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*Original Research*

# Ethnobotanical Survey and Pharmacological Screening of Medicinal Plants Used as Antihypertensive in Sefrou Province (Middle-North of Morocco): Benefits and Challenges

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**Abstract**

Herbal medicine was used since the old time in the treatment of different types of diseases in Sefrou province, Morocco. However, few studies have been carried out to identify local medicinal flora and to scientifically document the knowledge of the traditional use of these medicinal plants by the population. This study aims to investigate the medicinal plants in Sefrou province, record their usage in folk medicine by the population and evaluate the hypotensive effect of selected plants using *in vitro* vascular activity. For that, an ethnobotanical survey was conducted among the Arabs and Amazighs population of Sefrou province from January 2017 to December 2018. The survey was conducted through oral interviews with a structured questionnaire. It covered those who knew and/or used plants for medicinal purposes, retailers, and wholesalers, and also included ecological repartition as well as the mode of administration. Then we selected some plants to evaluate the antihypertensive activity based on the *in vitro* bioassay. A total of 134 medicinal plants belonging to 52 families were identified; 61% are wild species, 49 (36%) are cultivated and 4 (3%) are cultivated as well as spontaneous. Medicinal plants used in Sefrou folk medicine have been investigated for their antihypertensive activity. They were selected based on their usage as cardiotonic, diuretics, and other uses related to the symptoms of hypertension. Most of the plants tested in this study were found to be more sensitive to relaxing contractions induced by noradrenaline. Out of 32 species examined, 14 (44%) showed more than 50% inhibition in isolated rat aortic rings, the vasorelaxant activity of these plants used for the screening was mostly inhibited by pre-treatment with N-$\omega$-nitro-L-arginine (L-NOArg). The plants inventoried are alleged to be active against 104 therapeutic indications. Nine common symptoms are widely treated in indigenous pharmacopeia: gastrointestinal (19 plants), renal (27 plants), broncho-pulmonary system (7 plants), skin (13 species), diabetes (12 plants), cardiovascular (13 plants), eye, ear, nose, teeth, and throat diseases (5 plants); gynecological disorders (6 plants); rheumatism and gnawing pain (11 plants). 14% (19 species) of the plant inventoried are traded on a large scale and scope and more than 90 percent of the medicinal plants purchased from Sefrou go to big cities for export. The expansion of unregulated trade and commercial use of medicinal and aromatic plants poses a major threat to biodiversity in the region. Overall, people in Sefrou hold rich knowledge of herbal medicine. The vasorelaxant activity proved for the documented plants will provide a basis for other preclinical and clinical investigations.

**Keywords:** medicinal flora; folk-medicine; Sefrou ethnobotany; antihypertensive; pharmacological screening; vasorelaxant activity; medicinal plants' incomes

## 1. Introduction

The ethnobotanical survey is a fundamental work for the selection of some folk-medicine plants for the scientific study named ethnopharmacology. The principles of this field have long been followed in the interchange of information between different cultures [1]. For a few decades, the investigation of medicinal plants has resulted in some important therapeutic advances. Many therapeutically bioactive compounds have been isolated from such plants, for instance, morphine (pain killer) and codeine (cough suppressant) isolated from *Papaver somniferum* [2]; atropine (anticholinergic) from *Atropa belladonna* [3]; digoxin and digitoxin (cardiac glycosides) from *Digitalis purpurea* [4]; quinine (antimalarial) and quinidine (antiarrhythmic) from *Cinchona* bark [5], etc.

Thus, this promising field must be one of the other fundamental strategies for sustainable development in many developing countries. These countries have no choice but to overcome the serious lack of sanitary infrastructure unless they make western medicine and traditional medicine work together at every level of the healthcare system. Considering the important and widespread traditional use of these plants, additional clinical toxicological evaluations need to be performed for the sake of the safety of the population [6].

High blood pressure is the main risk factor for cardiovascular diseases. The prevalence of hypertension increases with age. Furthermore, several chronic disorders, including insulin resistance, atherosclerosis, and obesity are linked to high blood pressure [7]. A typical definition of hypertension is based on a systolic blood pressure (SBP) average of 140 or higher, and a diastolic blood pressure (DBP) of 90 or higher. According to this criterion, 1.4 billion individuals worldwide are expected to have hypertension, yet 14% of them have their blood pressure managed with antihypertensive medication therapy to an SBP/DBP of less than 140/90 mmHg, especially in countries with low and moderate incomes [8]. Medicinal plants employed in traditional medicine are gaining popularity as alternate sources of treatment regimens, especially when backed by scientific evidence of their clinical usefulness. This is because various natural products used in folk medicine are beneficial, have fewer clinical adverse effects, and are generally inexpensive [9]. Numerous reports have supported the pharmacological characteristics of phytochemicals derived from plants in the treatment of hypertension. For instance, it was found that the bioactive compounds of anti-hypertensive medicinal plants such as tannins, phenolic compounds, flavonoids, and coumarins can target the renin-angiotensin-aldosterone system, a critical signaling pathway in blood pressure control [10–12].

In our opinion, it is now more important than ever to inform medical researchers and professionals about the benefits of employing medicinal plants as affordable, natural, and secure alternatives to pharmaceuticals for the treatment of hypertension. For this reason, the present study aims to examine the usage of medicinal plants found in the province of Sefrou, Morocco. We proceeded first to establish a general inventory of medicinal plants used as a valuable resource of traditional medicine. Then we evaluated the antihypertensive activity of some of these plants, based on the *in vitro* bioassay for vasodilator activity.

## 2. Material and Methods

### *2.1 Study Area*

The study was conducted in the northern center of Morocco, in Sefrou city (Fig. 1) (latitude: 33.8305°N; longitude: 4.8353°W; altitude: 850 m; pluviometry: 3 to 14 mm; temperature: 7.7 to 25.6 °C). The city has an extension of 4008.76 km$^2$, with 286.489 inhabitants, 44% live in urban parts and 56% in rural. It is populated by two ethnic groups: Amazighs and Arabs. The Sefrou province is divided into three geologically different regions: (i) in the north and northwest: there is the plain named Sais, with a height ranging from 511 to 311 meters; (ii) in the northeast: there are pre-rural plateaus in the axis of Taza city, which characterized by various forms of relief and different peaks from Ras Todgha area to El-Manzil. This area is surrounded by Oued Sebou (a river); (iii) in the south and southeast region, we found the Middle Atlas Mountains, which stretch from mount Kinder to mount Bouiblane, characterized by refractions, comes from several sources and also the presence of forests and plateaus used for grazing, agriculture, and fruit trees.

The survey occurred in the province of Sefrou in line with the administrative map (Fig. 1); it started in January 2017 and was completed in December 2018 (during the four Seasons). A questionnaire was prepared to collect data. The common name of the voucher specimen, its scientific name, the ecological distribution of the species in the several province sections, the portion of the plant utilized, and its medical indication were among the information gathered during this study.

### *2.2 Chemicals Used and Methodology of the Ethnobotanical Survey*

Chemicals including sodium chloride (NaCl), potassium chloride (KCl), sodium bicarbonate ($NaHCO_3$), magnesium chloride ($MgCl_2$), calcium chloride ($CaCl_2$), glucose, acetylcholine, noradrenaline, N-$\omega$-nitro-L-arginine are purchased from sigma Aldrich.

To overcome any difficulties in gathering data, we adapted the survey to the local characteristics of the region following the administrative map (Fig. 1). The questionnaire consisted of three sections: (a) utilization survey of plants for medicinal purposes, (b) ecological repartition of specimens in two sections of the province, and (c) approximate income derived from important medicinal plants in the region.

