant. Administer once orally daily for 1 week with the addition of 1 tablespoon of honey until symptoms disappear.	7	0.02	Antioxidant ^h
<i>Raphanus sativus</i> L. (SSB1508)	P	Radis/Radish	Mucous discharge: HP138, HP139, Cough: CP140	S	Prepare a decoction of 6 seeds in 1 cup of water. Administer 1 cup twice orally daily for 3 days.	3	0.01	Anti-cancer, anti-inflammatory ⁱ
<i>Sinapis alba</i> L. (SSB1509)	P	Moutarde/White mustard	Cold: HP151, HPW234, flu: HBR146, SMBR147	O	Prepare a poultice by warming the leaves of <i>Morinda citrifolia</i> L. onto which <i>Sinapis alba</i> L. oil is rubbed. The leaves are then stuck onto the scalp. Administer topically as needed.	4	0.01	Antineoplastic, antimicrobial, and insecticidal ^j
Bromeliaceae								
<i>Ananas comosus</i> (L.) Merr. (SSB1510)	C	Zanana/Pineapple	Cough: HGP129, HBR142	F	Extract the juice of one fruit. Administer orally as needed.	2	0.01	Antioxidant, anticancer, anti-inflammatory, nausea, motion sickness, constipation, anthelmintic ^k
Caprifoliaceae								
<i>Lonicera japonica</i> Thunb. (SSC1511)	P	Chèvrefeuille/ Honeysuckle	Cold: CP140, CP149	Fl	Prepare a hot water infusion using 1 flower for 1 cup of water. Administer 1 cup 2–3 times orally daily for 2–3 days.	2	0.01	Anti-inflammatory, antiviral, antibacterial, antioxidant, hepatoprotective, anti-tumour, anti-pregnant activity ^l
Cucurbitaceae								
<i>Cucurbita galeottii</i> Cogn. (SSC1512)	C	Giraumon/ Pumpkin	Mucous discharge: HGP116, HP137, HRR237, HPL238	S	Prepare a decoction of 6 seeds in 1 cup of water. Administer 1 cup twice orally daily for 2–3 days.	4	0.01	Not reported
<i>Momordica charantia</i> L. (SSC1513)	C	Margoz/Bitter gourd	Cold: HGP239, flu: HGP240	L	Rub a few leaves under each armpit once daily for a single day. Administer topically as required.	2	0.01	Antidiabetic, anticancer, anti-inflammation, antiviral, and cholesterol lowering effects ^m
Ephedraceae								
<i>Ephedra sinica</i> Stapf (SSE1514)	P	Ephedra/Ephedra	Asthma: HBR030, Bronchitis: HGP132	St	Prepare a decoction of 3 stems in 1 cup of water. Administer 1 cup 2–3 times orally daily for 2–3 days and also as needed.	2	0.01	Antiasthmatic, decongestant, anti-obesity ⁿ

Euphorbiaceae

<i>Claoxylon glandulosum</i> Boivin ex Baill. (SSE1515)	W	Bois d'oiseau/NA	Sinusitis: HP004, CPW113, HGP117, CRR241, CGP242	L	Prepare a decoction of the leaves. Administer once orally daily for 5 days	5	0.01	Not reported	
<i>Ricinus communis</i> L. (SSE1516)	P	Huile de ricin/ Castor oil	Cold: HGP118, HGP119, HGP120, flu: HGP130, HRR243	O	Massage the oil on both soles to lower high body temperature due to fever. Administer topically as needed.	5	0.01	Male contraceptive ⁹	
Fabaceae									
<i>Glycyrrhiza glabra</i> L. (SSF1517)	P	Licorice/Licorice	Sore throat: HBR031, HGP121, HGP128, SMGP178, HPW182, HPW185, HPW192, HPW194, Lung infections: HGP195	R	Prepare a hot water infusion. Administer once orally daily until symptoms disappear.	9	0.02	Protects from myocardial ischemia ⁹	
<i>Millettia pinnata</i> L. Panigrahi (SSF1518)	W	Coqueluche/Indian beech	Cough: HBR150, CGP200, asthma: HGP201, respiratory disorders: HGP203, HGP206, HGP208, chest problems: HGP122	S	Make a chain with the seeds and tie it around the neck	7	0.02	Rheumatic pain ⁹	
<i>Myroxylon balsamum</i> (L.) Harms (SSF1519)	C, W	Baume du Perou/ Balsam of Peru	Cough: CP006, HP010, HBR013, HPL019, CPL021, CBR032, HPL038, HS039, HPL040, HPW112, CPW113, HGP114, HGP115, FMGP123, HGP212, HGP214, CGP251	L	Prepare a decoction of the leaves and add honey. Administer 1 cup orally once daily until symptoms disappear.	29	0.08	Asthma, rheumatism, bronchitis, cold, tuberculosis, headaches and abscess ^f	
			Cough: HF056, FMPL061, HPL065, HM068, HM074, HM078, CPL081, HPL083, HGP111, HGP124, HP151, HGP249	L	Heat the leaves in a cooking pan. Squeeze the leaves to extract the juice. Add honey and ghee. Administer 1 tablespoon orally daily just before bedtime for 3–5 days.				
<i>Senna occidentalis</i> (L.) Link (SSF1520)	W	Casse puante/ Coffee senna	Cold: HRR085, Flu: CBR033, HS250	L	Prepare a decoction of the leaves. Administer ½ cup 2–3 times orally daily for 2–3 days.	3	0.01	Antitrypanosomal ⁵	
Gentianaceae									
<i>Swertia chirata</i> Buch.-Ham. ex Wall. (SSG1521)	P	Chiraita/Chiretta	Cold: HRR087, CRR088, HPW092, CPW383, CPW384 flu: HPW093, HRR097, HGP110, CGP125	L	Infuse a few leaves in cold water for 24 h. Administer half cup orally 2–3 times daily for 2–3 days until symptoms disappear.	9	0.02	Antioxidative, anti-inflammatory and anticarcinogenic ^t	
Ginkgoaceae									
<i>Ginkgo biloba</i> L. (SSG1522)	P	Ginkgo biloba/ Ginkgo biloba	Influenza: HP007, HPW104, CPW382	L	Prepare a hot water infusion. Cover the head with a towel holding the preparation beneath. Inhale the vapours coming out. Administer as needed.	3	0.01	Alzheimer's disease as well as vascular and mixed dementia ⁴	
Lamiaceae									
<i>Mentha piperita</i> L. (SSL1523)	C	La menthe	Asthma: HP152, HGP252 bronchitis: HBR34, HGP108, CPW381, respiratory disorders: HPW109, HGP218, HPW219, chest problems: HGP126, FMPW223	L	Prepare an infusion of <i>Mentha piperita</i> L. and <i>Nasturtium officinale</i> R. Br. Aiton leaves infusion or extract the juice using a cloth. Administered until symptoms disappear.	16	0.04	Antibacterial antioxidant, cytotoxic ^v	
		Peppermint	Sore throat: HGP127, CS255, HGP257, throat infection: HBR035, HPW109, HF269		Boil the leaves in water and 1 cup of the preparation is administered once orally daily for 2–3 days.				
<i>Ocimum basilicum</i> L.	C	Basil/Basil	Asthma: HGP128, HP153	L	Prepare a decoction with the	13	0.03	Antimycobacterium activity ^w	

