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Important medicinal plants from traditional ecological knowledge: the case La Rosita community of Puerto Colombia (Atlántico, Colombia)

[Plantas medicinales importantes desde el conocimiento ecológico local: el caso Comunidad La Rosita de Puerto Colombia (Atlántico, Colombia)]

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Abstract: Traditional ecological knowledge (TEK) associated with the use of medicinal plants has been vital to numerous communities around the world. Nowadays, medicinal plants continue to be of great cultural importance and represent a viable option for health care in local communities. This study was conducted Colombian Caribbean region, particularly in the La Rosita neighborhood of the municipality of Puerto Colombia, with the purpose of collecting ethnobotanical information associated with the medicinal uses that the inhabitants give to the plants. For the analysis of ethnobotanical data, the cultural importance (CI) index was calculated. TEK of medicinal plants contributed to healing practices of the municipality of Puerto Colombia because during the decades the inhabitants have been able to verify the effectiveness of these plants in the treatment of diseases. However most of the medicinal species used are not non-native. Our results show the urgency of developing research that contributes to the documentation and analysis of ethnobotanical information and makes the importance of TEK as a cultural service of ecosystems visible.

Keywords: Traditional ecological knowledge; Service of ecosystem; Medicinal plants; Ethnobotany

Resumen: El conocimiento ecológico tradicional (TEK) asociado con el uso de plantas medicinales ha sido vital para numerosas comunidades en todo el mundo. Hoy en día, las plantas medicinales continúan siendo de gran importancia cultural y representan una opción viable para el cuidado de la salud en las comunidades locales. Este estudio se realizó en la región Caribe colombiana, particularmente en el barrio La Rosita del municipio de Puerto Colombia, con el propósito de recolectar información etnobotánica asociada a los usos que los habitantes otorgan a las plantas. Para el análisis de datos etnobotánicos, se calculó el índice de importancia cultural (IC). TEK de plantas medicinales contribuyó a las prácticas curativas del municipio de Puerto Colombia pues durante décadas los habitantes han podido comprobar la efectividad de estas plantas en el tratamiento de enfermedades. Sin embargo, la mayoría de las especies medicinales utilizadas no son nativas. Nuestros resultados muestran la urgencia de desarrollar investigaciones que contribuyan a la documentación y el análisis de la información etnobotánica y hacen visible la importancia de TEK como un servicio cultural de los ecosistemas.

Palabras clave: Conocimiento ecológico tradicional; Servicio del ecosistema; Plantas medicinales; Etnobotánica

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INTRODUCTION

Traditional ecological knowledge (TEK) has been defined as an accumulated body of knowledge, traditions, practices, beliefs and worldviews, transmitted culturally through generations on the relation of living beings to each other (including humans) and their environment (Berkes & Turner, 2006) distinguishing themselves from western scientific knowledge. The term is not exclusively attributed to aboriginal or indigenous cultures, but extends also to non-industrial or technologically less advanced societies that have a lifetime of observation and direct experience with natural environments and historical continuity in the use of natural resources (Williams *et al.,* 1993; Usher, 2000; Berkes *et al.,* 2000). The TEK is developed through trial and error over multiple generations and evolves from adaptive responses after error detection and crisis situations (Drew, 2005; Gómez-Baggethun, 2009). TEK constantly co-evolves with social and ecological systems, saving valuable information on the role of natural species for maintaining ecological sustainability and thus helping to strengthen the capacity of human societies to cope with disturbances (Gadgil *et al*., 1993; Nadasdy, 1999; Posey, 2000; Berkes & Turner, 2006).

There is a worldwide concern on the erosion of traditional knowledge and the decrease in its transmission, particularly the knowledge associated with medicinal plants (Kaul *et al*., 1989; Berkes *et al*., 1995; Case *et al*., 2005). The factors contributing to TEK loss are change in land use, acculturation, integration into the market economy and, in a more general sense, the phenomena of industrialization and globalization (Turner & Turner, 2008). Despite this loss, research in developed and developing countries suggests that socio-ecological memory "pockets" still persist in many rural and urban areas, mostly locked in local gardens (Gómez-Baggethun, 2009; Barthel *et al*., 2010).

Plants have been used in traditional medicine for thousands of years. It has been estimated that 28% of plants on land have been used for medicinal purposes in some culture (Farnsworth & Soejarto, 1991). The importance of medicinal plants is unquestionable since they provide locally available, culturally appropriate and economically accessible health care options for people with limited access to developed medical health care systems (World Health Organization, 2002). In recent years there has been a sudden increase in demand for plant-based products and plant-based drugs worldwide (Bhat *et al.,* 2013). According to a survey of novel chemical entities (NCE) approved by the US Federal Drug Administration over the last 30 years, more than 25% of the registered drugs originated from natural products, and more than half of them derived from medicinal plants (Newman & Cragg, 2012). The most important examples of plant-based pharmaceuticals are the anticancer taxanes (Taxol®), the podophyllotoxins (etoposide and teniposide), the camptothecins (topotecan and irinotecan) and the alkaloids vinblastine and vincristine (Oncovin®) (Amin *et al*., 2009), but also the antimalarial artemisinin (Artequick®), among others such as forskolin, silymarine, colchicine, digitoxin, pilocarpine, hyoscyamine, reserpine and quinidine (Balandrin *et al*., 1993). NCE derived from plants continue to be explored by pharmaceutical companies specially those which have proven by traditional medicine and well documented its ethnopharmacological uses (Atanasov *et al*., 2015).

The Neotropics have the highest levels of plant diversity in the world (Thomas, 1999; Corlett, 2016) and these have been a key component of traditional health systems and medicinal practices in Latin American countries (Montenegro & Stephens, 2006). Despite this diversity, in recent years, the traditional knowledge of medicinal plants has decreased, and important natural areas in these countries have been subjected to significant pressure of uncontrolled exploitation (Calixto, 2005). Colombia is the country with the second highest diversity in plants in the world with more than 27,860 species been identified (Bernal *et al*., 2016), and these species are at least the 10% of the total number of species inhabiting the planet (Bernal *et al*., 2011). Moreover around 23% of the Colombian species are endemic, and around 15% still remain to be discovered (Bernal *et al*., 2016).