Field studies required us to deal with two groups: the first group was those who knew and/or used plants for medicinal purposes and the second group was those who used plants and plant products for commercial purposes (plant collectors, wholesalers, retailers). The survey was carried out in each tribal area by the local native researchers who are aware of all local conditions. After frequent visits to the rural communes and weekly markets of each tribal area, having several conversations with and questioning users, and learning the trading practices, the verbal information collected was registered on a form. If a plant (or plant product) was used for medicinal purposes, a voucher herbarium specimen was collected. These samples were pressed and preserved for later identification by botanists at the National Scientific Institute. The plants were cleaned, shade dried, and boiled for 15 min using 10 g per 100 mL; of distilled water, the boiled extracts were filtered and lyophilized. The vasorelaxant effects of these plants were assayed in isolated aortic rings for the screening of the selected plants using 50 mg of dry extract/mL as concentration.

Based on the information gathered, a list of the most frequently reported illnesses and the plant (or plant product) used for their treatment was compiled. Also, the approximate income generated from medicinal plants in the sector was estimated.

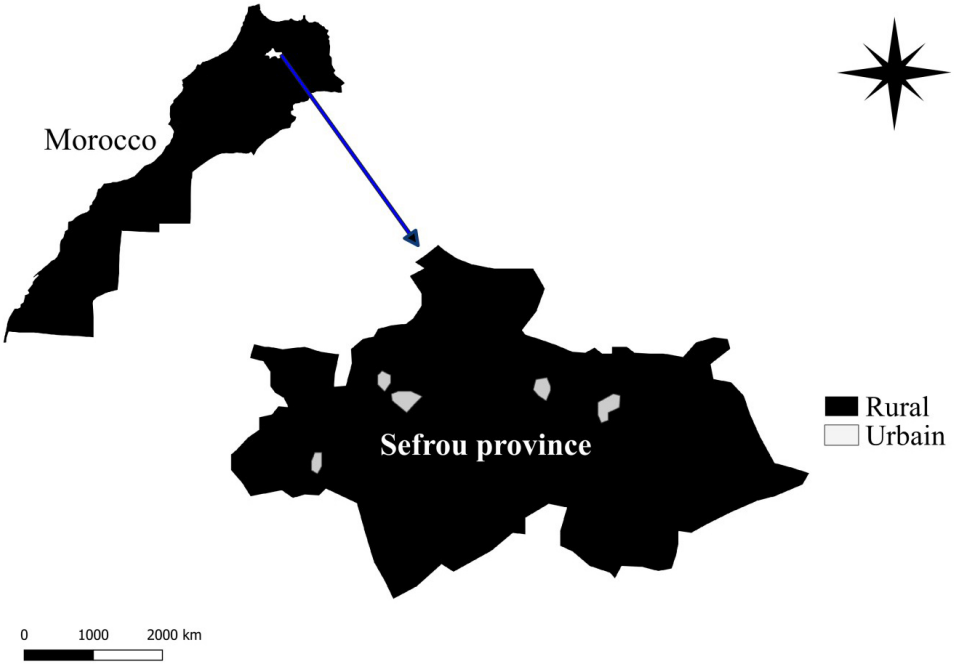


**Fig. 1. Map of Sefrou province, Morocco.**

Before the screening of plants for their antihypertensive activity, a selection criterion was exercised. This included plants used as cardiotonic, diuretic, blood purifiers, and those used for diseases related to the heart and edema. Some rarely used species, not related to the ones selected for their ethnomedical use, were also included in the study.

The International Code of Nomenclature for algae, fungi, and plants was followed to provide the scientific naming of the plants mentioned in this research [13].

### *2.3 In Vitro Studies in Aorta Rings*

The vasodilator activity of the plants selected was evaluated according to the method described by Bardai *et al*. [14]. For that, male Wistar rats weighing 200–250 g were anesthetized and sacrificed by decapitation. The thoracic aorta was rapidly isolated and excess fat and connective tissues were removed. Segments, about 2 mm in length were suspended between two hooks and mounted in 20 mL organ baths filled with a physiological solution having the following composition: 122 mM of NaCl; 5.9 mM of KCl; 15 mM of $NaHCO_3$; 1.25 mM of $MgCl_2$; 1.25 mM of $CaCl_2$; and 11 mM of glucose. The bath solution was maintained at 37 °C and gassed with a 95% $O_2$-5% $CO_2$ mixture. A basal tension of 20 mN was applied to the artery rings. After an equilibration period, each preparation was contracted by changing the physiological solution in the bath to a depolarizing 100 mM $K^+$ solution having the following composition: 27 mM of NaCl; 100 mM of KCl; 15 mM of $NaHCO_3$; 1.25 mM of $MgCl_2$; 1.25 mM of $CaCl_2$; and 11 mM of glucose. Endothelium integrity was tested by measuring the relaxation evoked by acetylcholine (1 $\mu$M). After washing, and 60 min recuperation time, test contraction was evoked either by changing the solution in the bath to the $K^+$ solution or by adding noradrenaline (1 $\mu$M) to the physiological solution in the bath. The effects of the plants were tested by cumulative addition into the bath when contraction had reached a plateau. The changes in the contractile tension evoked by the plants were compared to the effect of the addition of the same volume of the vehicle (physiological solution) into the bath. In some experiments, preparations were pre-incubated for 30 min with the NO synthase inhibitor N-$\omega$-nitro-L-arginine (L-NOArg, 100 $\mu$M).

### *2.4 Data Presentation and Statistical Analysis*

Responses to different cumulative concentrations of plants were calculated manually from the concentration-response curves obtained. The data are expressed as % of relaxation. Statistical analysis was performed using GraphPad Prism software (version 6.0; GraphPad Software, Inc., San Diego, CA, USA) using the analysis of variance (ANOVA) followed by the Tukey test. The significance level was set at $p < 0.05$.

## 3. Results and Discussions

### *3.1 General Data and Phytotherapy*

The data collected during this survey included the common name of the voucher specimen, its botanical name, the ecological distribution of the species in the different sections of the province, the part of the plant used, and the medicinal indication for which it is used. The results registered in a synoptic table (Table 1) are ordered in alphabetical order according to the family name.