Table 2 (continued)

Family plant species (collection number)	Source	VN/CEN	Indication (codes of informants) ^a	Part used	Therapeutic mode of utilization	Um=number of informant who cited a given plant species	UV=Um/n, where n is the total number of informants (384)	Previous recorded literature uses
(SSL1524)			HP154, HP155, HPW156, CP301 bronchitis: CP157, HPW158, bronchial problems: FMP008, chest problems: CPW380		addition of a few <i>Mentha piperita</i> L. leaves in 500 ml of water. Administer 1 cup orally 2 times daily for one week.			
<i>Ocimum tenuiflorum</i> L. (SSL1525)	C, W	Tulsi/Tulsi	Bronchitis: CS275, SMF284, SMF286 Cough: HP161, HPW162, HPW163, HBR036, CF375, HGP108, CS253, HF292, CF296	L	Consume 2–3 leaves raw. Administer orally as required. Prepare a decoction using 6–8 leaves in 1 cup of water. Administer 1/3 cup orally daily until symptoms disappear.	9	0.06	Cold, cough, fevers, hypercholesterolemia, hypertension, pulmonary ailments ^x
<i>Orthosiphon aristatus</i> (Blume) Miq. (SSL1526)	C, W	Autochiffon/Cat's Whiskers	Asthma: CP009, HP159, HP160, CP297, HP302, HF305, CP376, CPL377, HPW378, CPL379, bronchitis: HP010, CP011, HBR012, HBR013, CBR014, CBR015, CBR037, CP306, respiratory disorders: SMPW107, CGP254, CP323, HPW326, CP328	L	Prepare a decoction of a few leaves in a litre of water. Pour the resultant fluid in a bottle. Administer in small portions orally throughout the day as needed.	23	0.02	Antioxidant and anti-inflammatory ^y
<i>Thymus vulgaris</i> L. (SSL1527)	C	Di tin/Thyme	Cough: HP329, CPW369, HPL370, SMPW371, SMPW372, HP373, mucous discharge: CBR016, HPL038, HRR105, HGP164, HP302, HP330, HS374 chest problems: CF296, CP297, HP298, CP333	L	Prepare a decoction using 10–15 leaves in 1 cup of water with the addition of 1 tablespoon of honey. Administer 1 cup once orally daily until symptoms disappear.	31	0.08	Expectorant, antitussive, anthelmintic, diuretic properties, heals wound of mouth, evil tripe ^z
			Cold: CRR098, HRR106, HGP165, HPL368, CP340, HF299, HP300, HGP345, flu: HS039, HGP346, cough: HPL017, HPW348, chest problems: SMP295, SMF354	L	Prepare a decoction of a few leaves with one quarter inch <i>Zingiber officinale</i> Roscoe in 1/4 glass of water. Add a few drops of <i>Citrus × limonia</i> Obseck juice when warm. Administer once orally daily at night for 3 days.			
Lauraceae								
<i>Cinnamomum camphora</i> (L.) J. Presl (SSL1528)	P	Camphre/Camphor	Flu: HRR099, HRR100, HPW101, HRR102, HPL367 nose infection: CPW103, HPW104	B	Crush 1 stack of camphor in 100 ml of methanol. Mix by shaking. Inhale frequently to decongest the nose.	7	0.02	Cold, chest congestion, rheumatism, sprains, bronchitis, asthma and muscle pain ^{aa}
<i>Cinnamomum zeylanicum</i> Blume (SSL1529)	P	Canelle/Cinnamon	Cough: HPL018, HPL040, HPW356, mucous discharge: HRR097, CGP166, HPW357, cold: HPW167, HGP168, HPW170	B	Prepare a decoction of 2–3 barks in 1 l of water. Administer 1 cup orally 2–3 times daily.	9	0.02	Anti-microbial, anti-parasitic, anti-oxidant and free radical scavenging properties ^{ab}
Linaceae								
<i>Linum usitatissimum</i> L. (SSL1530)	P	Grain de lin/Flaxseed	Cold: HGP169, HF294, flu: CS041	S	Prepare an infusion of the seeds by soaking them in water for 24 h. Pour the infusion in a bottle. Administer orally in small portions throughout the day until symptoms disappear.	3	0.01	Anti-inflammatory, analgesic and antipyretic ^{ac}

Moraceae <i>Morus alba</i> L. (SSM1531)	W	Myrte/Mulberry	Cold: HGP172, Cough: HPW358	F	Eat 6–8 fruits raw. Administer as needed.	2	0.01	Vasodilator ^{ad}
Moringaceae <i>Moringa oleifera</i> Lam. (SSM1532)	C, W	Mouroungue/ Drumstick tree	Cold: FMPW173, flu: HGP174	FI	Heat 2 cloves of <i>Allium sativum</i> L. and 2 flowers of <i>Moringa oleifera</i> Lam. in sunflower oil. A teaspoon of the oil is poured into each ears. Administer once a week until symptoms disappear.	2	0.01	Hyperlipidemia ^{ae}
Myrtaceae <i>Eucalyptus robusta</i> Sm. (SSM1533)	C, W	Ecalyptis/ Eucalyptus	Sinusitis: HGP175, nose infection: HGP171, bronchitis: CPW359	L	Prepare a hot water infusion of 3–4 leaves. Cover the patient's head with a towel and inhales the vapours coming out from the infusion through the nose just before bedtime.	3	0.01	Dermatitis ^{af}
<i>Syzygium aromaticum</i> (L.) Merr. & L.M.Perry (SSM1534)	P	Ziroffe/Clove	Cough: HRR096, CPW360, CPW361	F	Prepare a decoction of 4 cloves into 1 cup of milk. Administer once orally daily until symptoms disappear.	3	0.01	Antiviral, antimicrobial, antiseptic, and anti-fungal ^{ag}
Nelumbonaceae <i>Nelumbo nucifera</i> Gaertn. (SSN1535)	P	Lotus/Lotus	Cold: HPL019, Flu: HP293	L	Prepare a decoction of 1 leaf in 1 l of water. Administer 1 cup 2–3 times orally daily for 2–3 days.	2	0.01	Diarrhea, high fever, haemorrhoids, leprosy, lipolytic, anti-obesity ^{ah}
Oleaceae <i>Syringa vulgaris</i> L. (SSO1536)	P	De l'huile lila/ Lilac	Asthma: HPL042, CPW363	O	Heat 250 ml of the oil in a cooking pan. Collect the oil when it becomes warm in a glass bottle. Administer 1 tablespoon orally every night just before bedtime until all the oil in the bottle is over.	2	0.01	Antioxidant, antidiabetic ^{ai}
Piperaceae <i>Piper betle</i> L. (SSP1537)	C, W	Betel/Betel	Cough: CP002, CGP176, HP303, HPW364, CPW365, HPW366	L	Extract the juice of three leaf by crushing it and squeezing it in a cloth. Repeat the same procedure for 1 in. length of <i>Curcuma longa</i> L. Heat 1 tablespoon of ghee in a recipient to which 1 tablespoon of honey is added followed by the extracted juice, a rusted nail is then heated and dipped and removed instantaneously from the preparation. Administer once orally daily in the fasting state for 3 days.	31	0.08	Asthma, adjuvant ^{aj}
			Asthma: HF292, HPL367, HPL368, CPW369, respiratory disorders: HPL370, SMPW371	L	Cover the chest of an infant patient with the leaves that have been warmed and oiled. Repeat this procedure for 3 days.			
			Cold: HPL020, HP043, HRR095, CPW363, HP373, CF375, flu:	L	Crush the leaves and add honey and butter. Administer 2 times orally			

