Insights and use of medicinal plants in relieving respiratory affections among students: A case study from Guelma district (Algeria)

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Research

Abstract

Background: In Algeria, respiratory disorders remain the main causes prompting medical attention. In recent years, there has been a growing interest in herbal remedies, which play an essential role in the treatment of this kind of disease. In this context, this study was conducted to examine the awareness and the use of medicinal plants to relieve respiratory symptoms among university students in Guelma district, in northeastern Algeria.

Methods: An ethnobotanical survey was conducted between December 2023 and May 2024 among 300 volunteered university students. The study explored students' individual experiences in using of medicinal plants to relieve respiratory diseases and the source of their knowledge. Rao-Scott χ^2 test and ethnobotanical parameters were used to analyze the data.

Results: Findings showed that over 96% of students use at least three medicinal plants to treat respiratory system ailments. No difference was registered between exogenous and endogenous knowledge sources. Students identified 33 medicinal plants species classified under 17 families. Myrtaceae and Lamiaceae exhibited the highest family importance values. *Syzygium aromaticum* (L.) Merr. & L.M.Perry (RFC=0.52; UV=38.8) and *Eucalyptus globulus* Labill. (RFC=0.42; UV=40.7) being the most frequently employed species. Strong agreement among students and absolute fidelity levels (FL=100%) were recorded for several species used to manage respiratory ailments.

Conclusions: The present study highlighted valuable information about students' ethnopharmacological knowledge. However, proper training in this field, as well as exploration of the bioactive molecules of the species mentioned and assessment of their safety, are necessary.

Keywords: Ethnobotanical data, Medicinal plants, Respiratory ailments, Students, Survey.

Background

Respiratory diseases are currently widespread due to challenging climate conditions and air pollution, both of which can enormously damage the respiratory system and weaken immunity (Akhtar *et al*. 2025). According to a recent report established by World Health Organization, chronic respiratory diseases are considered as the sixth cause of hospitalization and death, particularly among young population. In addition, acute respiratory illnesses remain high in many countries, which can rise pressure on health system (WHO 2025). Because of adverse effects of drugs and limited access to healthcare, particularly in developing countries, many people prefer to use traditional herbal treatments for numerous respiratory ailments, believing that medicinal plants are less harmful and more balanced (Akhtar *et al*. 2025).

Phytotherapy has been traditionally practiced in diverse cultural traditions to manage a variety of ailments, including diabetes, cardiovascular, and respiratory disorders. In recent years, the ethnomedicinal knowledge has steadily increased, and many modern medicines have been developed from natural herbs thanks to their rich content of phytochemicals (Mapunda & Mramba 2025). In Algeria, the use of medicinal plants is deeply rooted in its heritage. The variety of its pedoclimatic conditions has fostered the development of rich ethnobotanical traditions (Benchohra *et al*. 2025). Numerous surveys have explored ethnobotanical practices, reflecting the Algeria's ecological and cultural richness (Belhacini *et al*. 2024, Bensizerara *et al*. 2025, Bourouaha *et al*. 2025,). In recent times, many Algerian people have used various medicinal plants to relieve respiratory infections such as the common cold, influenza, and cough. This practice has gained increased importance since the emergence of the coronavirus (Ahmed-Gaid *et al.* 2025). However, there is a lack of published data on how medicinal plants are used to manage these health conditions among university students. Given that this category of population can play a crucial role in preserving and disseminating traditional knowledge of medicinal plants, thereby promoting their conservation and sustainable use.

Tian-Liang *et al.* (2025) reported that herbal medicines have been used frequently in rural and underdeveloped areas, and due to urbanization and availability of modern health facilities, many remedies are vulnerable of being lost. Furthermore, Gallois and Reyes-García (2023), demonstrate that the awareness about medicinal plant among younger generations remain unexplored, especially in ethnobiological studies. Therefore, conducting an ethnobotany survey to document knowledge about medicinal plant among younger population, particularly in urban areas, are crucial. In this context, the present study, carried out in an urban area, aims to examine, for the first time, the awareness of university students about the use of medicinal plants in relieving respiratory affections and the main ways of knowledge transmission. A quantitative analysis, supported by ethnobotanical indices were also used to document the cultural importance of plant species used by students in Guelma district.

Materials and Methods

Study area

The present study was carried out in Guelma city, which is located in northeastern Algeria (36°27′43″ N, 7°25′33″ E) (Fig. 1). Naturally, Guelma is surrounded by the mountains of Houara, Mahouna and Nador. It is an important part of the large Oued Seybouse watershed, which covers an area of 6 745 km^2, stretching from the Cheref-Bouhamdane confluence at Medjez Ammar in the northwest to the Nador hydrogeological threshold in the southeast. Guelma district is the largest urban center of the province, with an urbanization rate of 98%. The geological context of the study region is represented by mountainous and hilly relief forming the eastern end of the Constantine Mountains chain and the western foothills of the Medjerda chain. The rest of the relief is made up of plains and plateaus, hills and foothills (Guechi 2018). The climate of the area is sub-humid with an average annual precipitation range between 588 and 654 mm. The highest monthly temperature averages are observed during the summer period (July and August), with temperatures ranging from 27 to 35 °C. The cold season extends from November to April, with minimum temperatures varying between 8.24 and 8.57 °C in January and February. Because of its geographical position and the hydrographic profile of the area, Guelma is known for its vast biodiversity and agricultural practices. Cultivation is dominated by market gardening and a few citruses and fruit tree orchards (Baazi 2023).

Study population and data collection

This study included the students attending different grades of university (first, second, and third bachelor's, master's 1, and master's 2). In total, 300 students (110 boys and 190 girls) between 18 and 25 years old participated in the study. The survey was conducted between December 2023 and May 2024. After explaining our study's purpose to the students, an ethnobotanical survey was carried out by face-to-face interviews using a series of qualitative questionnaires. The questionnaire consisted of questions organized in two sections: The first section included participants' details (age, sex, academic level, students' general health status, sports activities, and parental social status) the second section concerned

the current use of plant remedies, for which respiratory ailments they were used, the plant parts used, their preparation and administration. Furthermore, the source of knowledge for each remedy was indicated in order to differentiate between endogenous sources (i.e., knowledge transmitted within the family members) and exogenous sources (i.e., scientific knowledge acquired). The home cultivation, confidence in effectiveness, and the origin of medicinal plant used were also determined (Bruschi *et al*. 2019).