In Colombia, around 2800 species of plants have been reported to be used for medicinal purposes, with 227 of them being endemic (Bello *et al*., 2014). The regulations for medicinal plants use is based on the 1993 Convention of Biological Diversity (CBD) and the Andean Decision 391 from Cartagena signed in 1996 by Bolivia, Colombia, Ecuador, Peru and Venezuela. The Colombian resolution 1348 from 2014 regulates the activities that may be configured to access the genetic resources and derived products, which require a contract with the Ministry of the Environment for scientific research of DNA/RNA isolation, secondary metabolites isolation and patent solicitation (Trujillo *et al*., 2009). The resolution 2834 from 2008 created the "Colombian Vademecum of Medicinal Plants", which for the 2016

update, includes 139 accepted species with therapeutic value, most of them been introduced, and thus not native.

The Colombian Caribbean region is the second most diverse region in terms of flora, after the Andean region. However, the tropical dry forest, the region's most extensive biome, as well as the mangrove swamps and forests, are in high degree of threat mainly due to the expansion of agricultural frontiers, urbanization, mining and the construction of infrastructure (Vilardy *et al*., 2011). Documenting traditional knowledge through ethnobotanical studies can strengthen conservation efforts and promote the rational use of biological resources, especially after the remarkable global interest in traditional medicine and the growing demand for plant varieties (Joshi *et al*., 2010). In addition, the imminent loss of valuable information on useful plants and local ecosystems resulting from the integration of these communities into the global network intensifies the urgency of this type of research. Various ethnomedicinal studies have been developed in different departments of the Colombian Caribbean (Cruz *et al*., 2009; Rosado-Vega & Moreno-Fernández, 2010; Estupiñán-González & Jiménez-Escobar, 2010; Gomez-Estrada *et al*., 2011; Carbonó-Delahoz & Dib-Diazgranados, 2013; Barrios-Paternina & Mercado-Gómez, 2014). This research is the first one of its kind carried out in the municipality of Puerto Colombia, located on the north coast of the Colombian Caribbean region, in the department of Atlántico. In terms of access to health care system, the Caribbean remains one of the regions with the greatest unmet clinical needs and less access to health services. Perhaps for this reason medicinal plants still retain great cultural importance among the inhabitants of the study area and have proved to be an economical and accessible alternative when treating diseases and affections. The main objective of this research is to collect ethnobotanical information of the medicinal plants that the residents of the La Rosita neighborhood identified as important for the care of diseases.

MATERIAL AND METHODS

Description of settlement, population and area of study

Puerto Colombia is a municipality of the Department of Atlántico, located in the Colombian North coast at an average altitude of 5 meters above sea level (Figure No. 1). According to census projections of the National Administrative Department of Statistics (DANE) for 2017, the municipality of Puerto Colombia has a population of 22,567 inhabitants, 51% of which are women, 49% are men and approximately 11.2% are persons over 50. According to figures from 2015 the indigenous population in the municipality is 930 inhabitants.

The settlement of the Department of Atlántico started 10,000-20,000 yrs ago (Baquero & de la Hoz, 2011). Prior to the construction of the Puerto Colombia dock in 1888 by the Cuban engineer Francisco Javier Cisneros to the foothills of Cerro Cupino, there were already human settlements belonging to the Mokaná ethnic group, which were engaged in hunting, fishing, animal husbandry, and corn, yucca and ahuyama cultivation (González, 2003). According to the historical reports of Colina & Colina (Colina, 1999), the engineer Cisneros made an exchange of land with the fishermen who were occupying the territory at the time, and also gave his workers land to build their hamlets. From that date on, settlers from other nearby coastal municipalities (Tubará, Sabanilla, El Morro and Galapa) started to arrive to Puerto Colombia. Foreigners also were attracted to the area, specially by its commercial boom being developed in the first decades of the 20th century, as the harbour of Barranquilla. Thus, the dock that gave origin to the municipality, also determined its original urban growth process with streets that moved parallel to the coastal border. The main square (which served as the center), the municipal hall and the church were established near the dock, and these structures became focal points of urban growth, around which the highest population and housing densities have been concentrated (Figure No. 1).

The present study was carried out in La Rosita neighbourhood located near the coastal border and adjacent to the town hall. Its location suggests being one of the first vicinities to be constituted and due to its old age, could be an important reservoir of TEK in the town. Although Puerto Colombia does not currently have accurate and up-to-date demographic information, according to a population census conducted by the community leaders of La Rosita, the neighbourhood has approximately 240 housing units and an estimated population of 1032 inhabitants.

In this study, a randomized stratified sampling was carried out using age and residence time as the inclusion criteria. A semi-structured questionnaire was applied between February and April 2017 to 49 residents of the area of study (Table No. 1). Most of the informants were natives of the municipality (70%) or have resided in it for more than 20 years (the remaining

30% belong to other municipalities of the Colombian Caribbean coast such as Barranquilla, Sabanalarga and Tubará). The average age of the participants was 61 years and the average number of inhabitants per house was 4.

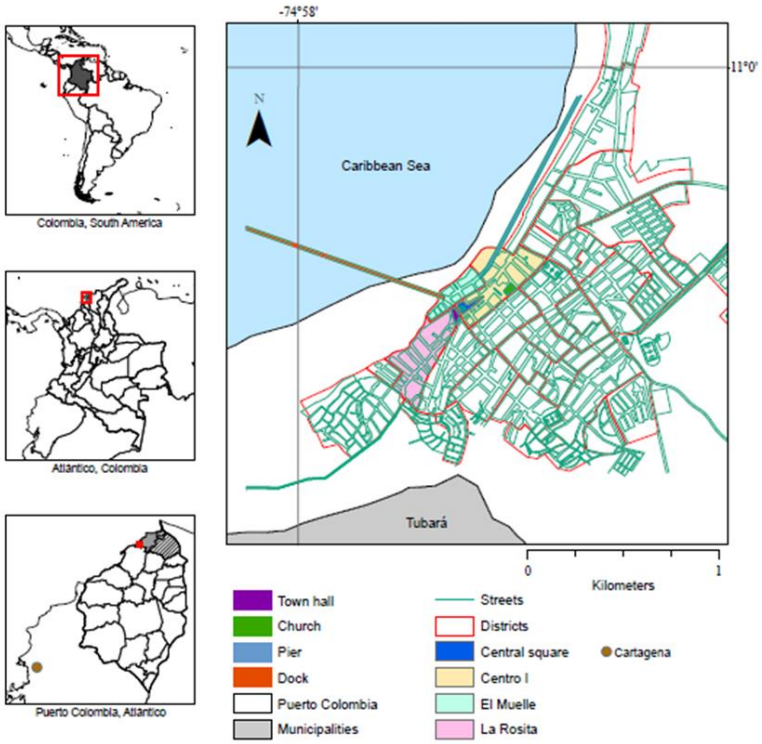

Figure No. 1
Location of the area of study in pink (La Rosita neighbourhood). The dock, the pier, the town hall and church are other important structures of the Puerto Colombia municipality