Table 2 (continued)

Family plant species (collection number)	Source	VN/CEN	Indication (codes of informants) ^a	Part used	Therapeutic mode of utilization	Um = number of informant who cited a given plant species	UV = Um/n, where n is the total number of informants (384)	Previous recorded literature uses
			CF375, HF304 Asthma: HPW364, CPW365, CP376, Bronchitis: HPW177, CPL377, respiratory disorders: CPL044, HPW378, CPL379 Sore throat: CPW362, throat infection: CPW380, cough: HS277, CPW382	L	daily for 3 days. Chew 1 raw leaf 3 times orally daily until symptoms disappear.			
<i>Piper nigrum</i> L. (SSP1538)	P	Di poivre/Black Pepper	Cough: HRR094, HF278, HF305	F	Heat the leaves in a cooking pan. Squeeze the leaves to extract the juice. Add honey and ghee. Administer 1 tablespoon orally daily just before bedtime for 3 days. Mix 1 teaspoon of powder in a glass of milk. Administer orally once daily just before bedtime for 3–5 days.	3	0.01	Anthelmintic, carminative, alegant, aphrodisiac, alexeteric, antiperiodic, deobstruant, diuretic, digestive, emmenagogue, rubefacient, stimulant, stomachic ^{ak}
Poaceae								
<i>Cymbopogon citratus</i> (DC.) Stapf (SSP1539)	C, W	Citronelle/Lemon grass	Cough: CPL021, HS045, SMF286, CPW384, bronchitis: HP010, CF289, HF290, HF291, asthma: SMGP178, HGP179, HGP180, SMF287, CF288, respiratory disorders: HBR046, HM068, HPW093 Cough: HGP184, HPW185, CPW186, bronchitis: CGR047, HPW181, HPW182, HPW183, asthma: HS039, SMGP178, HF279, FMF280, chest problems: HF281, CF282, CF283, SMF284, SMF285 Cough: CPL081, HPW092	L, R	Prepare a decoction of the leaf and root with addition of small amount of <i>Zingiber officinale</i> Roscoe and <i>Citrus × imonia</i> Obseck juice and administer 1 table spoon orally twice daily Prepare a decoction of the rhizome to which ethanol mainly “Eau de vie” is added to the preparation. Administer once daily orally just before bedtime for 3–5 days.	38	0.1	Antinociceptive, antifungal, anti-inflammatory, antimalarial, antimutagenicity ^{al}
			Cold: HPL048, HF292, flu: HPW187, HGP257	L	Prepare a decoction of 5–6 leaves and one inch length rhizome of <i>Zingiber officinale</i> Roscoe is added in 1 l of water. Administer 1 cup 3 times orally daily until symptoms disappear. Prepare a decoction of the 5–6 leaves is prepared and 1 cup. Administer 2–3 times orally daily until symptoms disappear.			
Ranunculaceae								
<i>Coptis chinensis</i> Franch. (SRS1540)	P	Huang lian/Huang lian	Asthma: HPW092, HGP130	Her	Prepare a hot water infusion. Administer 1 cup 2–3 times orally daily for 2–3 days.	2	0.01	Hypoglycaemic, hypocholesterolemic ^{am}
Rhamnaceae								
<i>Ziziphus mauritiana</i> Lam. (SSR1541)	C, W	Mason/Jujube	Asthma: CF351, bronchitis: CF352, bronchial problems: HPW353	L	Prepare a hot water infusion. Suitable for children only. Administer once orally daily for 7 days.	3	0.01	Soporific, nausea, vomiting, wound healing ^{an}

Rosaceae

<i>Eriobotrya japonica</i> (Thunb.) Lindl. (SSR1542)	C, W	Bibasse/Loquat	Sore throat: HP024, cold: SMF354, flu: HPW355, throat infection: HGR049	L	Prepare a hot water infusion of 5 leaves in 1 l of water. Administer 1 cup 2–3 times orally daily for 2–3 days.	6	0.01	Anti-inflammatory, antinociceptive ⁴⁰
			Cold: CPW361, flu: HGP188	F	Eat 4–5 raw fruits. Administer as needed.			

Rubiaceae

<i>Coffea arabica</i> L. (SSR1543)	P	Café/Coffee	Cough: CP003, HPL050, HF051, HPL052, HF053, HPL054, HF055, HRR91, HPW189, CP306, HPL307, HP313, HPW356, HPW357, HPW358, CPW359, CPW360	S	Prepare an infusion of a teaspoon in 1 cup of water followed by 50 ml of ethanol. Administer once orally daily just before bedtime for 5 days.	17	0.04	Antiproliferative, antioxidant, and antimicrobial ⁴¹
<i>Paederia foetida</i> L. (SSR1544)	W	Liane caca/Skunkvine	Sinusitis: HP309, SMPL310, CP311, HBR312	L	Prepare a decoction of 4 leaves in 1 glass of water. Administer once orally daily for 7 days.	4	0.01	Antihyperlipidemic, anti-hyperglycaemic and antioxidant ⁴²
<i>Morinda citrifolia</i> L. (SSR1545)	W	Noni/Noni	Sinusitis: HPW163, HGP190, HPW191, HPL308	F	Crush the fruit in a blender and administer 5 ml of the juice orally once daily.	13	0.03	Antibacterial, antiviral, antifungal, antitumor, antihelminthic, analgesic, hypotensive, anti-inflammatory, immune enhancing ⁴³
			Cold: HGP114, CS255, CP340, HPW350, CF375, flu: FMRR026, HF056, CRR090, CGP200	L	Warm the leaves and rub some mustard oil on them. Put the leaves on the scalp and leave it for one hour. Administer topically as needed.			