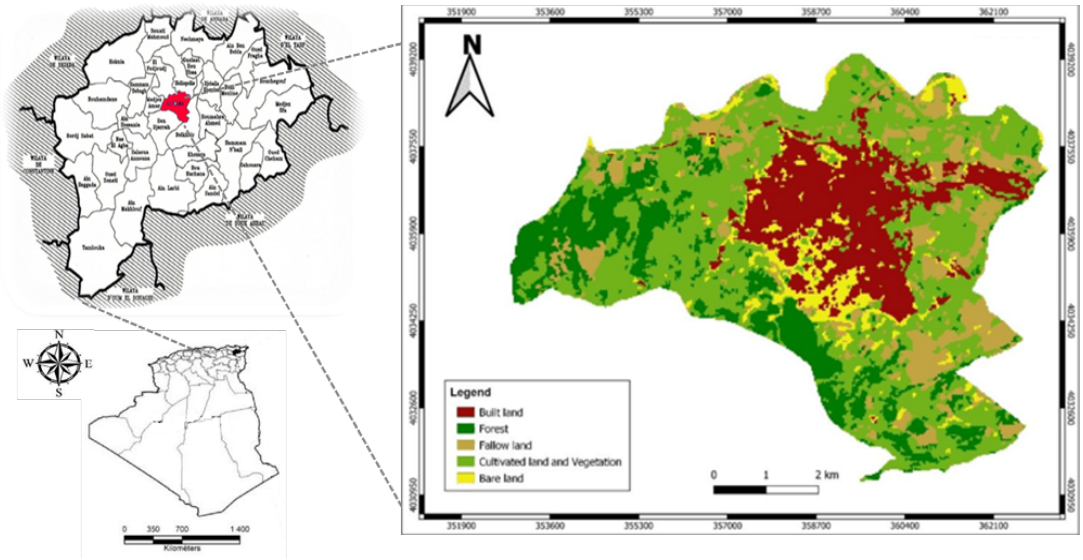

Figure 1. Map of Guelma district, Algeria, showing the study area

Botanical identification

Plant species were identified with the help of botanists and identification catalogs. Firstly, the medicinal plants mentioned by students were collected from the natural environment and from medicinal plant sellers (herbalists, druggists). The common names of the plants cited by informants were reviewed, and Latin names of the species were provided whenever possible using standard documents on the vegetation and medicinal plants of Algeria (Ali-Delille 2013, Chorfi *et al*. 2011) and authoritative databases (African plant database and Plants of the World Online). All collected plants were preserved as vouchers in the Ecobiology of Marine and Coastal Environments Laboratory, Faculty of Sciences, Badji Mokhtar University, Annaba.

Data analysis

The data collected in the ethnobotanical survey was analyzed by determining the most widely used ethnobotanical parameters according to Belhouala and Benarba (2021) and Horackova *et al*. (2023).

Family Importance Value

To determine the significance of plant families, the FIV was calculated by the following formula:

$$FIV = FC_{family}/Ns$$

Where FC is the number of informants mentioning the family and Ns is the total number of informants participated in the survey.

Relative frequency of citation

RFC was obtained by using the following formula:

$$RFC = FC/N \ (0 < RFC < 1)$$

Where FC is the frequency citation for every species and N is the total number of responders in the present survey.

Species Use Value

UV indicates the relative importance of each species known locally and give information about the species that are considered most important in traditional ethnobotanical knowledge. It is calculated using the following formula:

$$UV = (\Sigma U/N) \times 100$$

Where ΣU is the number of reported uses cited by each participant for a given plant species and N is the total number of participants interviewed.

Informant Consensus Factor

ICF was derived in order to test the homogeneity of ethnomedical knowledge between informants on the remedies reported for each respiratory ailment. The ICF value is calculated using the following formula:

$$ICF = (Nur–Nt)/(Nur– 1)$$

Where Nur is the number of use reports (UR) in each disease category; Nt is the number of species used in the same category by all interviewed informants. When the ICF value is near 1, this indicates that the plant is widely used by the participants. In contrast, when the ICF value is near 0, it means the participants disagree on the use of a plant to cure a specific ailment.

Fidelity level

FL was used to identify species with high fidelity of use for a given ailment category. It was calculated as:

$$FL (\%) = Np/N \times 100$$

Where Np is the number of use reports for a given species reported for a particular ailment category, and N is the total number of use reports cited for any given species.

Statistical analysis

Descriptive statistics were used to examine characteristics of the study population and prevalence of medicinal plant use. The second-order Rao-Scott chi-square test was used to test for group differences within specific subgroups. The statistical software SPSS (IBM Corp., Armonk, NY) was used and differences were considered significant at $p<0.05$. A heatmap and a Sankey diagram illustrating the association between respiratory diseases and medicinal plants were generated using Python (v.3.13); Seaborn, matplotlib, and plotly libraries were used (Dingo *et al*. 2023).

Results

Student profiles and source of knowledge

Out of the 300 university students who agreed to participate in the present survey, over 96% of students use at least three medicinal plants to treat respiratory system ailments. However, only 29% (n=87) of students reported using more than three species. With advancing age and academic level, the use of medicinal plants increases significantly. Regarding gender, there is significant use of medicinal plants among female students in a good general health. Notably, students who regularly practice sports activities and have a lower social status are more likely to use medicinal plants.

No difference was found between the sources of knowledge for each remedy; students reported that the most sources of their knowledge about medicinal plants came from family members (49.7% of the plant uses were shared by the students' parents). Exogenous knowledge was frequently represented by herbal practitioners and academic people (30%). Although a considerable fraction of responders did not cultivate any medicinal plants at home, the majority believed in their therapeutic efficacy. Among students who reported using medicinal plants, these products came mostly from herbalists, home garden, or relatives and neighbors ($p<0.05$) (Table 1).

Diversity of medicinal plants, used parts, methods of preparation and administration used

During the present survey, a total of 33 species distributed across 17 families were reported by university students in the Guelma district for the treatment of respiratory diseases (Fig. 2). In terms of species number, the richest family was Lamiaceae with 6 species (18.18%), followed by Apiaceae, Asteraceae, and Zingiberaceae with 3 species (9.09%). The remaining families (13 families) are represented by 2 or only one species (3.03%).