Table No. 1
Socio-demographic characteristics of the group of study (n=49)

Socio-demographic variable	Level	Value	Percentage
Gender	Women	38	78%
	Men	11	22%
Age (in years)	35-42	1	2.0%
	43-50	4	8.2%
	51-58	16	33%
	59-66	12	24%
	67-74	10	20%
	75-82	5	10%
	83-90	1	2.0%
Highest educational level reached	None	1	2.0%
	Primary	15	31%
	Secondary	22	45%
	Technical and University	11	22%

Collection of the Information

The questionnaire inquired about the knowledge of using medicinal plants to treat diseases or conditions. The questionnaire was based on previous studies representative of the subject (Reyes-García *et al*., 2016). For its validation, experts from the Socioecosystem Laboratory of the Autonomous University of Madrid, who have carried out studies using instruments on the ecosystem services used by medicinal plants, reviewed it (García-Llorente *et al*., 2016; Martínez-Sastre *et al*., 2017). Subsequently, a pilot test was conducted with a small group of the population to determine if it was easily understood. The information was collected on the nature of the plants used, its vernacular name, the type of diseases or specific conditions treated, the method of preparation and parts used, route of administration, dose or dosage (including amounts, frequency and duration of treatment), contraindications and other known uses (besides medicinal) given to the plant. In a second part of the questionnaire, the information concerning the members of the informant's family which were most involved in the preparation of remedies, the execution of rituals or special ceremonies at the time of applying the remedies, the transfer of knowledge about the medicinal plants, the frequency of exchange of plant material, and the sources of collection of medicinal plants, were collected.

Whenever possible, a direct verification of the mentioned species was carried out when there was presence of the plant in the vicinity. For the rest of the cases, the informants were asked for a physical description of the plant and the literature on national flora (Pérez, 1964; García, 1974; Piñeros *et al*., 1991; Fonnegra & Jiménez, 2007; Ministerio de la Protección Social, 2008; Bernal *et al.*, 2011) was consulted to support the identification of the species from the common names, descriptions and use reports provided by the informants. The indigenous leader Mokana, Santiago Alvaro, made a review of the plants identified by the interviewees, for the validation of the information.

Information Analysis

A set of categories of medical use were established with the help of health professionals to classify the information and subsequently to apply quantitative analyses. According to Alexiades (Alexiades, 1996), it cannot be assumed a priori that there is direct correspondence between local ailments and biomedical diseases and it is recommended to consider the social and cultural context in which the medicinal plant is embedded. Considering the above, the use of quotation marks ("") was used to distinguish local diseases. Ten categories were defined based on the systems or organs of the human body affected. Additionally, subcategories were created with the purpose of identifying which diseases or conditions were treated with the plants (Table No. 2). The collected information concerning the method of preparation used, the parts used and routes of administration were also categorized.

Once the answers from the informants were categorized, the data was validated if the treatment of a specific disease or condition (corresponding to the subcategories of use in Table No. 2) was mentioned by at least three informants (Friedman *et al*., 1986; Johns *et al*., 1990; Ali-Shtayeh *et al*., 2000; Pandikumar *et al*., 2011). Regarding the analysis of ethnobotanical data, this study used the cultural importance index (Tardío & Pardo-de-Santayana 2008), which considers not only the frequency of citation to define its cultural importance, but also its versatility (diversity of uses). The CI index of the species is given by the following equation:

$$CI_s = \sum_{u=1}^{NC} \sum_{i=1}^{N} RU_{ui} / N$$

where corresponds to the report of species within a category of use u=1,2,…,NC (being NC the total number of categories) for an informant i=1,2,…,N (being N the total number of informants). Takes the value of 1 when the informant i mentions the use of the species s in the use category u, otherwise Is equal to 0. To calculate the IC, first add the number of reports of use of the species within each established category of use (that is, the number of participants that mention each category of use for the species) and divide them among the total number of informants. Subsequently, the quotients are added to calculate the IC of the species. For example:

$$CI_{Aloe\ vera} = \sum_{i=1}^{49} RU_{2i}/_{49} + \sum_{i=1}^{49} RU_{4i}/_{49} + \sum_{i=1}^{49} RU_{7i}/_{49} + \sum_{i=1}^{49} RU_{10i}/_{49}$$

Table No. 2
Categories and subcategories of use of medicinal plants in Puerto Colombia municipality

Categories of use	Subcategories of use
1: Cardiovascular system	"Cleaning the blood", hypertension
2: Digestive system	Diarrhoeas (including intestinal infection), dyspepsia, colitis, gastritis, flatulence, intestinal parasites, "cleaning stomach, liver, gut"
3: Respiratory system	Cough and phlegm, laryngitis, flu
4: Integumentary system	Injuries (including cuts, bites or animal bites), alopecia, pruritic eruptions
5: Nervous system	Emotional disorders (including stress, anxiety, depression), headaches, insomnia
6: Urinary system	Renal disorders (including urinary infection, insufficiency, lithiasis)
7: Immune system	Fever, general inflammation ("ailments")
8: Endocrine system	Cholesterol and triglycerides, hyperglycemia (diabetes), overweight (therapies for weight loss)
9: Auditory system	Ear pain
10: Other syndromes	Cancer

Each one of the quotients obtained is a measure of the *relative importance* of each category of use. We denote in table 3 the abbreviations RI_u and RIS_u for the values of relative importance of each category and subcategory of use by species.

