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ETHNOBOTANICAL STUDY ON THE USE OF MEDICINAL PLANTS WITH ANTIVIRAL INTEREST, CASE OF SARS-COV-19, IN THE REGION OF SERAIDI (ANNABA, NORTH-EAST ALGERIA)

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ABSTRACT

The taxonomic diversity and the richness of the region of Seraidi (North-East Algeria) in medicinal plants, as well as the appearance of diseases of viral origin, in particular, the current pandemic of SARS-CoV-2, led us to the realization of an ethnobotanical survey of plants with antiviral interests. The survey was conducted based on a pre-established quiz, with 120 people from different categories of the population of Seraidi, with the aim of listing the medicinal plants used in the treatment of viral diseases and collecting as much information as possible on this subject. After analyzing, the information provided by the people interviewed, we listed 32 species belonging to 20 families, of which the Lamiaceae family is the most represented. Older women are the most affected by the use of plants; people without a higher intellectual level have the most knowledge about the use of plants with antiviral interest. The leaf is the most widely used organ, in the form of a decoction or infusion, administered orally.

Keywords **:** Medicinal plants with antiviral interest, Seraidi, ethnobotanical survey, traditional use, local population.

Introduction

Several researches on the use of plants in traditional medicine and pharmacopoeia have resulted in the discovery of the active ingredients of many drugs used in modern medicine today (Aboudou *et al.*, 2021; Leonti *et al.*, 2017; Soh and Benoit-Vical, 2007; Cragg, and Newman, 2002). That is why, until now, plants have played a main role in the art of healing.

To avoid the risk of loss of knowledge of medicinal plants and their uses in traditional medicine and in order to translate popular knowledge into scientific knowledge, ethnobotanical survey is essential.

Ethnobotanical investigation is a science that defines the interrelation between the plant populations in a socio-cultural context (Rivière *et al.*, 2005). The studies carried out in the Northeast of Algeria have revealed a wealth of medicinal flora, but there are still species that are little explored, and unknown.

To this end, we carried out an ethnobotanical survey in order to identify the medicinal species with antiviral interests, in the region of Annaba, represented by the area of Seraidi (North-East Algeria). This study was initiated following the health crises experienced over the past three years, with the appearance of the emerging virus SARS-CoV-2 (Coronavirus, COVID-19). Several studies have been carried out to find a natural remedy against this virus (Helali *et al.*, 2019; Haoud and Mellali, 2021; Plante *et al.,* 2021; Hamdani and Nouari, 2021; Sehailia and Chemat, 2021).

As a result, our study is a contribution to the recognition of medicinal plants with antiviral interests in the region of Northeast Algeria, Seraidi, state of Annaba, with the aim of a sustainable development of its natural resources.

On the other hand, the choice of an ethnobotanical survey within a local population is linked to their low income, leading to a return to traditional herbal medicine.

Materials and Methods

Description of the study area

The commune of Seraidiis a colonial forest village, located 13 km from the city of Annaba (capital of the state), and situated in the middle of the mountain range at 850 m of altitude.

This mountain range extends over a distance of 80 km, from the island of Cap of Keep to Cap of Iron. The highest point rises to 1008m above sea level and is located at a place called "Kef Esbâa" (Saadi, 2013).

The distribution of the vegetation at the level of the Edough massif is done according to the local ecological conditions: altitude, bioclimate, topography, substrate, soil, floors,… In addition, this forest is characterized by the presence of the most beautiful formations of cork oak (*Quercus suber*), Zen oak (*Quercus faginea*), with their floral procession, to which are added groups of maritime pine (*Pinus pinaster*) and chestnut (*Castanea sativa*) (Toubal, 1989).

The Edough massif enters the sub-humid bioclimatic stage, according to the pluvial-thermal quotient of Emberger (1957), with the highest temperatures being observed in August and the lowest in January. Precipitation is mainly encountered during the cold seasons, exceeding 900 mm (Bouzid, 2019).