Rutaceae

<i>Citrus × aurantium</i> L. (SSR1546)	C	Bigarade/Seville orange	Cold: FMPL061, HPW192, Flu: HPW219, HGP349, Mucous discharge: FMGP123	F	1 Raw fruit is consumed orally with salt chilli paste for 3 days.	8	0.02	Appetite stimulant, weight loss ⁴⁵
			Cold: HS039, Flu: HGP108, Mucous discharge: SMF286		Prepare a decoction of 8 leaves in 1 l of water. Administer once orally daily for 2 weeks.			
<i>Citrus × limonia</i> Osbeck (SSR1547)	C	Limon/lemon	Cough: HP025, HBR035, HS045, HF055, CPL057, HF058, HM078, HPW089, HGP130, HGP171, CGP193, HPW194, CGP200, HF305, HBR314, CBR315, HBR316, HP317, HPW318, HPW319, HPW348, SMF354, HPW358, CF375,	F	Extract juice from fruit, followed by addition of small amount of honey and ghee. Administer 1 table spoon once daily a night.	48	0.13	Antioxidant, anticancer and anti-inflammatory ⁴⁴
			Cold: HF059, HM078, CRR088, HGP119, FMGP123, HGP136, HGP195, HRR232, HP320,	F	Infuse a small amount of powdered <i>Camellia sinensis</i> (L.) Kuntze to which the extracted juice of half a lemon is poured followed by 1 table-spoon of honey. Taken 3 times daily until symptoms disappear			
			Cough: 60, HGP171, HPW189, HGP196, HPW233, CPW321, CPW322	F	Squeeze one fruit and add 1 table-spoon of honey. Administer 1 table-spoon orally once daily just before bedtime until symptoms disappear.			
			Cough: HPL019, CPL021, HGP197, CP323, cold: HPW324, CPW325, flu: HRR087, HPW326	F				
<i>Citrus sinensis</i> (L.) Osbeck (SSR1548)	P	Zoranze/orange	Mucous discharge: HRR027, FMPL061, CRR231, CS267, HF269, HP327, CGP347	Sk	Peel off 1 fruit. Crush the peel and add honey. Administer orally as needed.	7	0.02	Anti-inflammatory, anti-oxidant and hypolipidemic ⁴⁶
<i>Toddalia asiatica</i> (L.) Lam. (SSR1549)	W	La patte poulepi-quant/Orange	Cough: HP029, HGP198, CP328	L	Prepare a decoction of the leaves to which the rhizome of <i>Cymbopogon</i>	3	0.01	Malaria, cough, influenza, lung disease, rheumatism, nasal and bronchial pain,

Table 2 (continued)

Family plant species (collection number)	Source	VN/CEN	Indication (codes of informants) ^a	Part used	Therapeutic mode of utilization	Um = number of informant who cited a given plant species	UV = Um/n, where n is the total number of informants (384)	Previous recorded literature uses
		climber			<i>citratrus</i> (DC.) Stapf and the juice of <i>Citrus × aurantium</i> L. is also added. Sugar is then added to sweeten the decoction.			stomachache ^{av}
Solanaceae <i>Brugmansia suaveolens</i> (Humb. and Bonpl. ex Willd.) Bercht. and J. Presl (SSS1550)	W	Fleur trompette/NA	Asthma: HRR230, bronchial problems: HRR085	Fl	Collect the flowers. Dry them in sunlight. Prepare cigarettes from the dried flowers. Inhale as needed.	2	0.01	Induce spasm, sedation and mydriasis ^{aw}
Theaceae <i>Camellia sinensis</i> (L.) Kuntze (SST1551)	P	Di the'/Tea	Sinusitis: HF062, HRR087, HPW177, CF296, HPL367, cold: HPL086, HGP128, HGP136, CP140, HPW185, HGP199, CP323, cough: HF063, HM078, HP329, flu: CGP202, CRR229	L	Prepare a decoction by crushing 1 in. of <i>Zinziber officinale</i> Roscoe in 1 l of water followed by 2 tablespoon powdered <i>Camellia sinensis</i> (L.) Kuntze leaves are infused and the juice of half of <i>Citrus × limonia</i> Ob-seck is squeezed in the preparation. The final preparation is sweetened by adding honey according to taste. Administer 1 cup 3 time daily for 3 days.	17	0.04	Antioxidant, anticancer, antithrombotic, antiviral, antifungal, anticarcinogenic ^{ax}
Tiliaceae <i>Tilia cordata</i> Mill. (SST1552)	P	Tilleul/Basswood	Cough: HGP203, sore throat: HGP204, throat infection: HGP205	Fl	Prepare a hot water infusion. Administer 1 cup 2–3 times orally daily for 2–3 days.	3	0.01	Antioxidant ^{ay}
Xanthorrhoeaceae <i>Aloe vera</i> (L.) Burm.f. (SSX1553)	C, P, W	Aloe vera/Aloe vera	Mucous discharge: HBR097, HGP206, CGP207	WP	Cut off the skin and eat the jelly like substance inside. Administered once orally daily until symptoms disappear.	3	0.01	Anti-inflammatory, analgesic ^{az}
Zingiberaceae <i>Curcuma longa</i> L. (SSZ1554)	C	Safron/Turmeric	Cough: CPL021, HBR023, HF056, HF064, CPL081, HRR085, HPW104, CGP200, HGP201, HGP208, HPW228, HP330, HP331 Cough: HBR013, HPL065, HPL066, HM082, HPL083, HRR084, HGP128, HGP132, HRR227, CP332, CP333, HP334, HP335, HP336, HP337, CP338, CP339, HGP346 Cough: HP010, CM067, CPL081, HGP209, HPW226, HP344,	Rh Rh Rh	Mix a tea spoon of curcuma in a cup of milk. Administer once orally daily at night before bedtime. Mix half a teaspoon of powdered curcuma and half clove of <i>Allium sativum</i> L. in milk. Administer once orally daily at night before bedtime. Crush a 2 in. length rhizome, extract the juice and boil in a cup of milk to	54	0.14	Antioxidant and anti-inflammatory ^{ba}