Results

The informants initially reported the medicinal use of 80 plant species, and after applying the validation criteria, 50 species were excluded from the analysis. Of the 30 remaining species, only six were native to Colombia: *Petiveria alliacea* L., *Bursera glabra* (Jacq.) Triana & Planch., *Croton malambo* H. Karst., *Justicia secunda* Vahl, *Quadrella odoratissima* (Jacq.) Hutch. and *Crescentia cujete* L. Four of them were native to the study area: *Bursera glabra* (Jacq.) Triana & Planch., *Croton malambo* H. Karst., *Quadrella odoratissima* (Jacq.) Hutch. and *Crescentia cujete* L.). The average number of species cited by the informants was 5 (est. = 2.63), 15 being the largest number of species cited for one informant and 2 the lowest. The medicinal plant with the highest frequency of citation (FC) was *Origanum vulgare* L. (32 informants mentioned its medicinal use), followed by *Melissa officinalis* L. (29), *Aloe vera* (L.) Burm.f (28), *Eucalyptus* sp. (17), *Plantago major* L. (12), *Gliricidia sepium* (Jacq.) Walp. (12) and *Moringa oleifera* Lam. (eleven). The botanical families most used by the informants were Lamiaceae (with 5 species), Myrtaceae (2), Plantaginaceae (2), Asteraceae (2) and Rutaceae (2).

Ten different medicinal categories were used to classify the use of the plants. The species were used mostly for treating diseases belonging to the respiratory (22.3%) and digestive systems (19.5%) (Figure No. 2a), followed by conditions of the nervous system (12.3%) and related to immunity (10.7%).

The use of medicinal plants was reported for the treatment of 26 specific diseases or conditions. The highest proportion of reports occurred for the treatment of the cold and the flu (17.6%), followed by ear pain (9.1%), general inflammation or "ailments in the body" (8.8%), emotional disorders such as stress, anxiety and depression (7.9%), renal alterations such as urinary tract infection, renal insufficiency and lithiasis (6.9%), colitis (5.7%), hyperglycemia (5.3%), and flatulence (5.0%) (Figure No. 2b). The Figure No. 2c represented the percentage of use in different modes of application of the medicinal plants.

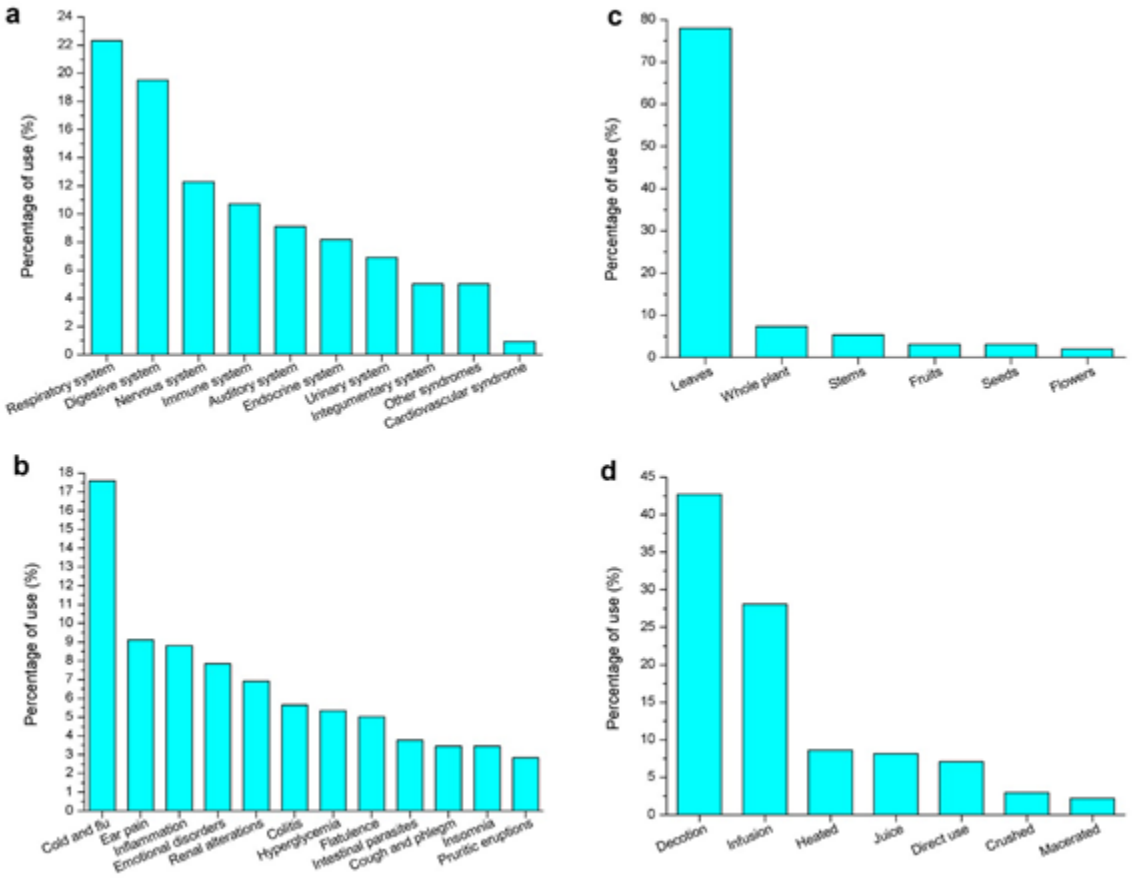

Figure No. 2
Therapeutic use, organs used and mode of preparation of the medicinal plants in Puerto Colombia. a. Percentage of use for the medicinal categories. b. Percentage of use for main medicinal subcategories. c. Percentage of use in different modes of application of the medicinal plants

The 30 plant species were ranked (Table No. 3) according to the CI index values. For each species, the common name, the medicinal use categories and subcategories, methods of preparation, part used and route of administration were reported in the Table. In addition, the relative importance values of each category (RI_u) and subcategory (RIS_u) were included. These values proved to be a valuable tool to identify the proportion in which each category and subcategory of use contributes to the CI of the species, and therefore, to prioritize and identify the most relevant medicinal uses for each species.