Table 1. Student profiles and prevalence of medicinal plant use.

	Students		Medicinal plant users		
	N	%	N	%	P-values*
Total	300	100	209	96.7	
Age groups (years)					
18-20	200	66.7	116	58	0.000
21-25	100	33.3	93	93	
Sex					
Male	110	36.7	67	60.9	0.01
Female	190	63.3	142	74.7	
Academic level					
Bachelor	200	66.7	116	58	0.000
Master	100	33.3	93	93	
General health					
Excellent	92	30.7	25	27.2	
Good	76	25.3	73	96.1	0.000
Fair	110	36.7	93	84.5	
Bad/very bad	22	7.3	18	81.8	
Sports activities					
Daily	5	1.7	5	100	
1-5 times a week	21	7	19	90.5	0.063
1-4 times a month	16	5.3	10	62.5	
Never	258	86	175	67.8	
Social status					
Lower	21	7	19	90.5	
Intermediate	219	73	165	75.3	0.000
Upper	60	20	25	41.7	
Knowledge's source					
Endogenous	219	73	142	56.9	0.256
Exogenous	81	27	67	43.1	
Home cultivation of medicinal plant					
Yes	53	17.7	29	54.7	0.307
No	247	82.3	180	72.9	
Confidence in effectiveness					
Yes	282	94	207	73.4	0.008
No	18	6	2	11.11	
Origin of medicinal plants used					
Relatives, neighbors	/	/	37	17.7	
Home garden			29	13.88	0.0001
Herbalists			113	54.1	
Pharmacy			19	9.1	
Traditional healers			11	5.26	

To treat respiratory ailments, students use several parts of medicinal plants. Leaves are the most part utilized (37%), followed by seeds (17.36%), branches (14%) and flowers (10%). Rhizomes, roots, fruits, and bulbus are also well used. However, minor use of the remaining parts (aerial parts and barks) has been reported (Fig. 3A).

The majority of students reported that decoction and infusion are the most traditional preparation methods used to extract bioactive compounds from medicinal plants (Fig. 3B). In addition, powders made from dried plants, such as *Syzygium aromaticum* (L.) Merr. & L.M.Perry and *Zingiber officinale* Roscoe, can be prepared and stored for further use. Other ways of preparation, such as maceration, raw materials, juice, and extraction, were also employed depending on the ailment.

Among the formulations cited, the majority are consumed orally (Fig. 3C) with water, tea, honey, oil, or milk. However, some plants are boiled and the resulting vapors, which contain volatile phytocompounds, are inhaled to relieve cough, store throat, influenza, cold, etc.

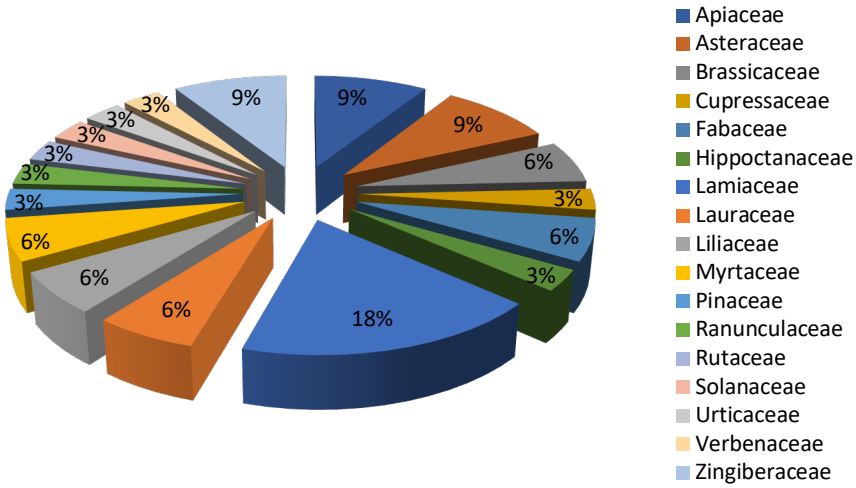

Figure 2. Distribution of medicinal plant families used by university students in Guelma district

