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Ethnopharmacological survey of traditional medicinal plants used for the treatment of infantile colic in Morocco

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ABSTRACT

The aim of this study is to compile plants and identify the important species used for the treatment of infantile colic in Moroccan traditional medicine. A field survey was carried out in a period of 2 years (2012–2014) in 6 cities of Morocco. A total of 222 people were interviewed, including 102 mothers with babies under 6 months of age who report using plants for the treatment of infantile colic and 120 herbalists. A semistructured questionnaire was used and the collected data were analyzed qualitatively and quantitatively. A total of 36 plant species distributed in 34 genera belonging to 18 plant families have been identified as being used in the treatment of infantile colic. The species most commonly cited were: Ammodaucus leucotrichus, Lippia citrodora, Carum carvi, Foeniculum vulgare, Pimpinella anisum, Origanum vulgare , Nigella sativa, Lavandula officinalis, Rosmarinus officinalis, Cuminim cyminum, Mentha pulegium, Zygophyllum geatulum, Punica granatum, Illicium verum and Artemisia herba alba. The majority of informants use complex mixtures of plants, rather than a single plant and most of the remedies are prepared in the form of infusion or decoction but the doses of the plants varied widely and some of them are well known to contain toxic compounds. The ethnopharmacological investigation made in this study identified the vegetal species used in different traditional preparations to treat infantile colic in Morocco. Further studies should be undertaken to investigate the effectiveness of these plants and to determine their chemical composition.

Key words: Ethnopharmacology, medicinal plants, survey, infantile colic, Morocco.

INTRODUCTION

Infantile colic can be distressing to parents whose infant is inconsolable during crying episodes that typically occur in the evening. It starts in the first weeks of life and ends at the age of 4 to 5 months [1]. Colic was defined as spells of unexplained irritability, agitation, fussiness or crying lasting more than three hours per day, for more than three days per week, and for longer than three weeks in an infant that is well-fed and otherwise healthy [2].This pathology is somewhat of a medical mystery despite many studies and theories about its origin and causes. Underlying organic causes account for less than 5% of infants presenting with excessive crying but they must be considered during the evaluation [3,4,5]. Gastrointestinal, psychosocial, and neurodevelopment disorders have also been suggested as possible causes of colic [3].

Infantile colic is difficult to treat and hard to investigate and measure. The large placebo effect, the transient nature of the phenomenon, and the undetermined etiology make colic unique. Several trials have looked at medications for treating infantile colic [6]. Simethicone, a safe, over-the-counter drug for decreasing intraluminal gas, has been promoted as an agent to decrease colicky episodes. A randomized, placebo-controlled, multicenter trial concluded

that treatment with this agent produces results similar to those of placebo [7]. Systematic reviews of studies using anti-cholinergic drugs in the treatment of colic found them to be more effective than placebo. The most commonly used agent, dicyclomine, has been associated with apnea and is no longer indicated for use in infants younger than six month [8]. Cimetropium bromide, a muscarinic antagonist with direct spasmolytic activity, is a quaternary ammonium semisynthetic derivative of scopolamine. One report from Italy found it more effective than placebo in reducing duration of crying (74% and 33%, respectively) [9]. Sleepiness, an adverse effect, was more common in the study group. When conventional therapy is ineffective, many parents search for alternative methods of treatment, especially for a "natural" way. Herbal tea containing chamomile (*Matricaria chamomilla*), vervain (*Verbena officinalis*), licorice (*Glycyrrhiza glabra*), fennel (*Foeniculum vulgare*) and balm-mint (*Melissa officinalis*) was effective in one randomized controlled trial [10]. Another double-blind, randomized, placebo-controlled trial, evaluated the effectiveness of fennel seed oil emulsion in infantile colic. The results showed that the colic of 65% of the infants in the treatment group was eliminated compared with 23.7% in the control group [11].

The use of plants for the treatment of infantile colic has a long and successful tradition in Morocco where the varied climate and heterogeneous ecologic condition have favored the proliferation of more than 4,200 species of plants across the large area of the country (710,850Km^2) divided into 135 families and 940 geniuses [12].

The purposes of the present investigation are to inventory and categorize traditional medicinal plants used for healing the infant colic and to document the traditional uses, preparations and applications of these medicinal plants in Morocco.