According to CI index ranking, *Melissa officinalis* L. (locally known as "Toronjil") was the most medicinally significant species for the study group (CI = 1.0204). The values of relative importance for the categories of use reported revealed that nervous (IRc = 0.551) and digestive (IRc = 0.306) related disorders were most commonly treated by "Toronjil" followed by respiratory (0.102) and immune (0.061) conditions. The

Table No. 3
List of medicinal plants species identified with their common names and categories and subcategories of medicinal use

#	***Scientific name*** **Family**	**Common name**	**FC[i]**	**CIs[ii]**	**Category of use**	RI_u	**Subcategory of use**	RIS_u	**Organ used**	**Mode of preparation**	**Adminis-tration**
1	*Melissa officinalis* L., Lamiaceae	Toronjil	29	**1,0204**	Nervous	0,551	Emotional disorders	0,429	Leaves and the whole plant	Decoction or infusion	Oral
							Insomnia	0,122			
					Digestive	0,306	Flatulence	0,184			
							Colitis	0,122			
					Respiratory	0,102	Cold and flu	0,102			
					Immune	0,061	Fever	0,061			
2	*Origanum vulgare* L., Lamiaceae	Orégano	32	**1,000**	Ear affection	0,592	Otalgia	0,592	Leaves	Heathing, decoction or infusion	Oral and ear instillatio n
					Respiratory	0,204	Laryngitis	0,082			
							Cold and flu	0,061			
							Cough and phlegm	0,061			
					Digestive	0,122	Dyspepsia	0,061			
							Flatulence	0,061			
					Endocrine	0,082	Hyper-glycemia	0,082			
3	*Aloe vera* (L.) Burm.f., Xanthorrhoea-ceae	Sábila	28	**0,959**	Digestive	0,388	Colitis	0,184	Leaves	Juice or direct use	Oral and topical
							Purge	0,143			
							Gastritis	0,061			
					Other syndromes	0,265	"Cleaning the blood"	0,163			
							Cancer	0,102			
					Immune	0,163	Inflam-mation	0,163			
					Integumen-tary	0,143	Wounds	0,082			
							Alopecia	0,061			
4	*Eucalyptus* sp., Myrtaceae	Eucalipto	17	**0,367**	Respiratory	0,367	Cold and flu	0,306	Leaves	Decoction	Oral and topical
							Cough and phlegm	0,061			
5	*Moringa oleifera* Lam., Moringaceae	Moringa	11	**0,327**	Endocrine	0,265	Cholesterol and trigly-cerides	0,102	Leaves or seeds	Infusion decocotion or direct use (seeds)	Oral
							Hyper-glycemia	0,082			
							Over-weight	0,082			
					Immune	0,061	Inflam-mation	0,061			
6	*Plantago major* L., Plantaginaceae	Llantén	12	**0,265**	Urinary	0,163	Renal disorders	0,163	Leaves	Decoction or infusion	Oral
					Immune	0,102	Inflam-mation	0,102			Oral and topical

7	*Gliricidia sepium* (Jacq.) Walp., Fabaceae	Matarratón	12	**0,245**	Integu-mentary	0,184	Pruritic eruptions	0,184	Leaves	Decoction, crushing or infusion	Topical
					Immune	0,061	Fever	0,061			
8	*Dysphania ambrosioides* (L.) Mosyakin & Clemants Amaranthaceae	Yerba santa	9	**0,184**	Digestive	0,184	Intestinal parasites	0,184	Leaves	Decoction or infusion	Oral
9	*Azadirachta indica* A.Juss., Meliaceae	Neem	7	**0,184**	Endocrine	0,122	Hyper-glycemia	0,122	Leaves	Decoction or infusion	Oral
					Immune	0,061	Inflammation	0,061			
10	*Ruta graveolens* L., Rutaceae	Ruda	7	**0,184**	Nervous	0,061	Cephalea	0,061	Leaves or the whole plant	Maceration or infusion	Oral and topical
					Digestive	0,061	Intestinal parasites	0,061			
					Respiratory	0,061	Cold and flu	0,061			
11	*Justicia secunda* Vahl Acanthaceae	Mochila	8	**0,163**	Urinary	0,163	Renal disorders	0,163	Leaves	Decoction or infusion	Oral
12	*Ocimum basilicum* L., Lamiaceae	Albahaca	7	**0,143**	Respiratory	0,143	Cold and flu	0,143	Leaves	Decoction or infusion	Oral
13	*Salvia officinalis* L. Lamiaceae	Salvia	5	**0,143**	Respiratory	0,143	Cough and phlegm	0,082	Leaves	Infusion	Oral
							Cold and flu	0,061			
14	*Crescentia cujete* L., Bignoniaceae	Totumo	7	**0,143**	Respiratory	0,143	Cold and flu	0,143	Fruits and seeds	Decoction	Oral
15	*Bursera glabra* (Jacq.) Triana & Planch., Burseraceae	Caraña	6	**0,122**	Respiratory	0,122	Cold and flu	0,122	Leaves	Decoction or infusion	Oral
16	*Aloysia citriodora* Pala u Verbenaceae	Cidrón	5	**0,102**	Nervous	0,102	Insomnia	0,102	Leaves or the whole plant	Decoction or infusion	Oral
17	*Apium graveolens* L., Apiaceae	Apio	4	**0,082**	Digestive	0,082	Flatulence	0,082	The whole plant	Decoction	Oral
18	*Mentha x piperita* L., Lamiaceae	Hierba buena	4	**0,082**	Respiratory	0,082	Cold and flu	0,082	Leaves	Decoction	Oral
19	*Citrus limon* (L.) Osbeck, Rutaceae	Limón	4	**0,082**	Respiratory	0,082	Cold and flu	0,082	Leaves or fruits	Decoction or juice	Oral
20	*Cymbopogon citratus* (DC.) Stapf, Poaceae	Limoncillo	4	**0,082**	Nervous	0,082	Emotional disorders	0,082	Leaves	Decoction or infusion	Oral
21	*Petiveria alliacea* L., Phytolaccaceae	Anamú	3	**0,061**	Other syndromes	0,061	Cancer	0,061	Leaves	Decoction	Oral
22	*Calendula*	Caléndula	3	**0,061**	Immune	0,061	Inflam-mation	0,061	Flowers	Infusion	Topical