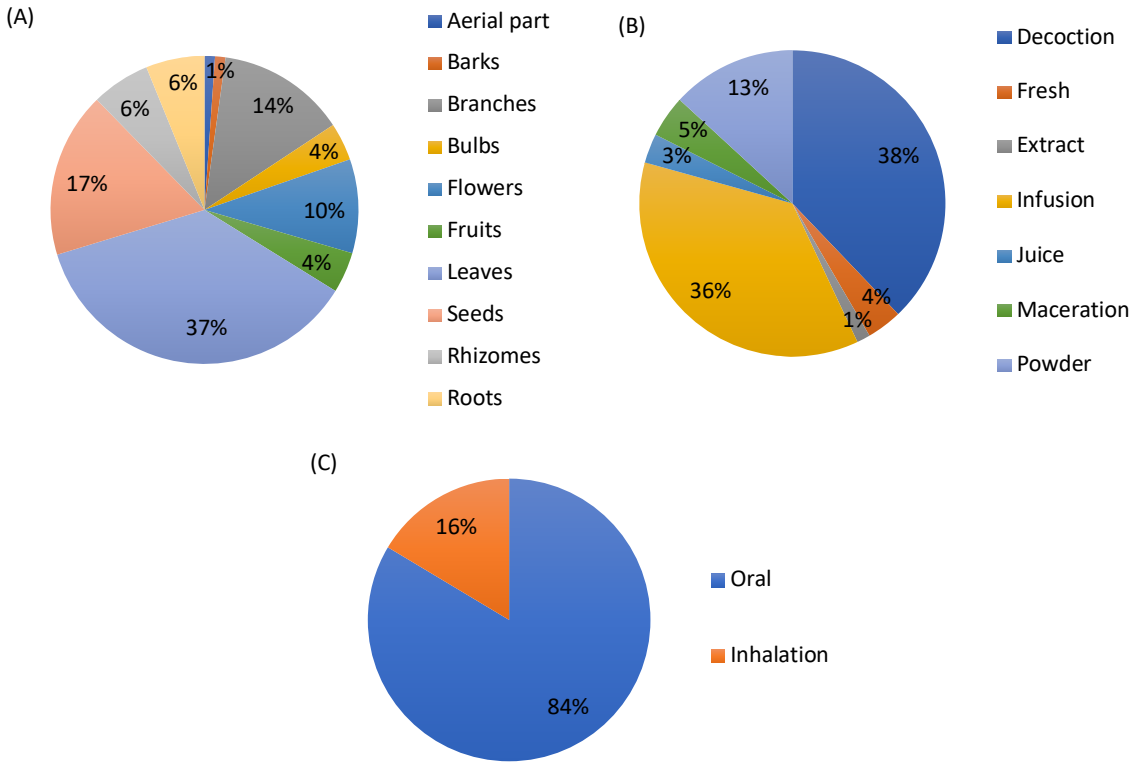

Figure 3. (A) used parts, (B) methods of preparation, (C) and modes of administration

Respiratory diseases treated with medicinal plants

According to the present survey, students treat eleven respiratory diseases using medicinal plants as remedies (Table 2). The relative frequency of each ailment was obtained according to the number of use-reports (UR). The common cold is the ailment most treated with medicinal plants (23.1%), succeeded by influenza (19.83%), cough (19.5%), bronchitis (13.02%), Asthma (6.75%), sore throat (4.93%), allergy (3.98%), respiratory inflammation (3.78%), pharyngitis (2.29%), laryngitis (1.88%), and tuberculosis (0.94%). In regard to plant species, the largest number of species (14) were reported to treat bronchitis, 12 species for cough, 11 for cold, 8 for asthma, and 7 species for allergy, influenza, and sore throat. Respiratory

inflammation and tuberculosis were treated using 3 species, whereas, pharyngitis and laryngitis were treated with two and one species, respectively.

Quantitative ethnobotanics

Family Importance Value

According to FIV (Table 2), the major significant families utilized by students to relieve respiratory disorders were Myrtaceae (0.943*),* Lamiaceae (0.842)*,* and Zingiberaceae (0.517). Families with FIV index ranged between 0.3 and 0.1 in sequence were Verbenaceae (0.387), Brassicaceae (0.354), Rutaceae (0.316), Liliaceae (0.287), Asteraceae (0.254) and Apiaceae (0.138), whereas the rest of the families represented the lowest FIV index (<0.09).

Relative frequency of citation

The present survey demonstrated that students frequently use four species of medicinal plants (with RFC values refunding between 0.52 and 0.31) in the treatment of their respiratory symptoms, comprising *Syzygium aromaticum* (L.) Merr. & L.M.Perry, *Eucalyptus globulus* Labill., *Aloysia citrodora* Paláu, and *Citrus* × *limon* (L.) Osbeck. Moderate RFC values were recorded for six medicinal plant species, including *Alpinia zerumbet* (Pers.) B.L.Burtt & R.M.Sm. (0.26), *Mentha pulegium* L. (0.24), *Zingiber officinale* Roscoe (0.23), *Thymus vulgaris* L. and *Allium sativum* L. (0.22), and *Brassica rapa* L. (0.21). The lowest RFC values, ranging from 0.15 to 0.01, were registered for the other species (Table 2).

Species Use Value

Based on the UV index, *Eucalyptus globulus* Labill. and *Syzygium aromaticum* (L.) Merr. & L.M.Perry showed an elevated intensity of use (40.7 and 38.8 UV>35). Medicinal plant species with considerable UV index (>20) are *Aloysia citrodora* Paláu 28.2, *Mentha pulegium* L. 24.9, *Allium sativum* L. and *Citrus* × *limon* (L.) Osbeck 22.0. In addition, certain medicinal plants exhibited non-negligible UV index (>16), such as *Zingiber officinale* Roscoe 18.6, *Lepidium sativum* L.*,* and *Alpinia zerumbet* (Pers.) B.L.Burtt & R.M.Sm. 16.7 (Table 2).

Informant Consensus Factor

As illustrated in figure 4, ICF values fluctuate between 1 and 0.85, indicating a strong agreement among students on the preference of medicinal plants in the treatment of respiratory ailments. The maximum ICF was recorded for laryngitis, highlighting a total agreement among students. One medicinal plant (*Zingiber officinale* Roscoe) is utilized to treat this respiratory disorder. It is significant that higher ICF values (>0.95) were obtained for influenza (treated by 7 species), followed by the common cold (treated by 11 species), pharyngitis (2 species used), respiratory inflammation (3 species used), and cough (12 species used). Furthermore, remaining ICF values indicated a higher consensus. Specifically, the ICF index for bronchitis, asthma, and sore throat is higher than 0.9, with 14, 8, and 7 medicinal plants used to relieve these respiratory ailments, respectively.

Fidelity level

The FL values enable the determination of the efficiency of medicinal plant species in relieving particular ailments compared to other plants utilized for the similar target. Table 3 demonstrated the medicinal plant species with FL index superior than 50%. Seven plants had a complete fidelity level (100%). These maximum values were registered for *Artemisia herba-alba* Asso utilized against cold and bronchitis, *Ceratonia siliqua* L. and *Laurus nobilis* L.*,* used in the treatment of bronchitis, *Cuminum cyminum* L.*, Petroselinum sativum* Hoffm.*,* and *Urtica dioica* L., used to manage allergy, and *Salvia rosmarinus* Spenn.*,* used in the treatment of asthma. Furthermore, high fidelity levels (> 80%) were noticed for other medicinal plants species, such as *Juniperus communis* L.*, Thymus vulgaris* L., *Allium sativum* L.*,* and *Chamaemelum nobile* (L.) All.*,* used respectively to relief cold, cough, and influenza.

Table 2. Most common medicinal plants used in relieving respiratory affections among university students of Guelma district.