EXPERIMENTAL SECTION

1. Study area

A field study had been carried out for a period of approximately 2 years (2012–2014) in different regions of Morocco. The research sites were selected to reflect the diversity and uses of medicinal plants in the country. Thus, the surveys were conducted in 6 cities: Casablanca, Marrakech, Rabat, Essaouira, Tangier and Safi. Fig 1 provides a map of the research sites.

Figure-1 Map of Morocco showing research sites

2. Data collection and analysis

The ethnopharmacological information was collected through interviews among herbalists and mothers with babies under 6 months of age. A total of 222 informants (120 herbalists and 102 mothers) were interviewed through semi-structured questionnaire. Only 102 mothers who report using plants for the treatment of infantile colic were interviewed among 120 mothers questioned.

After informed consent, the following data were recorded: name of the mother or herbalist, date and place of gathering information, names (vernacular names) and species of the plants, parts used (leaves, bark, fruits, seeds, aerial parts), mode of preparation (infusion, decoction ... etc.) and mode of administration (quantity, doses, frequency, period of use).

After compilation of the data, plant materials were also collected and identified at the Scientific National Institute, Rabat. Taxonomic identification of the plants and definite determination of their botanic names were conducted using the Traditional Pharmacopoeia [13], Molecular systematic botany [14], Medicinal plants of the Maghreb and basic care [15].

The names of plant families were listed in alphabetic order. Families of flowering plants were classified on the basis of APG (Angiosperm Phylogeny Group) III 2009 system (APGIII, 2009).

The Relative Frequency of Citation (RFC) of each medicinal plant species was calculated according to the following formula: RFC = FC x 100 / N

FC= number of informants mentioning the use of the medicinal plant species,
N=total number of informants participating in the survey.

RESULTS AND DISCUSSION

1. Percentage of use of phytotherapy

In the present survey, we asked 120 mothers whether they use plants for the treatment of infantile colic. 102 of them answered yes and were included in the data collection. This confirms that the percentage of use of phytotherapy is nearly 85%. The belief in traditional medicine and the dissatisfaction with medical treatment, represent the factors leading to the use of phytotherapy. Most of these herbal treatments still need to be studied scientifically.

2. Botanical analyses : families, species and parts of the plants used :

36 plant species distributed in 34 genera belonging to 18 plant families have been identified as being used in the treatment of infantile colic.

These plants are arranged in alphabetical order of family's and species and listed in a synoptic table (Table 1), which also contains the scientific and vernacular name of every plant, the part of the plant used, the common popular uses and the Relative Frequency of Citation (RFC).

The largest number of species was noted from the family Lamiaceae (11 species) followed by Apiaceae (6 species). Fewer numbers of species were found from other families as follows: Compositae, Myrtaceae, Zygophyllaceae (2 species each), Aristolochiaceae, Cactaceae, Illiaceae, Lauraceae, Liliaceae, Linaceae, Papaveraceae, Pedaliaceae, Punicaceae, Renonculaceae, Rosaceae, Rutaceae and Verbenaceae (1 specie).

The analysis of collected questionnaires showed that fifteen medicinal plants are the most used. The species most commonly cited are *Ammodaucus leucotrichus* (79%), *Lippia citrodora* (77%), *Carum carvi* (74%), *Foeniculum vulgare* (72%), *Pimpinella anisum* (70%), were reported from all the informants, followed *Origanum vulgare* (53%), *Nigella sativa* (50%), *Lavandula officinalis* (48%), *Rosmarinus officinalis* (47%), *Cuminim cyminum* (45%), *Mentha pulegium* (40%), *Zygophyllum geatulum* (30%), *Punica granatum* (25%), *Illicium verum* (22%) and *Artemisia herba alba* (20%). The rest of medicinal plants have been mentioned only by some informants (Figure 2) .