**Table 1. Medicinal plants used in folk medicine by the Sefrou province population.**

| Scientific name (Voucher specimen) | Vernacular name | Ecology | Part used | Preparation | Administration | Medicinal use |
|---|---|---|---|---|---|---|
| **Agavaceae** | | | | | | |
| *Agave sisalana* L. (LB-21) | Sabra | S(+++) | Leaf | Latex | Rubbing | Skin diseases |
| **Anacardiaceae** | | | | | | |
| *Pistacia atlantica* Desf (LB-22) | Btem, Ijj | S(+) | Leaf, Seed | Decoction | Oral | Gastroenteritis, violent diarrhea. |
| | | | Bark | Decoction | Oral | Rheumatism |
| *Pistacia lentiscus* L. (LB-23) | Drou, Tidejt | S(+++) | Leaf | Decoction | Oral | Gastrointestinal diseases |
| | | | Bark | Decoction | Bain | Fever |
| **Apiaceae** | | | | | | |
| *Amni visnaga* (L) Lam. (LB-29) | Bachnikha | S(+++) | Whole | Decoction | Oral | Kidney diseases, hypertension |
| | | | Umbel | Brut | Rubbing | Cleaning teeth |
| | | | Fruit | Decoction | Oral | Cough, asthma, angina, |
| *Anethum graveolens* L. (LB-30) | Essnout, kemmun | S(+++) | Leaf, Seed | Decoction | Oral | Carminative |
| *Apium graveolens* L. (LB-31) | Krafss | C(+++) | Leaf | Infusion | Oral | Kidney stones, insomnia |
| *Carum carvi* L. (LB-28) | Karwiya | S(+++) | Seed | Decoction | Oral | Aperitif, stomachic, carminative |
| *Coriandrum sativum* L. (LB-24) | Kossbor | C(+++) | Seed, Leaf | Decoction | Oral | Kidney stones, insomnia, intestinal pains, diabetes |
| *Daucus carota* L. (LB-25) | Khizou, Safrane | C(+++) | Seed | Decoction | Oral | Stomach disorders |
| *Ferula communis* L. (LB-26) | Besbass hrami | S(+++) | Whole | Decoction | Oral | Antispasmodic, vermifuge, articular pains |
| *Foeniculum vulgare* Mill. (LB-27) | Nafae | C(++) | Seed | Decoction | Oral | Antispasmodic, stomachic, diuretic |
| *Petroselinum crispum* Mill. (LB-32) | Maadnouss | C(+++) | Leaf, Seed | Infusion | Oral | Jaundice, cough, asthma |
| **Apocynaceae** | | | | | | |
| *Nerium oleander* L. (LB-33) | Dafla, Alili | S(+++) | Leaf | Decoction | Outer | Diabetes, eczyma |
| **Araliaceae** | | | | | | |
| *Hedera helix* L. (LB-34) | Louwaya, Tamnayt | S(+++) | Leaf | Decoction | Oral | Antispasmodic, hemolytic. |
| | | | | Ointment | Outer | Scar wounds, antiulcerous, skin diseases |
| **Asteraceae** | | | | | | |
| *Anacyclus pyrethrum* L. (LB-35) | Aka, quarha, Taguendest | S(+) | Root | Infusion | Oral | Women's infertility, asthma. |
| | | | | Powder | Smoking | Nasal congestion teeth pains |
| **Asteraceae** | | | | | | |
| *Artemesia absinthium* L. (LB-36) | Chiba | C(+++) | Leaf | Infusion | Oral | Stomachic pain, tonic, aperitif, digestive |
| *Calendula aegyptiaca* Desf. (LB-37) | Azwiwel | S(+++) | Flower | Compress | Outer | Skin diseases, wounds, sunburn |
| | | | | Infusion | Oral | Ulcerous, digestive system |
| *Centaurea cyanus* L. (LB-45) | Chouk mghila | S(+++) | Flower | Infusion | Oral | Kidney stones, digestive system |
| *Chamaemelum mixtum* L. (LB-39) | Babounje roumi | C(+) | Capitula | Infusion | Oral | Headache, jaundice, digestive disease, cramp |
| *Cynara scolymus* L. (LB-38) | Khorshef | C(+++) | Leaf, Stem | Decoction | Oral | Choleretic, diabetes |
| *Echinops spinosus* L. (LB-40) | Shouk-lahmir, Taskera | S(+++) | Leaf, Stem, | Decoction | Oral | Diuretic, depurative, laxative |
| *Inula viscosa* L. (LB-41) | Tarrahla | S(+++) | Leaf, Flower | Decoction | Oral | Bronchitis, tuberculosis, anaemia |
| | | | Seed, Root | Decoction | Oral | Fattening |
| *Lactuca serriola* L. (LB-43) | Dafla,sahrawia, Assafar n'ssem | S(+++) | Leaf | Infusion | Oral | Antidote, intestinal colic |
| *Lactuca sativa* L. (LB-44) | Elkhass | C(+++) | Leaf | Brut | Oral | Impotence |

**Table 1. Continued.**

| Scientific name (Voucher specimen) | Vernacular name | Ecology | Part used | Preparation | Administration | Medicinal use |
|---|---|---|---|---|---|---|
| *Silybum marianum* (L.) Gaertn.(LB-42) | Shouk ejjmal, Tawra | S(+++) | Leaf, Seed | Decoction | Oral | Gallbladder, heart, blood pressure |
| | | | Leaf | Powder | Outer | Burn |
| *Taraxacum officinale* L. (LB-46) | Snan sbaâ | S(+++) | Leaf, Flower | Infusion | Oral | Depurative, laxative, diuretic, tonic |
| **Brassicaceae** | | | | | | |
| *Erysimum vulgare* L. (LB-60) | Khili | S(+++) | Leaf, Flower | Decoction | Oral | Balsamic |
| **Borraginaceae** | | | | | | |
| *Echium vulgare* L. (LB-62) | Lessan le-beger | S(+++) | Leaf | Infusion | Oral | Depurative |
| | | | Flower | Infusion | Oral | Balsamic |
| | | | Seed | Infusion | Oral | Lactogen |
| **Cactaceae** | | | | | | |
| *Opuntia ficus indica* Mill. (LB-63) | El handia | S(+++) | Latex | Ointment | Rubbing | Skin disease |
| | | C(+++) | Flower | Powder | Oral | Stomachic pain |
| **Capparidaceae** | | | | | | |
| *Capparis spinosa* L. (LB-64) | Kabbar | S(++) | Flower, Fruit | Maceration | Oral | Rheumatism |
| **Caryophylaceae** | | | | | | |
| *Corrigiola telephiifolia* Pour. (LB-65) | Sarghina, Taousserghin | S(++) | Root | Decoction | Oral | Pulmonary disease |
| | | | | Decoction | Cleaning | Hair care |
| | | | | Fumigation | Inhalation | Magic |
| *Herniaria hirsuta* L. (LB-66) | Harrast lhjar | S(+++) | Leaf | Decoction | Oral | Diuretic, kidney stones |
| *Saponaria officinalis* L. (LB-67) | Tighicht, Tighighicht | S(++) | Rhizome | Decoction | Oral | Detersive, balsamic |
| *Sambucus nigra* L. (LB-68) | Oud lkalb | S(+++) | Flower | Infusion | Oral | Stimulant, purgative |
| | | | Fruit, Bark | Infusion | Oral | Laxative, sudorific, diuretic |
| **Chenopodiaceae** | | | | | | |
| *Chenopodium Ambrosioides* L. (LB-69) | Mkhinza | S(+) | Leaf | Decoction | Oral | Headache, febrifuge |
| **Convolvulaceae** | | | | | | |
| *Convolvulus arvensis* L. (LB-70) | Ellouwaya, Tamnayt | S(++) | Rhizome, flower | Infusion | Oral | Purgative, balsamic, asthma |
| **Crucifereae** | | | | | | |
| *Brassica oleracea* L. (LB-73) | Krombe, Mkaouar | C(+++) | Leaf | Decoction | Oral | Anaemia, kidney disease |
| *Raphanus sativus* L. (LB-71) | Lafjal | C(+++) | Rhizome | Brut | Oral | Intestinal disorders |
| *Sinapis arvensis* L. (LB-72) | Bouhamou | S(+++) | Seed | Decoction | Oral | Antibiotic, hypotensive |
| **Cucurbitaceae** | | | | | | |
| *Bryonia dioica* L. (LB-47) | Ellouwaya | S(+++) | Root | Decoction | Oral | Bronchitis, pneumonia, rheumatism |
| *Cucurbita pepo* L. (LB-74) | Garaa hamra, Taghsait | C(+++) | Seed | Brut | Oral | Vermifuge, diuretic |
| *Lagenaria siceraria* Mol. (LB-75) | Garaa slaoui, Taghsait | C(+++) | Seed | Brut | Oral | Vermifuge, vomitive |
| **Cupressaceae** | | | | | | |
| *Juniperus communis* L. (LB-49) | Taqqa | S(++) | Fruit | Infusion | Oral | Diuretic, digestive |
| | | | Leaf | Infusion. | Oral | Hemorrhoid, abortive |
| *Cupressus sempervirens* L. (LB-50) | Srou, blinz | C(+++) | Fruit | Infusion. | Oral | Hemorrhoid |
| *Tetraclinis articulata* Masters. (LB-48) | Aaraar | C(++) | Leaf | Fumigation | Inhalation | Magic |