Family name	Species name (Voucher N°)	Used part	Diseases treated	Preparation method	Route	UV	RFC	FIV
Apiaceae	*Cuminum cyminum* L. (EMCEL-PM-004)	Seeds	Allergy/Sore throat	Infusion	Oral	3.83	0.01	0.138
	Foeniculum vulgare Mill. (EMCEL-PM-012)	Seeds	Cough/Bronchitis	Infusion	Oral	2.87	0.03	
	Petroselinum sativum Hoffm. (EMCEL-PM-014)	Aerial part	Allergy	Fresh/Infusion	Oral	4.78	0.07	
Asteraceae	*Artemisia herba-alba* Asso (EMCEL-PM-002)	Leaves/Flowers	Cold/Cough/Bronchitis	Decoction/Infusion	Oral	6.7	0.07	0.254
	Chamaemelum nobile (L.) All. (EMCEL-PM-011)	Flowers	Allergy/Bronchitis/Influenza	Decoction/Infusion	Oral	5.74	0.05	
	Saussurea costus (Falc.) Lipsch. (EMCEL-PM-033)	Roots	Asthma/Cough/Bronchitis	Decoction	Oral	12.9	0.13	
Brassicaceae	*Brassica rapa* L. (EMCEL-PM-006)	Roots	Asthma/Cough	Fresh/Extract	Oral	11.9	0.21	0.354
	Lepidium sativum L. (EMCEL-PM-024)	Seeds	Allergy/Bronchitis/Cough	Decoction/Infusion	Oral	16.7	0.15	
Cupressaceae	*Juniperus communis* L. (EMCEL-PM-030)	Leaves/Branches	Asthma/Tuberculosis/Cold/ Respiratory inflammation	Decoction/Infusion	Oral Inhalation	6.69	0.04	0.038
Fabaceae	*Ceratonia siliqua* L. (EMCEL-PM-026)	Fruits	Bronchitis	Fresh/Decoction	Oral	1.91	0.03	0.072
	Glycyrrhiza glabra L. (EMCEL-PM-028)	Roots	Sore throat/Pharyngitis	Fresh/Decoction	Oral	3.35	0.04	
Hippoctanaceae	*Aesculus hippocastanum* L. (EMCEL-PM-022)	Fruits/Barks	Allergy/Tuberculosis	Decoction	Oral	2.39	0.05	0.053
Lamiaceae	*Lavandula officinalis* Chaix (EMCEL-PM-015)	Leaves	Bronchitis/Cough	Decoction	Oral Inhalation	3.35	0.06	0.842
	Mentha pulegium L. (EMCEL-PM-008)	Leaves	Cold/Respiratory inflammation	Decoction/Infusion	Oral	24.9	0.24	
	Mentha suaveolens Ehrh. (EMCEL-PM-007)	Leaves	Cough/Asthma	Infusion	Oral	12.4	0.15	

Table 2 (continued).

Family name	Species name (Voucher N°)	Used part	Diseases treated	Preparation method	Route	UV	RFC	FIV
Lamiaceae	*Salvia officinalis* L. (EMCEL-PM-020)	Leaves/Flowers	Asthma/Sore throat/ Respiratory inflammation	Decoction/Infusion Maceration	Oral	6.69	0.06	0.842
	Salvia rosmarinus Spenn. (EMCEL-PM-021)	Leaves/Aerial part	Asthma	Decoction/Infusion	Oral	5.26	0.09	
	Thymus vulgaris L. (EMCEL-PM-032)	Leaves /Flowers	Cough/Bronchitis/Sore throat	Decoction/Infusion	Oral Inhalation	11.0	0.22	
Lauraceae	*Cinnamomum verum* J.Presl (EMCEL-PM-017)	Barks	Bronchitis/Sore throat	Infusion	Oral	1.44	0.06	0.090
	Laurus nobilis L. (EMCEL-PM-001)	Leaves	Bronchitis	Decoction/Infusion	Oral	4.31	0.03	
Liliaceae	*Allium cepa* L. (EMCEL-PM-003)	Bulbs	Cough/Sore throat	Maceration	Oral	3.83	0.06	0.287
	Allium sativum L. (EMCEL-PM-005)	Bulbs	Cough/Sore throat	Maceration	Oral	22.0	0.22	
Myrtaceae	*Eucalyptus globulus* Labill. (EMCEL-PM-013)	Leaves/Branches	Cough/Influenza/Cold/ Bronchitis	Decoction/Infusion	Oral Inhalation	40.7	0.42	0.943
	Syzygium aromaticum (L.) Merr. & L.M.Perry (EMCEL-PM-027)	Seeds	Cough/Influenza/Cold	Decoction/Powder	Oral	38.8	0.52	
Pinaceae	*Pinus pinaster* Aiton (EMCEL-PM-016)	Barks	Cold/Bronchitis	Decoction	Oral	2.87	0.04	0.043
Ranunculaceae	*Nigella sativa* L. (EMCEL-PM-023)	Seeds	Allergy/Asthma	Fresh	Oral	4.78	0.07	0.072
Rutaceae	*Citrus* × *limon* (L.) Osbeck (EMCEL-PM-009)	Fruits	Cold/Influenza	Juice	Oral	22.0	0.31	0.316
Solanaceae	*Withania somnifera* (L.) Dunal (EMCEL-PM-031)	Roots	Asthma/Bronchitis	Decoction	Oral	1.91	0.02	0.024
Urticaceae	*Urtica dioica* L. (EMCEL-PM-025)	Leaves	Allergy	Infusion	Oral	0.96	0.03	0.029
Verbenaceae	*Aloysia citrodora* Paláu (EMCEL-PM-010)	Leaves	Cold/Influenza	Infusion	Oral	28.2	0.38	0.378

Table 2 (continued).

Family name	Species name (Voucher N°)	Used part	Diseases treated	Preparation method	Route	UV	RFC	FIV
Zingiberaceae	*Alpinia zerumbet* (Pers.) B.L.Burtt & R.M.Sm. (EMCEL-PM-029)	Leaves/Flowers	Cold/Influenza/Bronchitis	Decoction/Infusion	Oral	16.7	0.26	0.517
	Curcuma longa L. (EMCEL-PM-018)	Rhizomes	Cold/Tuberculosis	Infusion	Oral	1.91	0.03	
	Zingiber officinale Roscoe (EMCEL-PM-019)	Rhizomes	Cold/Laryngitis/Pharyngitis/ Influenza	Decoction/Infusion/ Powder	Oral	18.6	0.23	

Table 3. Fidelity Level by diseases categories (FL≥50%).