Table-1 Plants used in the treatment of infantile colic in Morocco

Family	Scientific name	Local name	Part used	Common popular uses	Indicated by		RFC
					Herbalists	Mothers	
Apiaceae	*Ammodaucus leucotrichus L.*	kammûn es-sôfi	Fruits	Frequently used, as an infusion, for diverse infantile diseases of the digestive apparatus: dysentery, nausea, regurgitation, vomiting. It also has tonic properties for babies and is taken as an infusion or in the bath.	X	X	*79*
	Carum carvi L.	Karwiyâ	Fruits	Carminative, stomachic, antispasmodic pediatric anti-diarrheal.	X	X	*74*
	Corindrum sativum L.	qezbor el yabs	Seeds	Epigastric pain, flatulence, poor digestion.	X	X	*16*
	Cuminum cyminum L.	Kammûn	Fruits	Carminative, stomachic, antispasmodic.	X	X	*45*
	Foeniculum vulgare Mill.	nâfa' beldi	Fruits	Treatment of the gastrointestinal discomfort, the icterus. Also used as galactagogue, carminative and pediatric antispasmodic.	X	X	*72*
	Pimpinella anisum L.	habbat hlâwa	Fruits	Appetizer, cholagogue, stomachic. Also used against aerophagia, difficult digestion and as pediatric antispasmodic.	X	X	*70*
Aristolochiaceae	Aristolochia longa [T]	Berztom	Root	Constipation and intestinal disorders.		X	*1*
Cactaceae	*Opuntia ficus indica Mill.*	Kermâs en-nsârâ	Seeds	Colic, diarrheas.		X	*4*
Compositeae	*Artemisia herba alba Asso [T]*	Shîh	Leaf, aerial parts	Stomachic, antispasmodic, intestinal antiseptic, tonic, carminative.	X	X	*20*
	Matricaria camomilla	Bâbûnaj	Flowers	Digestive disorders in infants.	X	X	*16*
Illiacées	*Illicium verum [T]*	Badiana	Fruit	Eupeptic, carminative, antispasmodic, stimulative of digestion, stomachic	X	X	*22*
Lamiaceae	*Ajuga iva*	Chendgora	Aerial parts	Intestinal disorders, gastric pain, diarrhea, antipyretic, colds, hypoglycemic, panacea, cicatrizing.		X	*2*
	Lavandula angustifolia	Khzama	Leaf, flower	Stomachic, pulmonary antiseptic,	X	X	*48*
	Marrubium vulgare	Merriwa	Aerial parts	Antitussive, antispasmodic, antiseptic, carminative, digestive, tonic, against headache and bronchopulmonary infections.	X	X	*6*
	Mentha pulegium	Fliyyo	Leaf	Gastrointestinal and liver disorders, antispasmodic, antiseptic, hypoglycemic, hypotensive, cholagogue, emmenagogue, diuretic.	X	X	*40*
	Mentha rotundifolia	Timijja	Leaf	Antispasmodic, carminative.		X	*4*
	Mentha spicata	Liqama, en'an 'e	Leaf	Carminative and tonic.		X	*6*
	Origanum vulgare	Za'tar	Leaf, stem	Digestive disorders: colic, gastric acidity, aerophagia Bronchopulmonary disorders : colds, bronchitis, flu.	X	X	*53*
	Rosarinus officinalis	Azîr	Leaf	Aperitif, cholagogue, stomachic	X	X	*47*
	Salvia officinalis	Salmiya	Leaf	General antiseptic.	X		*6*
	Saturja mentifolia/calamentha	Menta	Leaf	Bronchopulmonary disorders : colds, flu.		X	*4*
	Thymus vulgaris	Zîtra	Leaf	Digestive and bronchopulmonary disorders	X	X	*16*
Lauraceae	*Cinamomum cassia*	L qerfa	Crust	Digestive, carminative, anti nauseous		X	*4*
Liliaceae	*Allium sativum*	Touma	Bulb	Dysentery, infant colic, respiratory infections, cough.	X	X	*10*
Linaceae	*Linum usitatissimum*	Zarriat l Kettan	Seed	Cough sore throats and **constipation**.	X		*5*
Myrtaceae	*Eugenia caryophyllata*	Qrenfel	Flower	Stomachic	X	X	*12*
	Myrtus communis	Raihane	Leaf	Respiratory infections and diarrhea	X	X	*17*
Papaveraceae	*Papaver somniferum [T]*	Kherchacha	fruit	Analgesic, sedative.	X		*6*
Pedaliaceae	*Sesanum indicum*	Jenjlan	Seed	Fortifying food	X	X	*15*