**Table 1. Continued.**

| Scientific name (Voucher specimen) | Vernacular name | Ecology | Part used | Preparation | Administration | Medicinal use |
|---|---|---|---|---|---|---|
| **Dipsacaceae** | | | | | | |
| *Knautia arvensis* L. (LB-80) | Onk el hajla | S(+++) | Leaf | Decoction | Oral | Dermal disease, eczema |
| **Ericaceae** | | | | | | |
| *Arbutus unedo* L. (LB-81) | Sassnou | S(+) | Leaf | Decoction | Oral | Kidney disease |
| | | | Fruit | Brut | Oral | Diarrhea, diabetes |
| **Euphorbiaceae** | | | | | | |
| *Euphorbia helioscopia* L. (LB-82) | | S(+++) | Root | Infusion | Oral | Purgative, vomitive |
| **Fabaceae** | | | | | | |
| *Anagyris foetida* L. (LB-84) | Kharroub el Khanzir | S(+++) | Leaf | Powder | Topical | Headache, antitumor, oedema |
| *Calicotome villosa* (Poir.) Link (LB-134) | Gandoul | S(++) | Leaf | Powder | Topical | Scar wound |
| | | | Root | Decoction | Oral | Anti-rheumatic |
| *Ceratonia siliqua* L. (LB-85) | Kharoub, Tichit | S(+++) | Leaf | Decoction | Oral | Vermifuge |
| | | C(++) | Fruit | Brut | Oral | Digestive, antidiarrhoea |
| *Cicer arietinum* L. (LB-83) | Hamousse, Himze | C(+++) | Seed | Brut | Oral | Diarrhoea |
| *Lotus corniculatus* L. (LB-88) | Fessa lakhla | S(+++) | Flower | Decoction | Oral | Insomnia |
| *Phaseolis vulgaris* L. (LB-87) | Loubia | C(+++) | Clove | Decoction | Oral | Diabetes |
| *Pisum sativum* L. (LB-89) | Jalbane | C(+++) | Seed | Brut | Oral | Laxative |
| *Quercus rotundifolia* L. (LB-86) | Kerrouch, Akhlij | S(+++) | Bark | Infusion | Oral | Scar wound, Hemorrhoid, Diarrhoea |
| *Trigonella foenum graecum* L. (LB-90) | Halba, afidas | C(+) | Seed | Decoction | Oral | Aperitif, fattening, lactogen, diabetes |
| *Vicia sativa* L. (LB-91) | Jelbanlakhla,Thabaoucht | S(+++) | Leaf | Infusion | Oral | Rheumatism |
| | | | Seed | Infusion | Oral | Smallpox, measles |
| *Medicago sativa* L. (LB-92) | Fessa | C(+++) | Seed | Powder | Oral | Scurvy |
| **Geraniaceae** | | | | | | |
| *Pelargonium odoratissimum* L. (LB-12) | Leâtarcha | C(+) | Flower | Infusion | Oral | Balsamic |
| **Globulariaceae** | | | | | | |
| *Globularia alypum* L. (LB-13) | Ain larnab, Tasslgha | S(+) | Whole | Decoction | Oral | Diarrhea, antiseptic |
| **Graminaceae** | | | | | | |
| *Agropyron repens* (L.) (LB-14) | Njem, Affar | S(+++) | Rhizome | Decoction. | Oral | Kidney disease, gout, rheumatism |
| *Beta vulgaris* L. (LB-15) | Barba | C(+++) | Tuber | Jus | Oral | Expectorant |
| *Cynodon dactylon* (L.) Pers. (LB-16) | Njem | S(+++) | Rhizome | Decoction | Oral | Kidney stones, balsamic, asthma, |
| *Hordeum vulgare* L. (LB-17) | Chiir, Thimzine | C(+++) | Seed | Dough | Oral | Gastroenteritis |
| *Zea mays* L. (LB-18) | Dra | C(+++) | Seed | Decoction | Oral | Kidney disease, diabetes |
| **Juglandaceae** | | | | | | |
| *Juglans regia* L. (LB-19) | Gergaa | C(++) | Leaf, stem | Brut | Rubbing | Cleaning teeth |
| **Juncaceae** | | | | | | |
| *Juncus acutus* L. (LB-20) | Assmar, Azlef | S(++) | Latex | Ointment | Topical | Dermal disease |
| **Lamiaceae** | | | | | | |
| *Ajuga iva* L. (LB-76) | Chandgoura, Touftalba | S(+++) | Whole | Powder | Fumigation | Psychic disease |