			HPW348, CPW363		which sugar is added. Administer once orally daily at night before bedtime.			
			Cough: FMPL061, HF063, HPL065, HM068, HPL080, HPL083, HGP127, HGP210, HGP211, HGP212, CGP213, HRR225, CP340, CP341	Rh	1 in. length of the rhizome is crushed and boiled with <i>Camellia sinensis</i> (L.) Kuntze. 1 cup of the preparation is administered 2–3 times orally daily until symptoms disappear.			
<i>Zingiber officinale</i> Roscoe (SSZ1555)	C, P	Zinzam/Ginger	Cough: HGP108, HBR142, HGP171, HGP174, CGP200, HGP201, HGP214, HGP345	Rh	Crush a mixture of half inch length rhizome <i>Zingiber officinale</i> Roscoe, 4 fruits of <i>Syzygium aromaticum</i> (L) Merrill & Perry, 4 fruits of <i>Elettaria cardamomum</i> (L.) Maton, and 4 leaves of <i>Ocimum tenuiflorum</i> L. in 1 l of water. Administer 1 glass once orally daily just before bedtime.	50	0.13	Antioxidant and anti-inflammatory ^{ba}
			Cough: HPL019, HM070, HM079, HPW109, HPW215, HPW224, HP302, flu: HPL071, HGP114, HP161, CGP166, CPW216, FMPW223, CP333		Prepare a decoction of 1 in. length <i>Zingiber officinale</i> Roscoe rhizome and 4 leaves and root of <i>Cymbopogon citratus</i> (DC.) Stapf in 1 l of water. Sweeten with honey or sugar as desired. Administer 1 cup 3 times orally daily.			
			Sore throat: HM072, HPW092, FMGP123, CPW217, HGP218, CP297, CP306, CP342, CPW369, throat infection: HPW093, HP155, HGP218, HF305, CP343		Crush a 1 in. rhizome. Cook in sugar. Administer orally as needed.			Antioxidant, hypoglycaemic and hypolipidaemic ^{bb}
			Influenza: HPL040, CM073, HP151, HPW222, Cold: HS039, HPW219, HGP220, HP334		A decoction of a 1 in. length of the rhizome is crushed and boiled in 1 l of water. Administer 1 cup orally daily.			
			Cough: HM074, HM075, CRR221, flu: HPL076, HPL077, HM078		A half inch length rhizome is crushed and boiled with 1 tablespoon of <i>camellia sinensis</i> (L.) Kuntze in half litre of water. 1 cup of the preparation is administered 2–3 times daily until symptoms disappear.			

B=bark; Bu=bulb; F=fruit, Fl=Flowers; Her=herb L=leaf; O=oil; S=Seeds; R=Rhizome, R=Root; Sk=Skin; WP=Whole plant. VN=Vernacular Name; CEN=Common English Name; SN=Scientific Name; NA=Not applicable; Um=Use mentions.

^a Informant code – The code is composed of initials of the ethnic group (the first letter), the district (the two first letter), and followed by the order number of the informant. Refer to [Supplementary file](#) for more details.

^b Thakurta et al. (2007).

^c Capasso (2013).

^d Tung et al. (2012).

^e Gauvin-Bialecki and Marodon (2008).

^f Bartolome et al. (2013).

^g Christaki et al. (2012).

^h Bahramikia and Yazdanparast (2010).

ⁱ Kim et al. (2014a).

^j Al-Qudah et al. (2011).

^k Hossain et al. (2015).

^l Shang et al. (2011).

^m Joseph and Jini (2013).

ⁿ Kim et al. (2014b).

^o Nath et al. (2013).

^p Ojha et al. (2013).

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- ^s Ibrahim et al. (2010).
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- ^{au} Mallick and Khan (2014).
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- ^{aw} Shekhawat (2012).
- ^{ax} Sinija and Mishra (2008).
- ^{ay} Vinha et al. (2013).
- ^{az} Devaraj and Karpagam (2011).
- ^{ba} Wickenberg et al. (2010).
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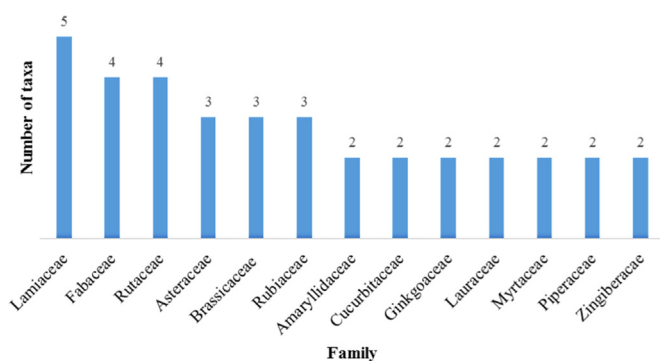


Fig. 2. Distribution of medicinal plant family.

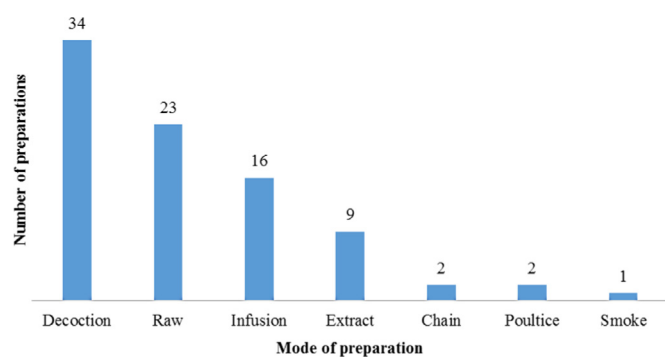


Fig. 3. Modes of preparation of herbal remedies.

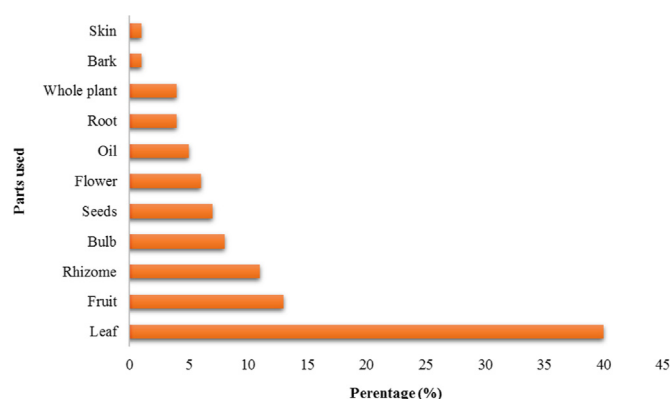


Fig. 4. Plant parts used. Source of medicinal plant.

3.3. Medicinal plant family distribution

Fig. 2 shows that the most used plant family was Lamiaceae with 5 used taxa. Fabaceae and Rutaceae were also extensively employed with equal number of taxa involved (4). Similar frequency of taxa use (3) were recorded for Asteraceae, Brassicaceae and Rubiaceae families. Seven plant families involved 2 taxa each; Amaryllidaceae, Cucurbitaceae, Ginkgoaceae, Lauraceae, Myrtaeaceae, Piperaceae and Zingiberaceae.