Punicaceae	*Punica granatum*	rummân âmroûj	Flowers	Diarrheas, recurrent vomiting	X	X	*25*
Renonculaceae	*Nigella sativa*	Sanouj	Seed	Digestive disorders: colic, gastric acidity, Bronchopulmonary disorders : colds, bronchitis, flu.	X	X	*50*
Rosaceae	*Rosa damascena*	El ward	Flower	Stomach pain	X	X	*17*
Rutaceae	*Ruta montana [T]*	Fijel	Aerial parts	Colic, respiratory diseases, fevers	X	X	*12*
Verbenaceae	*Lippia citriodora*	Lwîza	Leaf	Pediatric antispasmodic, eupeptic sedative	X	X	*77*
Zygophyllaceae	*Peganum harmala [T]*	Harmel	Seeds	Infant toxicosis and childhood diarrhea.		X	*16*
	Zygophyllulm gaetulum	l'aggâya	Stem	Antispasmodic, against gastralgia.	X	X	*30*

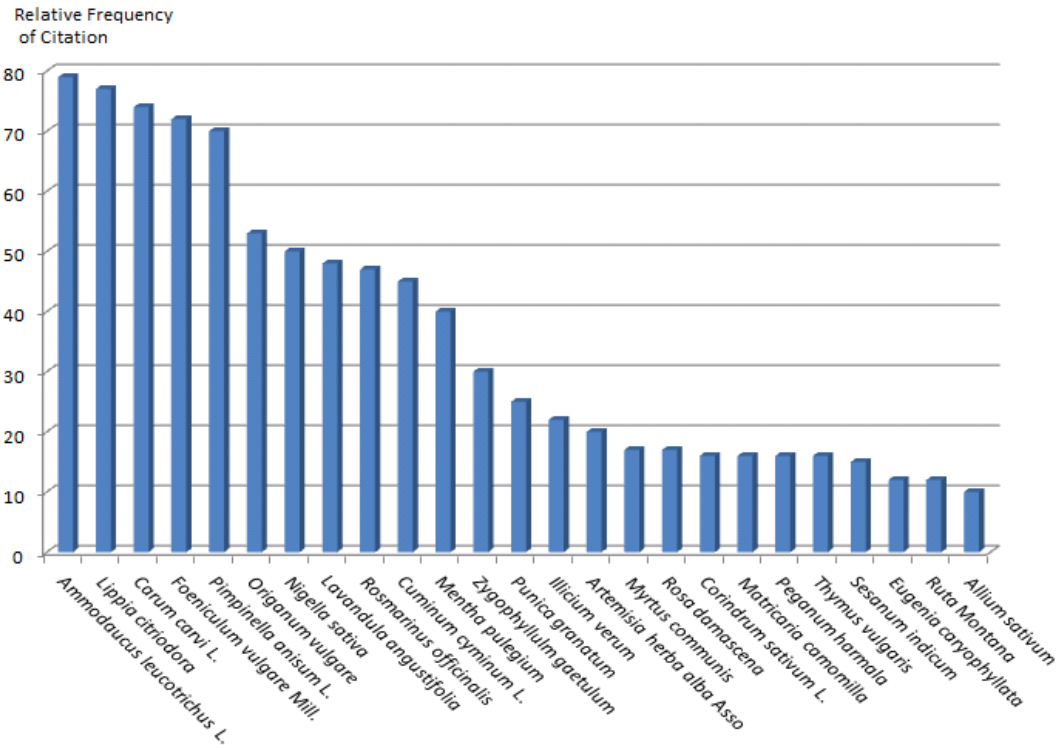

Figure-2 Frequency of use of the medicinal plants identified

Different parts of the medicinal plants are used. Leaves (12 species) were the most frequently used plant parts, followed by seeds (11 species), flowers (5 species), aerial parts (4 species), fruits (2 species), stems (2 species), roots (1 species), bark (1 species) and bulbs (1 species).

3. Methods of drug preparation and administration

The majority of informants use complex mixtures of plants, rather than a single plant. On average, the number of plants used is fifteen per preparation. Pharmacological action from plant mixtures should be attributed to the synergy among all plants more than to individual medicinal properties, so that the recognition of the contribution of each plant to the final effect becomes somehow difficult.