	officinalis L., Asteraceae										
23	*Russelia equisetiformis* Schltdl. & Cham. Plantaginaceae	Cola de caballo	3	**0,061**	Urinary	0,061	Renal disorders	0,061	Stems	Decoction	Oral
24	*Psidium guajava* L., Myrtaceae	Guayaba	3	**0,061**	Digestive	0,061	Diarrhoea	0,061	Leaves	Decoction	Oral
25	*Croton malambo* H.Karst., Euphorbiaceae	Malambo	3	**0,061**	Digestive	0,061	Colitis	0,061	Leaves	Infusion	Oral
26	*Chamaemelum nobile* (L.) All., Asteraceae	Manzanilla	3	**0,061**	Immune	0,061	Inflam-mation	0,061	Flowers	Infusion	Oral
27	*Cannabis sativa* L., Cannabaceae	Marihuana	3	**0,061**	Immune	0,061	Inflam-mation	0,061	Leaves	Decoction	Oral
28	*Manilkara zapota* (L.) P.Royen, Sapotaceae	Níspero	3	**0,061**	Urinary	0,061	Renal disorders	0,061	Seeds	Decoction	Oral
29	*Morinda citrifolia* L., Rubiaceae	Noni	3	**0,061**	Endocrine	0,061	Hyper-glycemia	0,061	Fruits	Juice	Oral
30	*Quadrella odoratissima* (Jacq.) Hutch., Capparaceae	Olivo	3	**0,061**	Cardio-vascular	0,061	Hypertension	0,061	Leaves	Infusion	Oral

[1] Frecuency of citation. [2] Cultural importance index by species. [3] Relative importance of the category of use. [4] Relative importance of the subcategory of use

emotional disturbances (IRsc = 0.429), followed by flatulence (IRsc = 0.184), insomnia (IRsc = 0.122), colitis (IRsc = 0.122), cold and flu (IRsc = 0.102) and fever (IRsc = 0.061) were the specific conditions treated with *Melissa officinalis* L. The species *Origanum vulgare* L. (CI = 1.000) appeared as the second most important medicinal plant from the municipality.

Oregano was employed mainly for the treatment of otalgias (IRsc = 0.592) and respiratory system diseases such as laryngitis (IRsc = 0.082). Thirdly, *Aloe vera* (L.) Burm.f. (CI = 0.959) was mainly used for the treatment of colitis (IRsc = 0.184), to "clean the blood" (IRsc = 0.163), as anti-inflammatory (IRsc = 0.163) and as a purgative (IRsc = 0.143). Other culturally important species according to CI values, were *Eucalyptus* sp. mainly for the treatment of cold and flu, *Moringa oleifera* Lam., for treating high cholesterol and triglycerides, *Plantago major* L., for renal disorders, *Gliricidia sepium* (Jacq.) Walp., for treating pruritic eruptions, *Dysphania ambrosioides* (L.) Mosyakin & Clemants, as anti-parasitary, *Azadirachta indica* A.Juss., for diabetes, *Ruta graveolens* L., for treating cold and flu symptoms, *Justicia secunda* Vahl., against renal disorders, *Ocimum basilicum* L., against cold and flu, *Salvia officinalis* L., for cough and phlegm, *Crescentia cujete* L., against cold and flu, *Bursera glabra* (Jacq.) Triana & Planch., for treating cold and flu symptoms, and *Aloysia citriodora* Palau, for treating insomnia.

The leaves (78%) were reported to be the plant organ (Figure No. 2c) most often used for plant remedies followed by the whole plant (7.4%), stems

(5.4%), fruits (3.1%), seeds (3.1%) and flowers (2%). Decoction (42.7%) was the most frequent method of preparation of the medicinal plants, followed by infusion (28.1%), heated (8.6%, corresponding to all treatment reports of otalgias with heated or roasted oregano leaves), juice (8.2%), direct use (7.1%), crushed (3.0%) and macerated (2.2%). Most of the remedies were administered (Figure No 2d) internally (87%), by oral route (76%), followed by instillation in the ears (11%). The external route most habitual was the bath (6.7%), followed by topical application (6.2%).

The correlation between the frequency of citation (FC) and the cultural importance index (CI) variables is high (R^2 = 0.96809, Figure No. 3), showing that there is a positive relation between the number of times a species is mentioned and its versatility (diversity of uses). The species *Ruta graveolens* L. and *Eucalyptus* sp., are singular cases, as rue shows a low citation frequency but it is used for the treatment of several conditions (digestive, nervous and respiratory conditions), whereas *Eucalyptus* sp. is frequently mentioned by informants, and it is always used for treating respiratory ailments. The software (free) used for the graph of the correlation is called R (R Core Team, 2013).

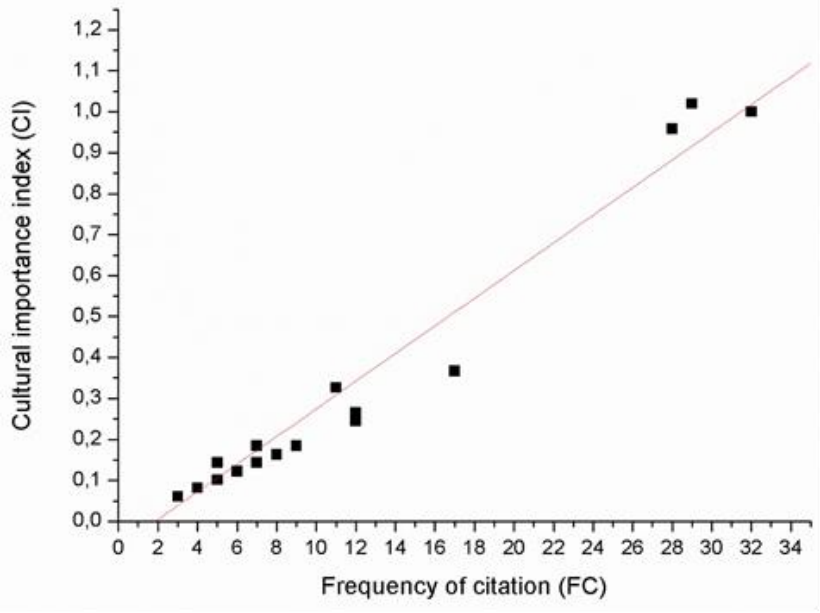

Figure No. 3
Relation between the cultural importance index and the frequency of citation for the 30 plants included in this study