3.4. Modes of preparation

As illustrated in Fig. 3, decoction was the preferred mode of preparation of herbal remedies with 34 recipes being concocted in that way. Raw consumption (23), infusion (16) and extraction (9) were also common modes of preparation. The least opted forms of preparations were chains (2), poultices (2) and cigarettes (1) for smoking.

Table 3
Uses of plants against RTD reported in previous ethnobotanical surveys and new uses.

Plant species	Uses reported	SR	% similarity	NU	%NU
<i>Allium cepa</i>	Prevention of flu, ^a TB, ^b cough, ^c sore throat ^d	2:2	50	5	56
<i>Allium sativum</i>	Antibronchitic, ^a pneumonia, ^e TB, ^b asthma, ^c flu, ^f fever ^f	4:2	67	4	40
<i>Ayapana triplinervis</i>	Cough ^g	0:1	–	2	67
<i>Nasturtium officinale</i>	Cough, ^h flu ^h	1:2	33	2	40
<i>Raphanus sativus</i>	Asthma, ⁱ bronchitis, ^j cough, ^j	1:2	33	1	25
<i>Ananas comosus</i>	Sore throat ^k	0:1	–	1	50
<i>Lonicera japonica</i>	Cold ^l	1:0	100	–	–
<i>Ephedra sinica</i>	Asthma, ^m bronchitis ^m	2:0	100	–	–
<i>Ricinus communis</i>	Bronchitis, ⁿ Cold ⁿ	1:1	50	1	33
<i>Glycyrrhiza glabra</i>	Bronchitis, ^e sore throat ^e	1:1	50	1	33
<i>Milletia pinnata</i>	Cough ^o	1:0	100	–	–
<i>Myroxylon balsamum</i>	Bronchitis, ^p Cough ^m	1:2	33	–	–
<i>Senna occidentalis</i>	Cold ^q	1:0	100	–	–
<i>Swertia chirata</i>	Cold ^m	1:0	100	1	50
<i>Ocimum basilicum</i>	Cough, ^l Fever ^d	0:2	–	4	67
<i>Ocimum tenuiflorum</i>	Asthma, ^r cough, ^s cold, ^s flu ^t	1:3	25	–	–
<i>Thymus vulgaris</i>	Bronchial problems, ^e sore throat, ^e bronchitis ^e	0:3	–	5	63
<i>Cinnamomum zeylanicum</i>	Asthma, ^u bronchitis ^v	0:2	–	2	50
<i>Linum usitatissimum</i>	Pneumonia ^a , sore throat ^a , bronchitis ^v	0:2	–	2	50
<i>Morus alba</i>	Cough ^l , expectorant ^c	1:1	50	2	50
<i>Syzygium aromaticum</i>	Cough ^w , fever ^w	1:1	50	–	–
<i>Piper betle</i>	Cold, ^o cough ^o	2:0	100	6	75
<i>Piper nigrum</i>	Cough ^l	1:1	50	–	–
<i>Cymbopogon citratus</i>	Cough, ^o cold ^o	2:0	100	5	71
<i>Eriobotrya japonica</i>	Cough ^x	0:1	–	4	80
<i>Morinda citrifolia</i>	Asthma, ^l Cold, ^h flu, ^h TB ^b	2:1	67	1	25
<i>Citrus x limon</i>	Cold, ^f cough, ^o flu ^f	3:0	100	–	–
<i>Camellia sinensis</i>	Cough ^o	1:0	100	3	75
<i>Tilia cordata</i>	Cough ^m	2:0	100	1	33
<i>Aloe vera</i>	Asthma, ^l cough ^l	0:2	–	1	33
<i>Curcuma longa</i>	Cough, ^h cold ^h	1:1	50	–	–
<i>Zingiber officinale</i>	Expectorant, ^b flu, ^h cough, ^f cold ^h	3:1	75	3	43

^a Rigat et al. (2013).

^b Nagata et al. (2015).

^c Ahmed et al. (2015).

^d Josabad et al. (2012).

^e Cavero and Calvo (2014).

^f Tribess et al. (2015).

^g Coelho-Ferreira (2009).

^h Siew et al. (2014).

ⁱ Sarić-Kundalić et al. (2011).

^j Sargin et al. (2013).

^k Mohamad et al. (2011).

^l Song and Kim (2011).

^m Mahomoodally and Muthoorah (2014).

ⁿ Sivasankari et al. (2014).

^o Nunkoo and Mahomoodally (2012).

^p Sanz-Biset et al. (2009).

^q Juárez-Vázquez et al. (2013).

^r Kadir et al. (2014).

^s Rao et al. (2015).

^t Xavier et al. (2014).

^u Prabhu et al. (2014).

^v Menale and Muoio (2014).

^w Chander et al. (2015).

^x Andrade-Cetto (2009).

Table 4
ICF for different ailment categories.

Ailment category	FOC	Number of taxa	ICF
Asthma	50	15	0.71
Bronchitis	32	12	0.65
Bronchial problems	5	3	0.50
Chest problems	19	9	0.56
Cold	86	24	0.73
Cough	216	19	0.92
Flu	63	23	0.65
Influenza	7	2	0.83
Lung infections	1	1	1.00
Mucous discharge	30	6	0.83
Nose infection	5	2	0.75
Pneumonia	2	1	1.00
Respiratory disorders	20	6	0.74
Sinusitis	22	5	0.81
Sore throat	23	6	0.77
Tonsilitis	3	1	1.00
Throat infection	11	5	0.60
Whooping cough	3	1	1.00

FOC: frequency of citation.

3.5. Parts used

Fig. 4 shows that the most used plant organ for medicinal preparation were leaves (40%). Fruits (13%), rhizomes (11%), bulbs (8%), seeds (7%), flowers (6%) and oils (5%) were also extensively used. Other least common plant organ employed were the whole plant (4%), bark (1%) and skin of the fruits (1%).

As shown in Fig. 5, most medicinal plant species for example *Allium cepa*, *Allium sativum*, and *Thymus vulgaris* were cultivated. Other species such as *Milletia pinnata* and *Bidens pilosa* were wild plants and hence available free of cost. In addition, medicinal plants such as *Panax ginseng*, *Ephedra sinica* and *Tilia cordata*, were imported and available from traditional healers operating in the “bazaars” or who held a shop as well as in supermarkets and pharmacies.