The majority of remedies were prepared in the form of infusion or decoction. According to the traditional mode of preparation, the fresh or dried plant parts were washed, dried and finely powdered in a mixer. An infusion is prepared by soaking the plants in boiling water for 10–20 min. The infusion is filtered and sugar or honey can be added to sweeten it. Extracts may also be prepared by boiling the plants in a mixture of water and olive or argan oil. In most cases, a precise quantitative formulation of the remedies remains difficult to establish, because dosages are not always known (or only approximately given, almost never in units such as grams). Only terms like pinch, spoonful, handful…etc are in general used.

4. Other indications of the plants used against infantile colic

This ethnopharmacological survey revealed that the traditional medicinal plants used against infantile colic and listed in our study are also known in the Moroccan traditional pharmacopeia to be used against gastro-intestinal

affections like colic (100% of the plants identified), gas (40%), vomiting (30%) and diarrhea (23%). They are also used to treat respiratory diseases like bronchial cough (17%), thinners (12%) and cold (6%). Other indications include neurologic properties: as relaxant and sedative (28%), against irritability and agitation (18%) and also antiseptic properties (10%), (Fig3).

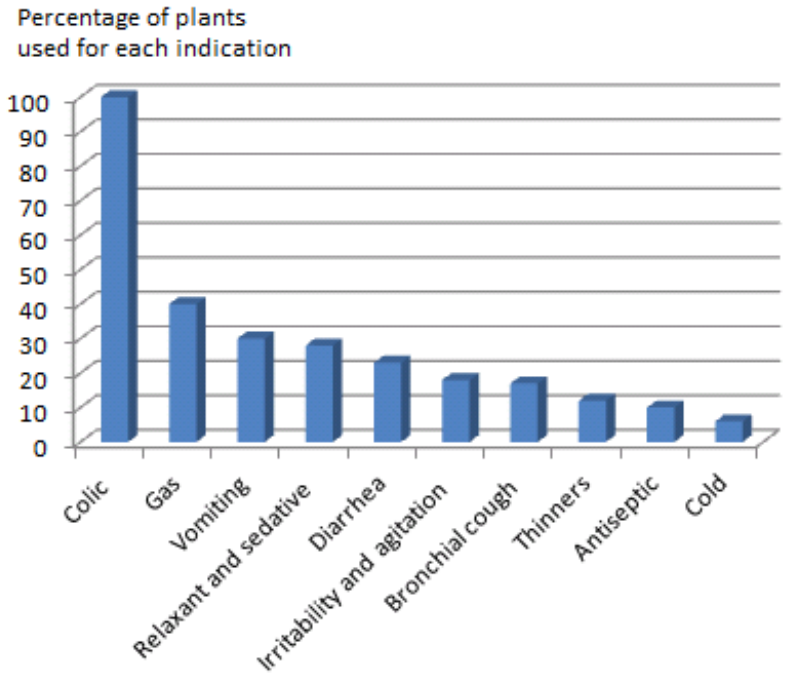

Figure-3 Other indications of the plants used against infantile colic

Otherwise, a traditional preparation containing eleven of the plants listed was clearly shown to have a significant antispasmodic effect on rat intestine. These plants are : *Cuminum cyminum*, *Artemisia berba alba*, *Lavandula angustifolia*, *Mentha pulegium*, *Origanum vulgare*, *Rosarimus officinalis*, *Illicium verum*, *Punica granatum*, *Nigella sativa*, *Lippia citriodora* and *Zygophyllum gaetulum* [16].