When informants were asked who in their families were most involved in the preparation of remedies with medicinal plants, most of them reported that women in the household (mothers and grandmothers) did so more frequently (75%). Secondly, parents and grandparents (12%) and thirdly other family members (2%). Only 10% of informants stated that in their home, mothers, grandmothers, parents and grandparents participated equally in the preparation of remedies. The highest proportion of informants gained knowledge about the use of medicinal plants from their parents or grandparents (80%). The remaining 20% reported having obtained it from close friends and media, in equal proportion.

The exchange of medicinal plants does not seem to be a common practice among the study population. The largest proportion (36.7%) reported that they exchanged medicinal plants from time to time (once every 6 months) and 32.7% stated that they did so rarely (once a year). Only 14.3% of the respondents stated that they did it very often (every week) and 8.2% never traded medicinal plants. Most

of the informants believed that new generations were not acquiring knowledge related to the use of medicinal plants (32.7%). The rest believed that there was transfer of knowledge (28.6%), although some was lost (14.3%).

Most of the informants (61.2%) gathered the medicinal plants themselves for the preparation of remedies from the patios of their house. Other sources of collection in order of importance were the gardens of relatives or friends, nearby green areas but also supermarkets, the latter being the least frequented source of collection. Traditional healers were not reported as a source of plants or plant remedies, except for healing the "mal de ojo" using *Ruta graveolens* L.

DISCUSSION

According to our results, the medicinal uses given to the plants by the study community are valid and congruent with the results from other ethnobotanical studies, including some in the Colombian Caribbean (Cruz *et al*., 2009; Rosado & Moreno, 2010; Gomez-Estrada *et al*., 2011; Gomez-Estrada *et al*., 2011; Barrios-Paternina & Mercado-Gómez, 2014). Some of the medicinal plants and uses reported in this and other studies in the region are *Aloe vera* (L.) Burm.f. (for the treatment of colitis, cancer, inflammation and wounds), *Origanum vulgare* L. (ear pain), *Eucalyptus sp.* (flu), *Plantago major* L. (renal disorders), *Gliricidia sepium* (Jacq.) Walp. (fever), *Dysphania ambrosioides* (L.) Mosyakin & Clemants. (intestinal parasites), *Crescentia cujete* L. (flu), *Manilkara zapota* (L.) P.Royen (renal disorders) and *Croton malambo* H. Karst (colitis).

Medical conditions associated with the respiratory and digestive systems were mostly treated with medicinal plants, as is the case in other communities worldwide (Ali-Shtayeh *et al*., 2000; Gomez-Estrada *et al*., 2011; Cadena-González *et al*., 2013; Khan *et al*., 2013). The decoction was the most frequent preparation method and the leaves were the most habitual plant organ used, similar to the results found in other ethnobotanical studies (Keter & Mutiso, 2012; Bhat *et al*., 2013).

The three plants with a significant CI index (CI>0.95) were *Melissa officinalis* L., *Origanum vulgare* L. and *Aloe vera* (L.) Burm. f. The plant with the highest CI, *Melissa officinalis* L., was mostly used to attend emotional disorders, and researchers have linked this plant to the regulation of an important neurotransmittor, gamma-aminobutyiric acid (GABA). *Melissa officinalis* L. displays GABA transaminase inhibition, with rosmarinic acid and the triterpenoids ursolic acid and oleanolic acid, being responsible for this biochemical effect (Awad *et al.*, 2009). Most of the calming effect of this plant for nervous crisis have been found on the water-soluble polar fractions *(Pereira et al*., 2014), confirming the TEK use in decoctions and infusions in community of La Rosita. *Melissa officinalis* L., is also widely employed for treating digestive ailments such as colitis and flatulence, and this use is also well supported by literature (Weizman *et al*., 1993). *Origanum vulgare* L. showed the second highest CI, and was mostly employed for treating otalgia, and to a lesser extent respiratory and digestive conditions. This plant is recognised for its potent antimicrobial activity specially against microorganisms typically found in otitis problems such as *Pseudomonas aeruginosa*, *Staphyloccocus aureus* and *Malassezia pachydermatis* (Souza-Prestes *et al*., 2008). A patent for the antimicrobial application of *Origanum vulgare* L. in veterinary medicine for treating aural infections was filled in 1996 (Nitsas, 2000). *Aloe vera* (L.) Burm. f. was reported to be useful for treating digestive problems such as colitis, purge and gastritis, but also as a therapy against cancer. *Aloe vera* leaf pulp contains a mucilage rich in complex polysaccharides such as acetylated mannans, maloyl glucans, arabinogalactan and pectin together with anthraquinones and chromones and other components (Hamman, 2008). This plant has demonstrated in several studies to display anti-inflammatory (Reynolds & Dweck, 1999), inmunomodulatory (Zhang & Tizard, 1996; Chow *et al*., 2005), anti-cancer (Boudreau & Beland, 2006) and wound healing (Choi *et al*., 2001) effects. Specifically against the gastritis-causing agent *Helicobacter pylori*, *Aloe vera* seems to be a potent remedy as it confers healing to the ulcers, protection against mucosal injury and reduction of leukocyte adhesion and tumour necrosis factor α release (Prabjone *et al*., 2006). Native plants such as *Justicia secunda* Vahl., *Crescentia cujete* L., *Bursera glabra* (Jacq.) Triana & Planch., *Croton malambo* H. Karts., and *Manilkara zapota* (L.) P. Royen, were less reported in this study, however they have been found to be medicinally important in other locations of the Caribbean (Cruz *et al*., 2009; Rosado & Moreno, 2010), validating their use in traditional healing practices and being selected as source of potentially profitable phytoconstituents.