**Table 1. Continued.**

| Scientific name (Voucher specimen) | Vernacular name | Ecology | Part used | Preparation | Administration | Medicinal use |
|---|---|---|---|---|---|---|
| | | | Leaf | Infusion | Oral | Diabetes, cancer, asthma, rheumatism |
| | | | Stem | Infusion. | Oral | Digestive disorders, hypertension |
| *Calamintha officinalis* Moench (LB-77) | Mentha | S(+++) | Leaf, Stem | Infusion | Oral | Febrifuge, cough |
| *Lavandula stoechas* L. (LB-95) | El halhal, Amezzour | S(+++) | Flower | Decoction | Oral | Stomach colic, diabetes |
| *Lavandula multifida* L. (LB-96) | Kohayla, Iggiz | S(+++) | Flower | Decoction | Oral | Kidney disease and stones, cough |
| | | | | Powder | Topical | Suppleness and brilliance of hair |
| *Lavandula officinalis* L. (LB-97) | Khzama | C(+) | Flower | Distillation | Topical, Oral | Cosmetic, hypertension |
| *Marrubium vulgare* L. (LB-01) | Mriwa, Marrioute | S(+++) | Leaf, Flower | Decoction | Oral | Intestinal colic, cough, hypertension |
| | | | Flower | Powder | Topical | Ear infection, hemorrhoid |
| *Mentha pulegium* L. (LB-02) | Fliyou, Tafliout | S(+++) | Leaf, Stem | Infusion | Oral | Balsamic, expectorant |
| *Mentha rotundifolia* Muds. (LB-03) | Mchichtrou, Timarssad | S(+++) | Leaf, Stem | Infusion | Oral | Colic, anti-diarrhoeal |
| *Mentha viridis* L. (LB-04) | Naanaa Roumi | C(+++) | Leaf, Stem | Infusion | Oral | Nervous disorders, tiredness, indigestion |
| *Melissa officinalis* L. (LB-05) | Hbika | C(+++) | Leaf | Infusion | Oral | Stomachic, sedative, antispasmodic |
| *Mentha spicata* L. (LB-06) | Naanaa | C(+++) | Leaf, Stem | Infusion | Oral | Digestive disorder, antispasmodic |
| *Ocimum basilicum* L. (LB-07) | Lahbak | C(++) | Seed | Decoction | Oral | Hemorrhoid, heart disease |
| *Origanum majorana* L. (LB-08) | Mardadouch, Mloul | C(+) | Leaf, Stem | Infusion | Oral | Tranquilizer, spasmodic cramp |
| *Origanum vulgare* L. (LB-09) | Zaatar, Tazoukenite | S(+++) | Leaf, Stem | Infusion | Oral | antidiabetic, anti-diarrhoeal, antispasmodic |
| *Rosmarinus officinalis* L. (LB-93) | Iklil jbal, Assir | S(++)C(+) | Leaf | Infusion | Oral | Gastric disease, diuretic |
| | | | | Decoction | Oral | Febrifuge, cool, stomach colic |
| *Salvia officinalis* L. (LB-94) | Salmia, Touyaafit | C(+++) | Leaf | Infusion | Oral | Cool, rheumatic, cough |
| *Teucrium polium* L. (LB-78) | El khayata, Jaadia, Tayrart | S(+++) | Flower | decoction | Oral | Articular pains, antidote |
| *Thymus vulgaris L.* (LB-79) | Ziitra, Tazoukenit | S(+++) | Leaf, Stem | Infusion | Oral | Hearth and digestive system diseases, |
| **Lauraceae** | | | | | | |
| *Laurus nobilis* L. (LB-98) | Wrak sidna moussa | C(+) | Leaf | Infusion | Oral | Stomachic, sudorific |
| **Liliaceae** | | | | | | |
| *Allium sativum* L. (LB-99) | Touma, Thichert | C(+++) | Bulb | Brut | Rubbing | Hair strengthening, snake-bites |
| | | | | Infusion. | Oral | antihypertensive |
| *Allium cepa* L. (LB-121) | Bassla, Azalim | C(+++) | Bulb | Heating | Poultice | Abscess |
| *Asparagus officinalis* L. (LB-122) | Sekoum, Tazzout | S(+++) | Root | Decoction | Oral | Spermatogenesis, jaundice, kidney stones |
| | | | Seed | Decoction | Oral | Hemorrhoid |
| *Urginea maritima* (L.) Baker (LB-123) | Bassla lkalb | S(+++) | Bulb | Decoction | Oral | Diuretic, cardiotonic |
| | | | | Powder | Topical | Rheumatism, tumor |
| **Malvaceae** | | | | | | |
| *Althaea officinalis* L. (LB-124) | Khobaiza, Tibinsert | S(++) | Root | Decoction | Oral | Gastro-intestinal disease, kidney disease |
| *Malva parviflora* L. (LB-125) | Bakoula, Thibi | S(+++) | Leaf | Infusion | Oral | Emollient, laxative |
| *Malva sylvestris* L. (LB-126) | Bakoula, Thibi | S(+++) | Leaf, Flower | Infusion | Oral | Digestive, diuretic, laxative, Emollient |
| **Myrtaceae** | | | | | | |
| *Eucalyptus globulus* Labill. (LB-127) | Kalitus | C(+) | Leaf | Fumigation | Inhalation | Cough, flu |
| | | | Leaf | Infusion | Oral | Balsamic, expectorant |

**Table 1. Continued.**

| Scientific name (Voucher specimen) | Vernacular name | Ecology | Part used | Preparation | Administration | Medicinal use |
|---|---|---|---|---|---|---|
| **Moraceae** | | | | | | |
| *Ficus carica* L. (LB-128) | Karmouss, Tazart | C(+++) | Seed | Decoction | Oral | Diuretic, digestive aid |
| *Morus alba* L. (LB-129) | Toutt chajar | S(++) | Fruit | Brut | Oral | Laxative, emollient, depurative, diuretic |
| **Oleaceae** | | | | | | |
| *Fraxinus excelsior* L. (LB-130) | Dardar, Touzalt | S(++) | Whole | Infusion | Oral | Diuretic, laxative, tonic, aphrodisiac, febrifuge |
| *Olea europeae* L. (LB-131) | Zaithoune | C(+++) | Leaf | Decoction | Oral | Diabetes, hypertension |
| | | | Fruit | Oil | Oral | Panacea |
| **Palmaceae** | | | | | | |
| *Chamaerops humilis* L. (LB-133) | Doum, Igzdem | S(++) | Leaf, Fruit | Decoction | Oral | Gallstones, hepatic disease, diabetes |
| **Papaveraceae** | | | | | | |
| *Papaver rhoeas* L. (LB-51) | Bennaaman | S(+++) | Petal | Distillation | Topical | Febrifuge |
| | | | | | Oral | Emollient, febrifuge |
| *Papaver somniferum* L (LB-52) | Khoch Khach, Tilidout | S(++) | Flower | Infusion | Oral | Insomnia, cough, headache |
| **Pinaceae** | | | | | | |
| *Pinus halepensis* Mill. (LB-53) | Sanawbar, Tayda | C(+++) | Leaf | Decoction | Oral | Antiulcerous |
| | | | Bark | Decoction | Topical | Dermal disease |
| **Plantaginaceae** | | | | | | |
| *Plantago major* L. (LB-10) | Rejel el ghrab | S(+++) | Whole | Decoction | Oral | Diuretic, insecticide, scar wound |
| *Plantago coronopus* L. (LB-11) | | S(+++) | Whole | Decoction | Oral | Bronchitis, asthma, tonsillitis |
| **Polygonaceae** | | | | | | |
| *Rumex acetosa* L. (LB-132) | Hmaida, Tassmamt | S(+++) | Leaf, Stem | Infusion | Oral | Constipation, hepatic disease |
| **Portulacaceae** | | | | | | |
| *Portulaca oleracea* L. (LB-54) | Rajla, Arghlim | S(+++) | Leaf | Infusion | Oral | Laxative, emollient, depurative, diuretic |
| **Punicaceae** | | | | | | |
| *Punica granatum* L. (LB-55) | Remane | C(+++) | Fruit | Powder | Oral | Diabetes, digestive disorders |
| **Rutaceae** | | | | | | |
| *Citrus limon* (L.) Burm. (LB-56) | El hamed | C(+++) | Fruit | Brut | Poultice | Cephalic, febrifuge |
| *Citrus aurantium* L. (LB-57) | Ronge | C(+++) | Flower | Juice | Topical | Cosmetic |
| | | | | | Oral | Febrifuge, tranquilizer |
| *Ruta chalepensis* L. (LB-58) | Fijel, Iouermi | S(+++) | Leaf | Fumigation | Smoking | Magic, headache |
| | | | Leaf | Juice | Topical | Ear pain |
| **Rosaceae** | | | | | | |
| *Crataegus laciniata* Ucr. (LB-61) | Admam | S(+) | Fruit, flower, | Raw/infusion | Oral | Cardiotonic, diuretic, vasodilator |
| *Crataegus monogyna* Jacq. (LB-59) | Admam | S(+) | Flower | Infusion | Oral | Heart, sedative |
| *Eriobotria japonica* (Thunb.) (LB-100) | Mzah | C(++) | Leaf | Decoction | Oral | Diabetes |
| *Fragaria vesca* L. (LB-101) | Toutt el Ard | C(+) | Rhizome | Decoction | Oral | Anti-diarrhoeal, antiseptic |
| **Rosaceae** | | | | | | |
| *Prunus cerasrus* L (LB-102) | Hab mllouk | C(++) | Stalk | Decoction | Oral | Refreshing drink |