Table-2 Toxicity of some medicinal plants used against infantile colic

Name of plant	Poisonous Parts	Toxic Constituents	Features of poisoning
Aristolochia longa	All parts	Aristolochic acid, Aristolochin, voltile oils	Its toxicity, not only related with aristolochic acid but also some of its volatile oils, includes nausea, vomiting, headache, **dyspnae**, fever, hypertension, spasm, convulsions, coma and respiratory disorders that may lead to death. In recent years, its renal toxicity became more evident due to aristolochic acid [13,17].
Artemisia herba-alba Asso	Aerial parts	ß-thuyone.	The toxicity is particularly reported in babies. It can produce convulsions, constriction of the jaws and appearance of froth in the mouth **[**13,15,25].
Papaver somniferum	Ripe and dried capsules	Morphine, Narcotine, Codeine Thebaine	It's the most common cause of poisoning in newborns in Morocco. Intoxication is manifested by drowsiness, nausea, respiratory disorders, bronchial hypersecretion, cyanosis, convulsions and coma [18, 19].
Peganum harmala L.	All parts	Harmaline, Harmine, Harmane, Harmalol, Asicine, Vasicinone	It's commonly used in traditional medicine in Morocco as sedative .This plant can be toxic at high doses, particularly in children. The signs of toxicity are: vomiting, vertigo, hyperthermia, headache, deep sleep, cardiac disorders, convulsion, paralysis, anuria, hyperuremia, paralysis of the nervous system center and death by respiratory arrest [20,21,22].
Ruta montana L.	Aerial parts	Methylnonylcetone furocoumarines	It's used against some child fevers and as an abortive drug. It can produce gastro-enteritis, vertigo, hypothermia and finally coma. The presence of furocoumarines can induce skin eruption [23,24].

5. Safety and Toxicity of the medicinal plants used against infantile colic

Whether a medicinal plant will do more harm than good in an individual patient depends on many factors, including the patient's age. The very young subjects may be more susceptible to the toxic effects of a drug because of age dependent differences in pharmacokinetic profiles or in drug-metabolizing enzymes, genetic make-up and pre-existing conditions.

Moreover, the plant itself, misidentification errors, an involuntary contamination (by another plant, by heavy metals, pathogenic microorganisms or agrochemical residues), or the dose administered may cause poisoning.

The following medicinal plants, cited in the present study, are well known to contain toxic compound: *Aristolochia longa* [13,17], *Artemisia herbaalba* [13,15,25], *Papaver somniferum* [18, 19], *Peganum harmala* [20,21,22], *Ruta montana* [23,24]. Some of these plants are toxic enough to cause serious health risks at children (Table 2).

The adulteration of Chinese star anise (*Illicium verum Hook F*.) with Japanese star anise (*Illicium anisatum*) is particularly problematic because Chinese star anise is often used to treat infant colic while Japanese star anise (*Illicium anisatum*) has been well documented to cause both neurologic and gastrointestinal toxicities. These effects are thought to be caused by secondary metabolites that act as potent neurotoxins, such as anisatin, neoanisatin and pseudoanisatin [26,27,28].

In addition, in the absence of a framing of traditional medicine in Morocco, several actors are brought to play a role of caregiver. Within this context, we can distinguish the "Ferraga", traditional healers for child, who often use mixtures of medicinal plants for the treatment of infantile colic. In a study conducted in the region of Marrakesh, 126 cases of poisoning by these practices for a period of one year were reported. Other cases of severe poisoning were also collected in the regions of Fez, Rabat and Casablanca [29,30].

CONCLUSION

The ethnopharmacological survey made in this study identified the vegetal species used in different traditional preparations to treat infantile colic in Morocco. Among these plants 15 species are the most important and are widely used : *Ammodaucus leucotrichus*, *Lippia citrodora*, *Carum carvi*, *Foeniculum vulgare*, *Pimpinella anisum*, *Origanum vulgare* , *Nigella sativa*, *Lavandula officinalis*, *Rosmarinus officinalis*, *Cuminim cyminum*, *Mentha pulegium*, *Zygophyllum geatulum*, *Punica granatum*, *Illicium verum* and *Artemisia herba alba*. It is therefore, recommended that further studies be carried out on all the above listed plants to validate their efficacy and safety in the treatment of infantile colic.