Category	Botany name	Reports	FL (%)
Allergy	*Cuminum cyminum* L.	6	100
	Petroselinum sativum Hoffm.	10	100
	Lepidium sativum L.	6	50
	Aesculus hippocastanum L.	5	60
	Nigella sativa L.	9	77.8
	Urtica dioica L.	2	100
Asthma	*Saussurea costus* (Falc.) Lipsch.	18	50
	Mentha suaveolens Ehrh.	22	50
	Salvia officinalis L.	8	75
	Salvia rosmarinus Spenn.	11	100
	Withania somnifera (L.) Dunal	3	66.67
Bronchitis	*Artemisia herba-alba* Asso	8	100
	Lepidium sativum L.	21	57.14
	Ceratonia siliqua L.	4	100
	Thymus vulgaris L.	12	58.33
	Laurus nobilis L.	9	100
	Pinus pinaster Aiton	4	50
	Withania somnifera (L.) Dunal	3	66.67
Cold	*Artemisia herba-alba* Asso	8	100
	Juniperus communis L.	6	83.33
	Mentha pulegium L.	42	52.38
	Eucalyptus globulus Labill.	58	58.62
	Pinus pinaster Aiton	4	100
	Citrus × limon (L.) Osbeck	34	61.76
	Aloysia citrodora Paláu	49	63.27
	Curcuma longa L.	3	66.67
	Zingiber officinale Roscoe	28	58.62
Cough	*Foeniculum vulgare* Mill.	6	66.67
	Artemisia herba-alba Asso	8	50
	Saussurea costus (Falc.) Lipsch.	18	61.11
	Brassica rapa L.	23	69.57
	Lepidium sativum L.	21	76.19
	Lavandula officinalis Chaix	7	71.42
	Mentha suaveolens Ehrh.	22	68.18
	Thymus vulgaris L.	12	83.33
	Allium cepa L.	7	57.14
	Allium sativum L.	31	96.77
	Syzygium aromaticum (L.) Merr. & L.M.Perry	76	67.11
Influenza	*Chamaemelum nobile* (L.) All.	6	83.33
	Citrus × limon (L.) Osbeck	34	73.52
	Aloysia citrodora Paláu	49	57.14
	Zingiber officinale Roscoe	28	53.57
Pharyngitis	*Glycyrrhiza glabra* L.	6	50
Respiratory inflammation	*Juniperus communis* L.	6	50
	Mentha pulegium L.	42	71.43
	Salvia officinalis L.	8	50
Sore throat	*Glycyrrhiza glabra* L.	6	66.67
	Salvia officinalis L.	8	50
	Thymus vulgaris L.	12	50
	Cinnamomum verum J.Presl	3	66.67
	Allium cepa L.	7	57.14
	Allium sativum L.	31	51.61
Tuberculosis	*Juniperus communis* L.	6	66.67
	Curcuma longa L.	3	66.67

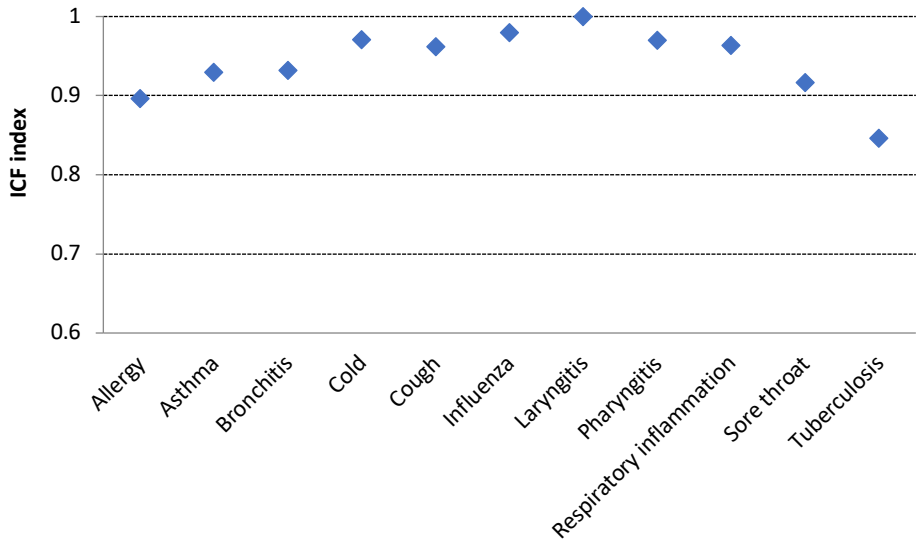

Figure 4. Informant consensus factor by category for the treatment of respiratory affections

Association between medicinal plants and respiratory ailments

As shown in figure 5, the most common medicinal plants used by students to treat cold, influenza, and cough, were *Syzygium aromaticum* (L.) Merr. & L.M.Perry, *Eucalyptus globulus* Labill., and *Aloysia citrodora* Paláu. Besides, *Mentha pulegium* L. were used frequently for treating respiratory inflammation and cold. Another species, *Alpenia zerumbet* (Pers.) B.L.Burtt & R.M.Sm., was notably cited by students to alleviate bronchitis, influenza, and cold. *Allium sativum* L. was linked to cough and sore throat. However, asthma demonstrated a moderate relationship with *Brassica rapa* L. and *Mentha sauveolens* Ehrh.