**Table 1. Continued.**

| Scientific name (Voucher specimen) | Vernacular name | Ecology | Part used | Preparation | Administration | Medicinal use |
|---|---|---|---|---|---|---|
| *Prunus dulcis* (Mill.) (LB-103) | Ellouz | C(+++) | Fruit | Oil | Topical | Cutaneous Inflammation |
| *Rubus ulmifoluis* Schott (LB-104) | Touth zerb, Tabgha | S(+++) | Leaf, fruit | Maceration | Oral | Diabetes, diarrhoea, digestive disease |
| *Rosa canina* L. (LB-105) | El ward roumi | S(+++) | Leaf, fruit | Maceration | Oral | Hematinic, diuretic |
| *Rosa centifolia* L. (LB-106) | El Ward baldi | C(+) | Petal | Infusion | Oral | Diarrhoea, febrifuge |
| **Rhamnaceae** | | | | | | |
| *Ziziphus lotus* Desf. (LB-107) | Cedra, Azougar | S(+++) | Fruit | Brut | Oral | Gastric disorder, diabetes, tonic |
| **Ranunculaceae** | | | | | | |
| *Adonis annua* L. (LB-108) | Demm laatrouss, Tagnanast | S(+++) | Whole | Infusion | Oral | Heart, diuretic, hearth, jaundice |
| *Adonis aestivalis* L. (LB-109) | Demm laatrouss, Tagnanast | S(++) | Whole | infusion | Oral | Emmenagogue, diuretic, febrifuge |
| **Salicaceae** | | | | | | |
| *Populus alba* L. (LB-110) | Safssaf | S(+++) | Leaf | Decoction | Oral | Gastro-intestinal disorder |
| **Synanthereae** | | | | | | |
| *Atractylis gummifera* L. (LB-111) | Chouk Alk, Addad | S(+++) | Leaf | Decoction | Oral | Kidney stone |
| | | | Root | Decoction | Oral | Abortive |
| | | | | Powder | Fumigation | Insecticide, rheumatism, articular pains |
| **Scrophylariaceae** | | | | | | |
| *Verbascum thapsus* L. (LB-112) | Msslah ndar | S(++) | Flower | Decoction | Oral | Diarrhoea, cramp |
| | | | Root | Powder | Topical | Inflammation eyes |
| **Solanaceae** | | | | | | |
| *Solanum nigrum* L. (LB-113) | Ainab dibb, Adil ouchen | S(+++) | Whole | Poultice | External | Tranquilizer, dermal disease |
| *Datura stramonium* L. (LB-114) | Chdaq-jmel, Tabourzigt | S(+++) | Seed | Brut | Fumigation | Hypnotic |
| **Thymeleaceae** | | | | | | |
| *Daphne gnidium* L. (LB-115) | Allezaz | S(++) | Leaf | Powder | Topical | Hair care and strengthening |
| **Tropaeolaceae** | | | | | | |
| *Tropaeolum majus* L. (LB-116) | Hkum | C(++) | Flower | Infusion | Oral | Bronchitis, balsamic |
| **Urticaceae** | | | | | | |
| *Urtica dioica* L. (LB-117) | Hraika, Tizerchmaz | S(+++) | Seed, Root | Decoction | Oral | Kidney disease, digestive, diabetes |
| **Verbenaceae** | | | | | | |
| *Aloysia triphylla* Britt. (LB-118) | Louiza | C(+++) | Leaf | Infusion | Oral | Antihypertensive, flatulence |
| **Vitaceae** | | | | | | |
| *Vitis vinifera* L. (LB-119) | El inab, Adil | C(++) | Leaf | Infusion | Oral | Venous blood vessel |
| **Zygophylaceae** | | | | | | |
| *Peganum harmala* L. (LB-120) | Harmel | S(++) | Seed | Decoction | Oral | Asthma, indigestion, diabetes, hypertension |

S, spontaneous; C, cultivated; +++, very abundant; ++, moderate; +, scarce.

In Sefrou city, the majority of the families interviewed used the plants for medicinal purposes. The empirical use of folk medicine is transmitted orally from one generation to another. Except in some urban places, no stores or shops are selling medicinal plants; the plants are collected, for folk medicine, in open areas and fields. More than 75 percent of the people in Sefrou province rely on folk medicine as a principal means of preventing and curing illnesses, and several traditional medical systems are based on the use of plants. There are several advantages to such systems: the plants involved are readily available, are easy to transport, and do not spoil quickly. Remedies based on these plants often have minimal side effects, and the relatively high cost of synthetic medicines in rural communes often makes traditional herbal medicines an affordable choice for the poor in these districts. Although modern medicine is available in some municipalities, it is usually inaccessible to the majority of people except in serious emergencies.

Often, people use more than one plant either separately or mixed. The plant products are consumed raw or in the form of a decoction, macerated material, or as an infusion for oral treatment, and as burnt products, ointments, or raw paste when applied externally.

During the field study, 134 plant species belonging to 52 families announced to be used for 104 therapeutic indications were inventoried and identified botanically (Table 1). Among the plants inventoried, 82 (61%) are wild species, 49 (36%) are cultivated and 4 (3%) are cultivated as well as spontaneous. Most of these plants are common and widespread and their medicinal uses have previously been reported in other inquiries undertaken in some Moroccan regions [15–18]. Of the 52 plant families spreading across the province, five are the most representative (58%): *Lamiaceae* (14%), *Asteraceae* (9%), *Fabaceae* (8%), *Apiaceae* (7%), and *Rosaceae* (6%).

Classification of our medicinal plants into various groups according to disease groups shows that local pharmacopeia used 114 different therapeutic indications (Table 2). The plants have a wide activity spectrum; they act as an aperitif, aphrodisiac, carminative, emmenagogue, emollient, diuretic, detersive, expectorant, febrifuge, lactogen, laxative, vermifuge, antihypertensive, antidiabetic, etc. However, the major treated illnesses are digestive disorders (19 plants), renal disease (27 plants), bronchopulmonary problems (7 plants), skin disease (13 species), diabetes (13 plants), cardiovascular disorders (13 plants) eye, ear, nose, teeth and throat diseases (5 plants); gynecological diseases (6 plants); rheumatic and gnawing pain (11 plants). It is worthy of note that diuretic, antihypertensive, and antidiabetic activities of the claimed therapeutic indications in empirical use have been widely investigated and some of them have been demonstrated to be such by experimental studies. Many antidiabetic plants exhibited in the present compilation have proven to have such property in preclinical and clinical studies such as *Ajuga iva*, *Ammi visnaga*, *Coriandrum sativum*, *Lavandula stoechas*, *Nerium oleander*, *Olea europea*, *Peganum harmala*, *Trigonella foenum-graecum* [19–25].

In addition, the antihypertensive activity of some plants included in the synoptic table has also been demonstrated. For instance, *Ajuga iva* [26], *Allium sativum* [27], *Coriandrum sativum* [28], *Marrubium vulgare* [29], *Olea europea* [30], *Peganum harmala* [31], *Rosmarinus officinalis* [32], *Urtica dioica* [33].

Moreover, the diuretic activity of some species reported in the present survey has been experimentally confirmed such as *Coriandrum sativum* [34], *Lavandula stoechas*, *Lavandula officinalis* [35], *Urtica dioica* [36], *Rosmarinus officinalis* [36], *Foeniculum vulgare* [37].

It seems that local pharmacopeia is well aware of some diseases than others such as renal, skin, and digestive disorders which are treated by many plants. This case can be linked to the high rate of these diseases among the population. These kinds of diseases are predominant in developing countries and are generally generated by the lifestyle of the population and the poor quality of water and alimentation.

### *3.2 Screening Aspect*

The results of the screening showed that most of the plants dose-dependently inhibited the contraction induced by noradrenaline and high $K^+$. Most of the plants tested in this study were found to be more sensitive to relaxing contractions induced by noradrenaline (Table 3).

Table 3 represents those plants that were selected based on their traditional use. Out of the 32 plant samples, 14 (43.75%) gave more than 50% inhibition of contraction, while 9 out of the 20 (45%) plant samples selected due to a close relationship with traditionally used plants, gave more than 50% inhibition of contraction. This small difference in positive hits shows the relevance of testing species closely related to traditionally used plants or plants used as substitutes. In total, 20 species out of 32 (62.5%) screened, are used in the traditional system of medicine in this region of study.