A low proportion of the medicinal plants traditionally used by the study population were native. In fact, the five most culturally important species are well known medicinal plants from Asia and Europe (*Melissa officinalis* L., *Origanum vulgare* L., *Aloe vera* (L.) Burm.f., *Eucalyptus* sp., *Moringa oleifera* Lam.). These results are not far from the national and Latin American reality of other local communities. The European invasion of America in the late 15th and early 16th centuries brought about drastic changes to the pre-Columbian peoples, cultures and territories and their interethnic and ecological relations, especially in coastal populations, which led to a miscegenation between the traditional systems of medicine and the western ones (Montenegro & Stephens, 2006). In Colombia, the importance of foreign species in the TEK associated with the use of medicinal plants is clearly evident in the reports of medicinal use of plants at the national level (Bernal *et al*., 2011; Bello *et al*., 2014). This on the one hand can prevent the overexploitation of native and endemic species, but it poses great challenges for the conservation of local flora, since introduced species are more valued culturally that species from the local territory.

The Mokaná, former settlers of the study area, took advantage of the medicinal plants available to them from the local forests, however after the Spanish conquest, the ethnic group underwent substantial cultural modification (Chavez, 1979). The descendants of the Mokaná still have presence in urban and rural areas of Puerto Colombia (and other nearby municipalities) and have begun a process of resignification of their indigenous identity in recent years. However our results suggest that there seems to be no transfer of knowledge between the Mokaná ethnic group and the local communities. The transmission of knowledge in a vertical and horizontal way requires an organization that facilitates this transmission, through the formation of social networks (Gunderson, 2001). The extension and consolidation of institutional frameworks and nested social networks, besides reducing social vulnerability, can be a strategy that enhances and enriches the knowledge and use of medicinal plants among the inhabitants of the area, while contributing to the resilience of community in the face of global change (Tompkins & Adger, 2004).

In this study, the backyard gardens called “patios” were found to be important reservoirs of medicinal plants available immediately to the families. These garden patios function as "pockets" for retention of socio-ecological memory in urban areas, storing knowledge and experiences often transmitted over several generations (McDaniel & Alley, 2005; Barthel *et al*., 2014). In addition, they generate ecosystem services and contribute to the maintenance of biodiversity in urban areas (Davies *et al*., 2009; Goddard *et al*., 2010). Home gardens operate in many cases as medicine cabinets, helping local communities to meet their health needs (Finerman & Sackett, 2003; Huai & Hamilton, 2009). Especially in the tropics, home gardens support a high diversity of species, constituting themselves as banks of germplasm, biodiversity reservoirs and key spaces for wild plant (Díaz-Reviriego *et al*., 2016). In addition, home gardens constitute spaces of cultural importance for the inhabitants of the area of study since they favour social and familiar encounter with nature.

In our study, most of the informants depended on home gardens and not on natural areas for accessing medicinal plants, which suggested that collection of medicinal plants had little impact on the wild areas of the territory. For these reasons, home gardens should be considered as focal points for promoting the use and in situ conservation of medicinal plants, especially the native ones. Moreover due to their capacity to increase the self-sufficiency of vulnerable populations to climatic, biological and market impacts (Tompkins & Adger, 2004; Kumar & Nair, 2004), they should be considered by key decision-makers in planning processes (Barthel *et al.*, 2014). It is also important to maintain the TEK transmission over time, and among social groups, rethinking the skills and knowledge necessary for its maintenance.

In our study, women (especially mothers and grandmothers) participated more often in the preparation of remedies with medicinal plants. Men seemed to have less knowledge about the use of medicinal plants, since when they were approached they constantly resorted to other people for information (mainly the elderly women of the home). Women had a high representation (78%) in our population sample. Several studies have reported that plant knowledge is influenced by factors such as gender (Garro, 1986; Begossi *et al*., 2002), and that the exchange of knowledge and plant material occurs primarily among women specially in the context of home gardens (Murrieta & WinklerPrins, 2003; Lope-Alzina & Howard, 2012). In Latin America, the

role of women as the main guardian of traditional communal social relationships, food security and home health is indisputable and their role in garden maintenance is key (Díaz-Reviriego *et al*., 2016). For this reason, any initiative aimed at strengthening TEK and revitalizing the use of medicinal plants in the study area should recognize women as key actors in the process.

In recent years, advances have been made in Latin American scientific production of ethnobotanical and ethnomedicinal research (Albuquerque *et al*., 2013), and basic and clinical studies on herbal medicines (Calixto, 2005). However, Colombia does not show a substantial number of ethnobotanical studies as compared to other Latin American countries such as Brazil, Mexico, Peru and Argentina (Bernal *et al*., 2011; Bello *et al*., 2014). A very low proportion of recent research in the Colombian Caribbean addresses social issues related to biodiversity or have an interdisciplinary approach (Aldana-Domínguez *et al*., 2017). The contribution of the social sciences and the recognition of cultural services provided by ecosystems is an urgent need in the region. The TEK, as a cultural service, becomes a tool that allows the classification of information on biodiversity in relatively isolated areas, where scientific knowledge has not had access. In addition, because it is developed in situ, taking into account the ecological and socio-cultural particularities of each site, it has great potential to provide relevant information and models for the management of ecosystem services.

CONCLUSIONS

The community of "La Rosita" in the municipality of Puerto Colombia was found to widely use medicinal plants to treat health conditions. The three most useful plants *Melissa officinalis* L., *Origanum vulgare* L. and *Aloe vera* (L.) Burm. f., were non-native and therefore introduced most probably from Europe, however their medicinal importance was well supported by biomedical research. Local use of medicinal plants contributed to the generation of biodiversity knowledge that makes possible the continuity of the TEK and the protection of the biocultural heritage. In the study area, traditional knowledge and practices in relation to plants are intangible services that belongs to its inhabitants. Through TEK, it was demonstrated that the inhabitants of the neighbourhood still give great cultural importance to plants, which offer them a solution to medical problems. Our results showed the urgency to document and perform analysis of ethnobotanical information, making visible the importance of TEK as a cultural service of the ecosystems capable of contributing to the wellbeing of the communities of the Colombian Caribbean with limited access to modern health systems. It also highlights the pertinence of research focused on the study of the Caribbean flora for its phytochemical and pharmacological properties.

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