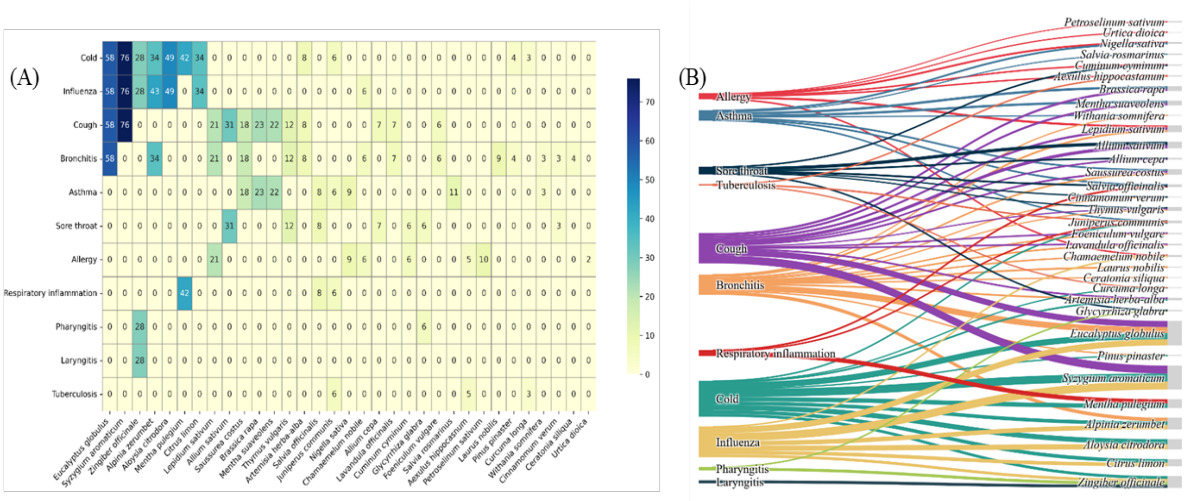

Figure 5. (A) Heatmap and (B) Sankey diagram showing the relationship between respiratory ailments and medicinal plants used by students

Discussion

Student profiles and source of knowledge

The present survey provides the firs information on university students' knowledge of medicinal plants used against respiratory ailments in Guelma district, an aspect that had never been explored before in Algeria. University students in Guelma reported 33 species members of 17 families for the relief of respiratory illnesses, which is close to the results of previous research conducted by Mapunda and Mramba (2025), which indicated that university students recognized 26 medicinal plants species utilized against numerous diseases including oral infections. However, Menghini *et al.* (2015) noticed limited utilization among university students in Italy. The crucial knowledge of the younger cohorts in this study can be justified by the sharing of direct experiences among the population of the region and their integration into an ethnobotanical culture and sustainable local resource use, which lead to a less link to conventional medicines. In addition,

many students, after receiving sufficient information about alternative treatments, confirm that they prefer herbal medicines and consider them safer for avoiding many medical problems such as drugs resistance. Logiel *et al.* (2021), confirmed that a higher academic level was positively related to a high prevalence use of herbal medicines. No difference was registered between exogenous and endogenous knowledge sources. Therefore, this survey suggests that transmission of ethnobiological awareness among students is first gained within the family and then influenced by exogenous sources, as reported by Bruschi *et al.* (2019).

Similar to our results, several investigations have demonstrated that girls are keener on use of medicinal plants. For instance, Büyüker (2023) indicated that female students (>60%) at Üsküdar University, Turkey, used medicinal plants to relieve cold, while male students preferred medication. This pattern may be related to sociocultural traditions that associate girls with elderly persons (e.g., grandparents, mothers, etc.), who are knowledgeable about traditional healing methods and are aware of well-being. In this study, the age of students is another factor that affects the use of medicinal plants, older students reported more medicinal plants use than the younger students, reflecting a deeper comprehension of the value of medicinal plants. Similar results were obtained by Alehegn *et al.* (2022), who demonstrated that senior students from Ethiopian University showed were more likely to use medicinal plants. In contrast to the reports by Bishoge *et al.* (2024), which established a link between living in rural areas and increased traditional medicine practices, the present survey reported that students living in urban areas and with intermediate incomes make greater recourse to medicinal plants. This pattern might be explained by individual's increased awareness of medicinal plants and the resources available to manage their own health and treat respiratory ailments without resorting to modern medicines, which is culturally adopted. Furthermore, students reported that the use of medicinal plants for management of respiratory ailments had increased after the COVID-19 pandemic, when young people recognized the importance of pharmacological effect of some medicinal plants. In the same line, Nyagumbo *et al.* (2022) confirmed that COVID-19 pandemic has led to renewed interest in medicinal plants that relieve respiratory diseases.

Diversity of medicinal plants, used parts, and methods of preparation and administration used

Students mostly use plant leaves to prepare herbal remedies, which is in line with several investigations in Algeria (Bensizerara *et al*. 2025, Soltani *et al*. 2025). This common practice may be explained by the fact that leaves are easy to collect and rich in bioactive molecules. The exploitation of leaves in preference to other parts (e.g., roots) can play a crucial role in the conservation of relevant species (Soltani *et al*. 2025). Seeds represent the second most commonly used part by students. Numerous ethnobotanical reports have demonstrated the pharmacological benefits of seeds, which are a reservoir of oils, bioactive compounds, and nutrients (Shahrajabian & Sun 2023).

Students use seven methods for making plant-based treatment for respiratory ailments. Decoction and infusion are the most common practices, which is in line with numerous ethno-preparations in various region in Algeria (Belhaouala & Benarba 2021, Bouredja *et al.* 2017) and other countries (Teka & Maryo 2023, Zia-Behbahani *et al*. 2025). Students' inclination towards these ways of preparation could be correlated to the ease and speed with which biomolecules can be extracted from plants, which are helpful for human internal use (Tian-Liang *et al*. 2025).

The present study highlighted the two largest routes of administration used by students suffering of respiratory disorders, which are oral and inhalation. Similarly, Bourouaha *et al.* (2025) mentioned that informants in Saida region of western Algeria, are also inclined to prefer oral and inhalation modes to relieve respiratory pathologies. Furthermore, Belhaouala and Benarba (2021), noticed that the choice of oral and inhalation applications, frequently utilized by the population in different regions in Algeria, depended on the therapeutic focus in the respiratory system and the pharmacological traits of each medicinal plant species.

Quantitative data on reported medicinal plants and treated respiratory diseases

Following FIV index, the botanical families with the highest values were Myrtaceae and Lamiaceae*,* reflecting the frequency with which their species were used by students to manage respiratory disorders. Correspondingly, the recent survey conducted by Ahmed-Gaid *et al.* (2025), demonstrated that Myrtaceae and Lamiacea families were the widely used plants (with an FIV of 0.778 and 0.597, respectively) against cold and flu in two Algerian communities. Additionally, Zingiberaceae exhibited broad application among students in the study area, which is common in Algerian ethnorespiratory studies (Bouredja *et al*. 2017, Bourouaha *et al*. 2025). The dominance of the above-mentioned families can be attributed to the diversity of their phytochemical components (e.g., flavonoids, tannins, saponins, etc.), their various pharmacological properties (e.g., anti-inflammatory and antimicrobial potential, etc.), which make them useful for relieving respiratory diseases, and their adaptation to the regional environment (Tian-Liang *et al*. 2025).