As far as possible, the traditionally used part of the plant was employed for the screening. However, in certain cases, other parts were also tested.

Values in the same column followed by different letters are significantly different by Tukey's multiple range test ($p < 0.05$).

The vasorelaxant activity of the plants used for the screening was mostly inhibited by pre-treatment with L-NOArg (Table 4).

Species resulting in a high vasorelaxant activity and with a reported hypotensive/cardiovascular activity are *Amni visnaga* and *Crataegus laciniata*, besides the different mechanisms reported, these results indicate that vasodilator activity may be an alternative mechanism leading to the hypotensive activity of these two species.

The cumulative additions of the aqueous extracts from

**Table 2. Relationships between medicinal plants and main therapeutic indications.**

| Main therapeutic indications | Number of citation | Percentage (%) |
|---|---|---|
| Anti-diabetic and hypoglycaemic | 13 | 11.4 |
| Antirheumatismal | 11 | 9.64 |
| Bronchopulmonary system | 7 | 6.14 |
| Digestive pathology | 19 | 16.66 |
| Gynecologic pathology | 6 | 5.26 |
| Mouth, dental hygiene, and ophthalmic disease | 5 | 4.38 |
| Renal pathology | 27 | 23.68 |
| Skin diseases | 13 | 11.4 |
| Vascular system disorders | 13 | 11.4 |
| Total | 114 | |

**Table 3. The relaxing activity of the screening plants against the contraction induced by noradrenaline and high $K^+$.**

| Plants | Maximal relaxation (%) | |
|---|---|---|
| | Noradrenaline | KCl |
| -*Agropyron repens* L. | $38 \pm 9^{m}$ | $15 \pm 7^{m}$ |
| -*Aloysia triphylla* Britt. | $12 \pm 9^{x}$ | No effect |
| -*Amni visnaga (L)* Lam. | $67 \pm 6^{d}$ | $58 \pm 17^{a}$ |
| -*Anacyclus pyrethrum* L. | $80 \pm 4^{a}$ | $52 \pm 4^{b}$ |
| -*Apium graveolens* L. | $27 \pm 9^{s}$ | No effect |
| -*Artemesia absinthium* L | $11 \pm 5^{y}$ | No effect |
| -*Atractylis gummifera* L | $26 \pm 8^{t}$ | No effect |
| -*Brassica oleracea* L | $22 \pm 11^{u}$ | No effect |
| -*Capparis spinosa* L | $58 \pm 9^{g}$ | $35 \pm 11^{g}$ |
| -*Centaurea cyanus* L | $52 \pm 9^{i}$ | $21 \pm 8^{j}$ |
| -*Ceratonia siliqua* L | $35 \pm 4^{p}$ | $18 \pm 9^{l}$ |
| -*Chamaemelum mixtum* L | $26 \pm 8^{t}$ | $15 \pm 7^{m}$ |
| -*Chenopodium Ambrosioides* L | No effect | No effect |
| -*Corrigiola telephiifolia* Pour | $29 \pm 6^{r}$ | $10 \pm 9^{p}$ |
| -*Crataegus laciniata* Ucr. | $74 \pm 12^{b}$ | $47 \pm 10^{c}$ |
| -*Cynodon dactylon* (L) Pers | $40 \pm 8^{l}$ | $38 \pm 7^{e}$ |
| -*Echinops spinosus* L. | $38 \pm 5^{m}$ | $21 \pm 8^{j}$ |
| -*Ficus carica* L. | $56 \pm 7^{h}$ | $40 \pm 9^{d}$ |
| -*Herniaria hirsuta* L. | $63 \pm 8^{e}$ | $59 \pm 10^{a}$ |
| -*Juniperus communis* L. | $61 \pm 12^{f}$ | $45 \pm 14^{c}$ |
| -*Lavandula multifida* L. | $59 \pm 12^{g}$ | $40 \pm 8^{d}$ |
| -*Lavandula officinalis* L. | $69 \pm 7^{c}$ | $37 \pm 9^{f}$ |
| -*Lavandula stoechas* L. | $49 \pm 16^{j}$ | $27 \pm 5^{h}$ |
| -*Mentha pulegium* L. | $51 \pm 4^{j}$ | $24 \pm 8^{i}$ |
| -*Morus alba* L. | $37 \pm 8^{n}$ | $20 \pm 6^{k}$ |
| -*Pistacia atlantica* Desf. | $15 \pm 7^{w}$ | No effect |
| -*Plantago major* L. | $20 \pm 9^{v}$ | No effect |
| -*Sambucus nigra L.* | $42 \pm 12^{j}$ | $13 \pm 8^{o}$ |
| -*Sinapis arvensis L.* | $52 \pm 8^{k}$ | $37 \pm 9^{f}$ |
| -*Rubus ulmifoluis* Schott | $33 \pm 8^{q}$ | $14 \pm 10^{n}$ |
| -*Thymus vulgaris* L. | $63 \pm 8^{e}$ | $60 \pm 9^{a}$ |
| -*Zea mays* L. | $36 \pm 4^{o}$ | $14 \pm 3^{n}$ |

Values in the same column followed by different letters (a–y) are significantly different by Tukey's multiple range test ($p < 0.05$).

**Table 4. The vasorelaxant activity of the plants used for the screening with and without L-NOArg.**

| Plants | Maximal relaxation (%) | |
|---|---|---|
| | Without L-NOArg | With L-NOArg |
| -*Amni visnaga* (L) Lam. | $67 \pm 6^{d}$ | $35 \pm 7^{g}$ |
| -*Anacyclus pyrethrum* L. | $80 \pm 4^{a}$ | $56 \pm 6^{a}$ |
| -*Capparis spinosa* L. | $58 \pm 9^{h}$ | $27 \pm 11^{j}$ |
| -*Centaurea cyanus* L. | $52 \pm 9^{j}$ | $24 \pm 6^{k}$ |
| -*Crataegus laciniata* Ucr. | $74 \pm 12^{b}$ | $41 \pm 5^{d}$ |
| -*Ficus carica* L. | $56 \pm 7^{i}$ | $31 \pm 6^{h}$ |
| -*Herniaria hirsuta* L. | $63 \pm 8^{e}$ | $44 \pm 8^{c}$ |
| -*Juniperus communis* L. | $61 \pm 12^{f}$ | $40 \pm 6^{e}$ |
| -*Lavandula multifida* L. | $59 \pm 12^{g}$ | $37 \pm 6^{f}$ |
| -*Lavandula officinalis* L. | $69 \pm 7^{c}$ | $31 \pm 8^{h}$ |
| -*Lavandula stoechas* L. | $49 \pm 16^{l}$ | $28 \pm 7^{i}$ |
| -*Mentha pulegium* L. | $51 \pm 4^{k}$ | $15 \pm 3^{m}$ |
| -*Sinapis arvensis* L. | $52 \pm 8^{j}$ | $23 \pm 4^{l}$ |
| -*Thymus vulgaris* L. | $63 \pm 8^{e}$ | $51 \pm 4^{b}$ |

Values in the same column followed by different letters (a–m) are significantly different by Tukey's multiple range test ($p < 0.05$).