3.6. Inventory of other traditional remedies employed by informants

As depicted in Table 5, RTD are managed with a plethora of other traditional remedies over the island. Cold, flu and sore throat had the highest and equal number of citations (5). Tonsilitis was

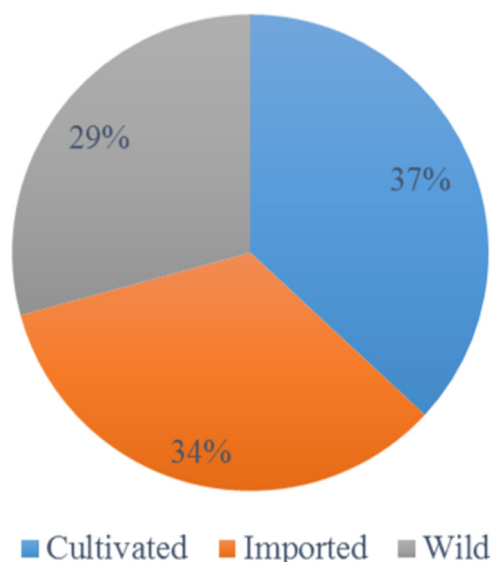


Fig. 5. Source of medicinal plant.

managed by altogether 4 natural therapies while mucous discharge and cough could be dealt with 2 different native remedies. Tuberculosis treatment could be complemented by bringing the patient to the seaside regularly as the air in the vicinity of the sea was considered to be beneficial to the patient.

3.7. Ethnobotanicity index

The EI value obtained in this study was 7.73% and revealed that a low utilization of plant species in against RTD.

4. Discussion

Notoriously, morbidity and mortality related to RTD remains challenging to fully address despite laudable advances in conventional medicine during the recent years. Similarly, a surge in the incidence and prevalence of RTD has been witnessed in the tropical island of Mauritius during the recent years (MOHQL, 2013). In addition, 5% of all mortality figures over the island are attributed to chronic RTD only (WHO, 2014b). Despite the fact that a multiplicity of local studies have investigated the use of TM in managing a vast array of ailments, no single study has been geared solely towards RTD up to now. The present study can be considered as the first attempt to document and analyse the traditional practices engaged in concocting medicines which have been once the major means of alleviating the suffering of patients suffering from RTD over the island.

Amongst the informants interviewed, it was found that those residing in rural areas were more familiar and sensible to the use of TM. In addition, medicinal plants were readily accessible to residents of rural areas as forests were in close proximity to their homes. Several informants from rural areas were of the belief that the use of TM is sacred as it comes from their ancestors. TM was also portrayed as being congruent with their beliefs; cheap or free of cost; easily accessible and relatively good in providing comprehensive relief.

Prominent use of TM against RTD were found among women in comparison to men. This can be explained by the fact that most women were either unemployed or self-employed allowing them more time to devote to TM preparation. A number of reports tend to show that women are more holistically minded than men and tend to prefer personal preventive control measures over their health (Warriner et al., 2014). Besides, women have also been found to be frustrated by the fact that despite their suffering conventional medicine cannot cure all diseases successfully (Ernst, 2001). It is this discontentment that urges women to try anything complementary and/or alternative that would help and finally opting for TM.

On the other hand, the ease of access to modern health care systems, deforestation and a hectic life made inhabitants of urban areas more reliant on conventional medicine even if they had knowledge on TM. In some urban areas houses were so compact that no land was available either for medicinal plant cultivation or raising animals. This unavailability of TM in times of need might explain the greater dependence on conventional medicine in rural areas and a decreasing trend in the use of TM use and preparations compared to rural areas.

Informants who cited the most number of plant species employed against RTD were elder people and above 60 years of age. Some were too old to recall all the information related to the recipe of the TM they were citing. Consequently, it can be considered that an important part of information related to TM practices are disappearing over the island.

A total number of 55 medicinal plants belonging to 32 families were recorded to be employed by residents to manage 19 specific

Table 5
Other traditional remedies employed by informants.

Local name/Common English name	Indication	Method of preparation	Administration
DI l'eau disel/table salt in water	Cold, flu, tonsillitis, mucous discharge, sore throat Mucous discharge, sore throat	Add 1 table spoon of table salt to one glass of water and gargle evenly. Inhale the water via nostrils and release it.	Orally
Eau de vie/ethanol Termogen/mentholatum	Cough, Cold, flu Cold, flu	A quarter glass is taken orally just before bedtime for 3 days. Prepare a hot water infusion of the past. Make the patient covers his/her head with a towel and inhale the vapours coming out of the infusion.	Orally Inhalation
Iode/Povidone-Iodine	Sore throat, tonsillitis	Add 1 table spoon of table salt to one glass of water followed by 2–3 drops of iodine and gargle evenly	Orally
Vinaig/vinegar	Sore throat, tonsillitis	Take a cup of warm water and add a small amount of vinegar which is used to gargle the mouth thoroughly	Orally
Vinaig pomme/apple cider vinegar	Sore throat, tonsillitis	A cup of warm water is taken to which a small amount of vinegar is added and the mixture is gargled thoroughly in the mouth	Orally
L'alcool blanc/methanol	Cold, flu	Crush a few camphors in 100 ml of methanol. Mix by shaking. Breathe in frequently to decongest the nose.	Inhalation
Coulou rouiller/rusted nail	Cough	Extract the juice of three leaf by crushing it and squeezing it in a cloth. Repeat the same procedure for 1 in. length of <i>Curcuma longa</i> , heat 1 tablespoon of ghee in a recipient to which 1 tablespoon of honey is added followed by the extracted juice, a rusted nail is then heated and dipped and removed instantaneously from the preparation. Administer once orally daily in the fasting state for 3 days.	Orally
Vitamin C L'air la mer/sea air	Cold, flu Tuberculosis	Administer once orally daily throughout the year specially in winter Take the patient near the sea for him to inhale the air coming out of the sea. Repeat every week to make the patient feel better.	Orally Inhalation

RTD. Out of the 55 plant species mentioned 23 have been cited for the first time to be used against specific RTD as compared to previous ethnobotanical studies. Amongst the 32 plants noted to be used against RTD previously, new uses were identified for 22 species.

The most used plant species belonged to the following; Lamiaceae (9%), Fabaceae and Rutaceae (7%). Altogether, 81 different recipes were concocted from the medicinal plants and the most common route of administration was oral followed by inhalation and lastly topical application. Sivasankari et al., 2014 has reported that oral administration is the most commonly employed as it is considered simple and does not require the use of any other accessories or equipment.

The preferred modes of preparation were decoction, raw consumption and infusion. Decoction implies the heating or boiling of the plant material in water while infusion is carried out by suspending the plant material in cold or pre-warmed water (Sivasankari et al., 2014). The least used mode of administration was smoking since this practice is generally considered unsafe in patients suffering from RTD.

Plant parts most widely employed for therapeutic application were; leaves, fruits and rhizomes. Leaves were the most used plant part probably because it is easier to collect and they are more abundant than any other plant parts (Tuttolomondo et al., 2014). Important emphasis was laid upon the dosage and frequency of administration of the herbs to reflect the mode of preparation as accurately as possible. Nonetheless, many informants gave a vague description about the posology of some plants as for *Glycyrrhiza glabra* and *Claoxylon glandulosum*.