Among the species recorded, *Syzygium aromaticum* (L.) Merr. & L.M.Perry and *Eucalyptus globulus* Labill. displayed the greatest RFC and UV values. These species are well known for their major bioactive compounds and their use in various industries (food, pharmaceutical, cosmetics, etc.). According to Maggini *et al*. (2024), cloves have been used in various human health therapies, especially oral diseases, physical discomfort, loss of appetite, and headaches. They contain eugenol, which is known for its antimicrobial, antioxidant, anti-inflammatory, and analgesic effects. Eucalyptus leaves are widely utilized in traditional Algerian remedies to relieve respiratory disorders (Ahmed-Gaid *et al*. 2025, Soltani *et al*. 2025). Different compounds (e.g., 1,8-cineole, α-pinene, γ-terpinene, etc.) have been reported in the leaves and arial parts of eucalyptus, which are interrelated with positive effects against a wide range of microorganisms (Cmiková *et al*. 2023). It is worth noting that *Aloysia citrodora* Paláu is widely used as an infusion by the students in Guelma district to manage cold and influenza. A recent report conducted by Athanasiadis *et al*. (2024) showed that *Aloysia citrodora* Paláu, widely cultivated in North Africa, is rich in polyphenols, carotenoids, and ascorbic acid, which justifies its use in traditional medicine as an antioxidant and antimicrobial agent. The frequency of citation and use of the other medicinal species, like *Mentha pulegium* L., *Allium sativum* L., *Citrus* × *limon* (L.) Osbeck, *Zingiber officinale* Roscoe, *Lepidium sativum* L., and *Alpinia zerumbet* (Pers.) B.L.Burtt & R.M.Sm., also reflects the considerable diversity of university students' ethnobotanical knowledge in Guelma district. Compared to other Algerian communities, similar patterns were observed by Bourouaha *et al*. (2025) in Saida and Hadj-Said and Bouazza (2023) in Tizi-Ouzou.

The medicinal plants cited by the university students were predominantly used to treat eleven respiratory system ailments. The most frequently treated diseases were cold, influenza, and cough, which are common disseminated respiratory diseases in the region, especially in the cold season. These findings are in agreement with several observations made around the world (Afzal *et al*. 2021, Shawarb *et al*. 2023). In general, notable ICF values were recorded for the majority of respiratory ailments, reflecting the sharing of traditional knowledge among students and probably high efficacy of certain plants for specific diseases. The strongest consensus on the use of *Zingiber officinale* Roscoe to treat laryngitis, suggests that its bioactive molecules are effective in managing this respiratory disease. Similarly, many reports have confirmed the important role of ginger rhizome, rich in gingerols, in relieving respiratory infections, such as cold, throat irritation, difficulties of breathing, bronchitis, and coughs (Beristain-Bauza *et al*. 2019, Kodikara *et al*. 2022). Furthermore, the present survey showed that influenza, the common cold, pharyngitis, respiratory inflammation, and cough had the highest ICF values, which agrees with previous Algerian ethnorespiratory studies (Belhacini *et al*. 2024, Gherairia *et al*. 2025).

The significant association observed between certain medicinal plants and respiratory diseases treated by students, along with the absolute FL values (100%) for seven medicinal plant species, reflect their high healing potential against respiratory ailments. Similarly, Hassaïne and Benmalek (2022) noted a high FL (>96%) for *Artemisia herba-alba* Asso used to manage respiratory diseases in the Algerian Sahara. Likewise, Louafi *et al.* (2024) underlined the benefits of *Ceratonia siliqua* L. in relieving lungs ailments. Our findings are also in agreement with those of Bakhshaee *et al*. (2017) and Soltani *et al*. (2025) who documented the effectiveness of *Urtica dioica* L. against allergic rhinitis, and *Salvia rosmarinus* Spenn. against asthma, respectively. Conversely, several studies have reported that *Laurus nobilis* L., *Cuminum cyminum* L., and *Petroselinum sativum* Hoffm. species were commonly employed to alleviate digestive affections and inflammation (Ahmed 2024, Khalil *et al*. 2024, Mahdi *et al*. 2024). Therefore, our findings highlighted promising directions for further ethnobotanical research on these species.

Conclusion

The present survey demonstrated that university students in Guelma district possessed deep insights into medicinal plants used to alleviate respiratory disorders. It was noted that they exhibited both rational and empirical knowledge regarding the utilization of these plants, highlighting the preservation of such knowledge across generations and its relevance to modern pharmacological research. A dominance of Myrtaceae and Lamiaceae families, as well as a preference for leaves to prepare orally remedies, were noted. The high UV and RFC indices of *Syzygium aromaticum* (L.) Merr. & L.M.Perry, *Eucalyptus globulus* Labill., and *Aloysia citrodora* Paláu validate their fundamental importance in therapeutic practices. Besides, the strong agreement among students regarding a specific respiratory disease confirms the significant therapeutic role of the ethnomedicinal species. However, the limited geographical scope is a significant limitation of this study, which does not allow for a more representative view. Therefore, it is recommended that a nationwide study be conducted in order to represent the entire ethnobotanical knowledge of Algerian students. Furthermore, it is crucial to create databases in order to stimulate intergenerational exchanges and preserve local biocultural biodiversity.

Declarations

List of abbreviations: FIV - Family Importance Value; FL - Fidelity Level; ICF - Informant Consensus Factor; RFC - Relative frequency of citation; UV - Use Value.

Ethics approval and consent to participate: The study complied with ethical and legal guidelines for research involving human subjects, in accordance with the International Society for Ethnobiology (ISE) Code of Ethics. All participants were fully informed about the ethnobotanical nature and purposes of the study. Participation was entirely voluntary, and informed consent was obtained from each participant before data collection.

Consent for publication: Not applicable. All data are anonymized.

Availability of data and materials: All data generated during this survey are included in the present article.

Competing interests: The authors have no conflict of interests to declare.

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Author contributions: L.B. designed the study, analyzed the data, and wrote the text. S.A. participated in the theoretical background and the data collection. S.B. participated in statistical analysis. A.O. assisted with manuscript revision.

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