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REFERENCES

[1] MM Garrison, DA Christakis. *Pediatrics.*, **2000**,106, 184-190.
[2] MA Wessel, JC Cobb, EB Jackson. *Pediatrics.*, **1954**, 14, 721.
[3] DM Roberts, M Ostapchuk and JG O'brien. *American Family Physician.*, **2004**, 70(4), 435-440.
[4] AEM kheir. *Italian Journal of Pediatrics.*, **2012**, 38(34),1-4.
[5] RG Barr. *Pediatrics.*, **1998**, 102, 1282-1286.
[6] AL Rogovik, RD Goldman. *Can Fam Physician.*, **2005**, 51 (9), 1209–1211.
[7] TJ Metcalf, TG Irons, LD Sher, PC Young. *Pediatrics.*, **1994**, 94, 29-34.
[8] PL Lucassen, WJ Assendelft, JW Gubbels, JT Van Eijk, WJ Van Geldrop, AK Neven. *British Medical Journal*, **1998**, 316, 1563–1569.
[9] F Savino, C Brondello, F Cresi, R Oggero, L Silvestro. *J Pediatr Gastroenterol Nutr*, **2002**, 34, 417–419.
[10] Z Weizman, S Alkrinawi, D Goldfarb and C Bitran. *J Pediatr.*, **1993**, 122, 650-652.
[11] I Alexandrovich, O Rakovitskaya, E Kolmo, T Sidorova, S Shushunov. *Alternative Therapies in Health and Medicine.*, **2003**, 9, 58-61.
[12] MS Taleb, J Eloualidi , (2014). *International Scholarly and Scientific Research.*, **2014**, 1, 12.
[13] J Bellakhdar. La pharmacopée marocaine traditionnelle: Médecine arabe ancienne et savoirs populaires, Ibis Press, Paris, **1997,** 764.
[14] F Dupont, JL Guignard. Botanique systematique moleculaire, 14ème Edition, Elsevier Masson, Paris, **2012,** 304.
[15] J Bellakhdar. Plantes medicinales du Maghreb et soins de base : Précis de phytothérapie moderne, 1ère Edition, Le Fennec, Casablanca, **2006,** 385**.**
[16] G Mamadou, B Meddah, N Limas-Nzouzi and al. *Phytopharmacology.*, **2011**, 1(3), 20-35.
[17] S Shibutani, H Dong, N Suzuki, S Ueda, F Miller, and A.P Grollman. *Drug metabolism and disposition.*, **2007**, 7(35), 1217-1222.
[18] S Achour, N Rhalem, M Windy, A Khattabi, R Mokhtari, A Soulaymani, R Soulaymani. *La presse medicale.*, **2011**, 40, 971-972.
[19] I Iken, A Attari, A Amarti, S Achour. *Toxicologie analytique et clinique.*, **2014**, 26(2), S51.

[20] S Achour, N Rhalem, A Khattabi, H Lofti, A Mokhtari, A Soulaymani, A Turcant, RS Bencheikh. *Therapie.*, **2012**, 67(1), 53-58.
[21] M Mahmoudian, H Jalil, P Salehian. *Iranian J Pharmacol Ther*., **2002**, 1, 1–4.
[22] G Zouiri, MA Radouani, N Badrane, A Assermouh, F Benbrahim, El Hafidi, S Benchekroun and C Mahraoui. *Journal of Pediatrics & Neonatal Care*., **2015**, 2, 1-2.
[23] W Masri, I Belwaer, F Khlifi, A Nouioui, D Ben salah, D Amira, A Hedhili. *Phytotherapie.*, **2015**, 13, 36-38.
[24] C.J Seak, and C.C Lin. *Clinical Toxicology*., **2007**, 45(2), 173-175 .
[25] M Bnouham, H Mekhfi, A Legssyer, A Ziyyat. *Int J Diabetes & Metabolism*, **2002**, 10, 33-50.
[26] C Perret, R Tabin, J.P Marcoz, J Lior, J.J Cheseaux. *Archives de Pediaterie.*, **2011**, 18, 750-753.
[27] D Ize-Ludlow, S Ragone, IS Bruck, JN Bernstein, M Duchowny, BM Peña. *Pediatrics.*, **2004**, 114(5), 653-656.
[28] P Minodier, P Pommier , E Moulène, K Retornaz, N Prost, L Deharo. *Archives de Pediaterie.*, **2003**,10 (7), 619-621.
[29] S Abourazzak, S Achour, G Draïss et al. *Toxicologie Maroc.*, **2012**, 12, 9-11.
[30] G Draiss, N Ennaim, FE Lahlimi, M Bourrous, M Bouskraoui. *Actes du 3ème congrès international de Toxicologie*, **2010**. Consultable à l'url : http://www. smtca.ma/ journées et congrès.