Highest number of plant species were employed in the prophylaxis and management of cold. Interestingly it was found that a single plant could be used in the management of more than one RTD. For example *Citrus × limonia* was used for cold, cough, flu; *Zingiber officinale* used for cough, cold, flu, sore throat, throat infection, influenza; and *Camellia sinensis* used for cold, cough, sinusitis. In some cases more than one plant organ could be used to prepare different medicines as for *Cymbopogon citratus*, *Eriobotrya japonica* and *Morinda citrifolia*. It was also found that most of the time the whole plant itself was collected whenever a plant part was required for medicinal application.

The recommended dosage varied among the plants in treating different RTD. The posology of liquid preparations of herbal medicine was estimated in terms of the quantity poured into cups with reference to the age of the patient, type of illness and immediacy of the situation. Fruits were consumed raw and in numbers ranging from one to eight depending on their size. Remedies were either administered until the symptoms subside or for a few days and in some cases whenever required. The frequency of administration was dependent upon the severity of the disease.

Most medicinal plants for example *Ricinus communis*, *Milletia pinnata* and *Bidens pilosa* were collected in the wild. It was also a common practice of inhabitants to cultivate medicinal plants in their kitchen gardens. In addition, medicinal species such as *Allium cepa*, *Allium sativum*, and *Thymus vulgaris* are also important food plants and are grown throughout the island. A wide array of not grown locally such as *Panax ginseng*, *Ephedra sinica* and *Tilia cordata*, are imported and procured from traditional healers operating in the traditional “bazaars” of the island or from shops as well as in supermarkets and pharmacies.

Natives would also advise other individuals suffering from RTD to use and benefit from the curative properties of these plants. For example some individuals stated that they were advised to use medicinal plants such as *Toddalia asiatica* and *Ocimum tenuiflorum* when they had an episode of cough by people who grew these plants. Individuals who had knowledge on herbal medicine used to cure RTD were very cooperative in helping other people in recovering from certain RTD such as asthma, cold, cough and flu. Medicinal plants were given free of cost to other people not having access to them and needing them to assuage their suffering. It is important to emphasize that a number of plants reported to be used against RTD were also used for their nutritional and aromatic properties. These medicinal plants were eaten raw or added to a variety of dishes. The raw consumption of fruits such as *Eriobotrya japonica*, *Citrus × aurantium* and *Citrus × limonia* were believed to have additional nutritive value and helping in the prophylaxis of cold and flu.

Three ethnobotanical indices were employed to evaluate the level of medicinal plant use over the island. High UV value (UV ≥ 0.10) were recorded for *Curcuma longa* followed by *Zingiber officinale*, *Citrus × limonia* and *Cymbopogon citratus*, indicating that

these were the most utilized medicinal plants against RTD. The lowest UV values (UV=0.01) were obtained for *Bidens pilosa*, *Sinapis alba* and *Ananas comosus* amongst others showing that the traditional uses of these plants have not been preserved over the years.

The EI value obtained in this study was 7.73%. This suggests that only a small proportion of the flora was employed in medicinal preparation for RTD management. Nonetheless, when compared to other local studies for other ailment conditions investigated by Mootoosamy and Mahomoodally (2014); diabetes and related complications (EI=16%), Sreekeesoon and Mahomoodally (2014); pain management (EI=11%) and Nunkoo and Mahomoodally (2012); infectious diseases (EI=5%) it was found that the use of plants for medicinal application against RTD is well established over the island given the high prevalence of diabetes, pain and infectious disease conditions over the island.

A plethora of other natural therapies were found to be widely used by the inhabitants. These therapies included preparations such as dissolving table salt in warm water and gargling evenly. Such preparation was used to manage more than one RTD condition such as cold, flu, mucous discharge, sore throat and tonsillitis. Interestingly, it has been shown that a hypertonic solution of sodium chloride can create an osmotic gradient that can draw water out of pathogens thereby resulting in their death (Wangen, 2012). In addition, preparations using ethanol were also commonly advocated to manage asthma, cold, cough and flu. In patients with chronic COPD ethanol has been shown to increase the forced vital capacity by 9% and exercise tolerance by 7% and hence is effective in treating breathlessness (Woodcock et al., 1981). Ailments such as sore throat and tonsillitis were also managed by gargling with povidone-iodine solution. Indeed, it has been shown that such preparation can effectively prevent respiratory infections (Nagatake et al., 2002). A number of informants were found to be employing prophylactic measures against cold and flu by taking ascorbic acid supplements especially during the winter season. Ascorbic acid is related to a number of validated health benefits in humans and it has been validated to bear antioxidant, anti-atherogenic, anti-carcinogenic, immunomodulator effects and helps in the prevention of cold (Naidu, 2003).

Informants were of the idea that the herbal remedies administered are generally safe and formed part of their cultural heritage. Since there is a lack of standardization to herbal medicine use informants were found to overuse them whenever they did not experience the desired effects. This points to the risk of adverse events from the use of herbals and herb-drug interactions arising in patients with comorbidities. Available data suggests that a daily intake of up to 4 cloves of *Allium sativum* can cause bleeding and interact with antiplatelet and anticoagulant drugs (Tachjian et al., 2010). Interestingly exceeding the recommended dose of *Ephedra sinica* can result into heart attack, stroke, seizure or death (Cupp, 1999). Fifteen reports of adverse cardiovascular events by *Citrus × aurantium* out of which were serious and one even included a case of myocardial infarction. This effect was induced due to the high coumarin content which is believed to have anticoagulant potentials as warfarin (Cohen and Ernst, 2010).

5. Conclusion

Given the multiplicity of TM employed against RTD, there is no denying that this study presents itself as a prominent repertoire of novel primary ethnopharmacological information. Indeed, this pioneering study revealed that a plethora of TM are extensively used by the inhabitants for the prophylaxis, management or cure of a disparate number of major and minor RTD. The easy accessibility, low cost and availability of TM determine in large part their

use. Women and inhabitants of rural areas were the most prominent users of TM. The quantitative indices depicted that *Curcuma longa*, *Zingiber officinale*, *Citrus × limonia* and *Cymbopogon citratus* were the most cited plants employed against RTD. In addition, the most common RTD managed with plants was cough while the highest number of plant species were used against cold. Using available literature, several herbs reported in this study were found to have adverse effects and interact with conventional drugs when used in large doses. In this endeavour, this study provides baseline information to warrant further pharmacological studies for plant bearing high level of use alongside promoting their conservation and generating more awareness regarding their use.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.jep.2015.11.029>.

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