*Anacyclus pyrethrum* and *Lavandula officinalis* induced the greatest relaxation (80 ± 4 against noradrenaline and 52 ± 4 against $K^+$; 69 ± 7 against noradrenaline and 37 ± 9 against $K^+$ respectively), whereas the antihypertensive activity of these plants is not evident from the literature. A similar observation was made for *Capparis spinosa* and *Lavandula officinalis*. These four species require further studies to understand the precise mode of action. The pharmacological activity of the other species in Table 3 implies that their effect on blood pressure and heart is probably not due to vasodilator activity; some of them have been demonstrated to possess vasodilator activity: *Apium graveolens* [38]; *Capparis spinosa* [39]; *Mentha pulegium* [40]; *Sambucus nigra* [41].

### 3.3 Economic Importance of the Medicinal Plant Sector

Provincial trade in medicinal plants both within Sefrou and other Moroccan regions is growing in economic importance. The plant medicinal sector is exploited by a network

**Table 5. The economic importance of medicinal flora of Sefrou province.**

| Specific name | Staggering of collection (month) | Part used | Quantity collected (q) | Selling price (Dh/Kg) | Productive value (Dh) ($\times 10^3$) |
|---|---|---|---|---|---|
| -*Ajuga iva* L | 4,5,6 | Whole | 4 | 20 | 8 |
| -*Aloysia triphylla* Britt | 5,6 | Leaf | 10 | 100 | 100 |
| -*Calamintha officinalis* Moench | 4,5 | Leaf | 4 | 40 | 16 |
| -*Mentha pulegium* L. | 6,7 | Whole | 14 | 25 | 35 |
| -*Origanum majorana* L. | 6,7,8 | Whole | 20 | 40 | 80 |
| -*Thymus vulgaris* L. | 6,7,8 | Whole | 5 | 70 | 35 |
| -*Rosmarinus officinalis* L. | 7,8 | Leaf | 6000 | 15 | 9000 |
| -*Tetraclinis articulata* Masters. | 6,7 | Leaf | 40 | 10 | 40 |
| -*Corrigiola telephiifolia* Pour. | 5,6 | Root | 2 | 40 | 8 |
| -*Peganum harmala* L | 6,7 | Fruit | 40 | 20 | 80 |
| -*Ruta chalepensis* L. | 5,6,7 | Leaf | 20 | 20 | 400 |
| -*Ceratonia siliqua* L. | 6,7 | Fruit | 3000 | 9 | 2700 |
| -*Citrus aurantium* L. | 5,6, | Flower | 30 | 25 | 75 |
| -*Daphne gnidium* L. | 4,5,6 | Leaf | 8 | 25 | 20 |
| -*Herniaria hirsuta* L. | 5,6,7 | Leaf | 2 | 20 | 4 |
| -*Lavandula stoechas* L. | 4,5,6 | Whole | 1 | 60 | 6 |
| -*Lavandula officinalis* L. | 4,5,6 | Whole | 60 | 80 | 480 |
| -*Marrubium vulgare* L. | 4,5,6 | Leaf | 1 | 60 | 6 |
| -*Trigonella foenum graecum* L. | 5,6,7 | Fruit | 60 | 15 | 90 |
| Total | | | | | 12.823 |

of collectors who were less willing to cooperate because they avoid taxes. The merchandise (plants and plant products) is purchased from farmers in the mountain regions at a very low price by retailers who sell with large profits to wholesalers. As depicted in Table 5, 14% of the plant inventoried are traded on a large scale and more than 90 percent of the medicinal plants purchased from Sefrou go to big cities for export, earning an estimated US$1,424,777 annually. The expansion of unregulated trade and commercial use of medicinal and aromatic plants poses a major threat to biodiversity in the region. Smugglers tend to collect the highest value or most popular plant species, leading to over-harvesting or species extinction. Furthermore, rising demand and a dramatic increase in the trade of medicinal plants attest to worldwide interest in these products as well as in traditional health systems. But with most of these plants being taken from the wild, hundreds of species are now threatened with extinction because of over-harvesting, destructive collection techniques, and conversion of habitats to crop-based agriculture. For instance, the plants with high yields in essential oils such as *Calamintha officinalis*; *Mentha pulegium*; *Origanum majorana*; *Thymus vulgaris*; *Rosmarinus officinalis*; *Lavandula stoechas*; *Lavandula officinalis* have recently become heavily traded and endangered species, these plants are also threatened by cutting and collecting techniques. They are avidly sought by industrial companies in the big towns. Large quantities of these plants are collected and exported annually, although their harvesting is illegal in the province.

Sefrou province occupies an important place in the national and international markets of medicinal and aromatic plants, thanks to its diversified and abundant production. For this reason, it is critical to safeguard endangered plants by trying to mitigate: (a) the increase in urbanization to the detriment of the natural environment, which leads to the degradation of biodiversity; (b) the overexploitation of rangelands owing to cattle overgrazing; (c) the irrational exploitation of aromatic and medicinal plants; (d) the illegal cutting of firewood; (e) the forest degradation due to fires; (f) urban and industrial pollution, and (g) strengthen the cultivation of medicinal and aromatic plants in this region such as *Lavandula officinalis*, *Rosa canina*, *Aloysia triphylla*, *Mentha spicata*, *Prunus cerasus*, *Ceratonia siliqua*, and *Olea europaea* [42,43].

## 4. Conclusions

In conclusion, the present study reveals the richness of Sefrou province in medicinal plants. The results indicate that 134 plant species from 52 families are used for 104 medicinal indications. In addition, the screening has confirmed alleged effects in terms of vasodilator activity for 44% of the examined species (32) prescribed in traditional medicine for hypertension, cardiac or renal disorders in Sefrou. These plants are: *Amni visnaga*, *Anacyclus pyrethrum*, *Capparis spinosa*, *Centaurea cyanus*, *Crataegus laciniata*, *Ficus carica*, *Herniaria hirsuta*, *Juniperus communis*, *Lavandula multifida*, *Lavandula officinalis*, *Lavandula stoechas*, *Mentha pulegium*, *Sinapis arvensis*, and *Thymus vulgaris*. Thus, the ethnobotanical approach defined in the introduction has proved quite fruitful. These

results also call for a closer study of the medicinal plant used by the population in this region of study and their effects pharmacologically.

The information gathered in this study may help to promote appropriate production and post-harvest technologies, marketing strategies, community-based enterprises, market information, dissemination systems, and appropriate policies to improve rural livelihood and reduce poverty in the province. In this context, the local authorities must collaborate in a study of forest resource management and its impact on the province's ecology and economy to explore the underlying causes of medicinal plant overexploitation and unsustainable management. Other goals are to identify actions needed to encourage sustainable management of medicinal plants that will help conserve biodiversity and to propose legal, policy, economic, social, technical, and institutional initiatives to mitigate overexploitation.

## Availability of Data and Materials

The data used to support the findings of this study are available from the corresponding author upon request.

## Author Contributions

BL designed the research study. BL and MB analyzed the data, did the statistical analysis, and wrote the manuscript. KCT contributed to the ethnobotanical survey and *in vitro* study. JEH and CH writing-review and editing. BL and CH submitted the manuscript. All authors read and approved the final manuscript.

## Ethics Approval and Consent to Participate

The care and handling of the animals used in this study followed the internationally accepted principles for laboratory animal use and care as found in for example the European Community guidelines (EEC Directive of 1986; 86/609/EEC). The protocol was approved by Sidi Mohamed Ben Abdellah University in Fez under the responsibility of the Laboratory of Natural Substances, Pharmacology, Environment, Modeling, Health, and Quality of life (SNAMOPEQ), Department of Biology, Faculty of Sciences Dhar EL Mahraz of Fez, Morocco(USMBA-SNAMOPEQ 2018-03).


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## Conflict of Interest

The authors declare no conflict of interest.

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