Ethnobotanical survey

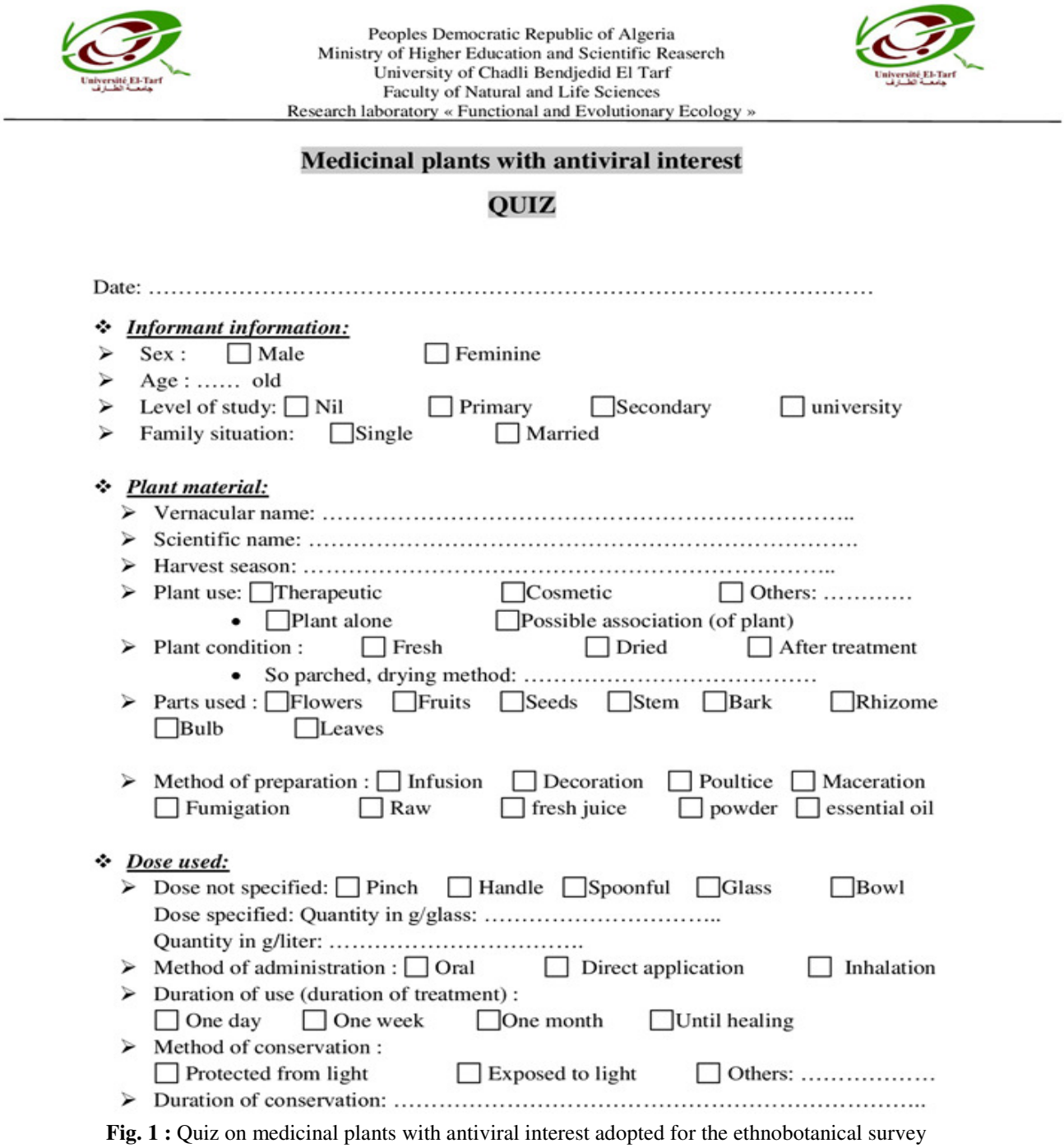
In order to collect and constitute a source of information ready to be exploited on the scientific level, in the field of the valorization of medicinal plants with antiviral interest, an ethnobotanical investigation was carried out.

This information was collected using a questionnaire. The answers to the elaborated questions were made through conversations with healers, herbalists and rural women's cooperatives installed in the Seraidi region and the local population.

The people, who agreed to share their knowledge with us in the antiviral interest, enabled us to draw up a technical sheet **(Figure-01)**, containing the following information: the vernacular name of the plants; the method of preparation, route of administration; and parts of the plants used.

The survey took place between July 2020 and September 2021, using the quiz that was submitted to people in direct contact with the medicinal plants mentioned above, throughout the Seraidi region. The number of people questioned is 120, of different ages, of different intellectual levels, and divided between the two sexes.

The information collected in the technical sheets has been processed and analyzed. At the same time, a bibliographical research was developed for the scientific identification of the listed taxa, in order to be able to select the species having an antiviral activity with the aim of sustainable valorization, through an in-depth phytochemical study. To do this, we consulted online documentation related to plant systematics and taxonomy (INPN, 2022; APGIII, 2009; APGIV, 2016).



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Medicinal plants with antiviral interest

QUIZ

Date: ……

❖ ***Informant information:***
- Sex : ☐ Male ☐ Feminine
- Age : …… old
- Level of study: ☐ Nil ☐ Primary ☐ Secondary ☐ university
- Family situation: ☐ Single ☐ Married

❖ ***Plant material:***
- Vernacular name: ……..
- Scientific name: ……
- Harvest season: ……..
- Plant use: ☐ Therapeutic ☐ Cosmetic ☐ Others: ……
  - ☐ Plant alone ☐ Possible association (of plant)
- Plant condition : ☐ Fresh ☐ Dried ☐ After treatment
  - So parched, drying method: ……
- Parts used : ☐ Flowers ☐ Fruits ☐ Seeds ☐ Stem ☐ Bark ☐ Rhizome ☐ Bulb ☐ Leaves
- Method of preparation : ☐ Infusion ☐ Decoration ☐ Poultice ☐ Maceration ☐ Fumigation ☐ Raw ☐ fresh juice ☐ powder ☐ essential oil

❖ ***Dose used:***
- Dose not specified: ☐ Pinch ☐ Handle ☐ Spoonful ☐ Glass ☐ Bowl
  Dose specified: Quantity in g/glass: ……..
  Quantity in g/liter: ……
- Method of administration : ☐ Oral ☐ Direct application ☐ Inhalation
- Duration of use (duration of treatment) :
  ☐ One day ☐ One week ☐ One month ☐ Until healing
- Method of conservation :
  ☐ Protected from light ☐ Exposed to light ☐ Others: ……
- Duration of conservation: ……..

Fig. 1 : Quiz on medicinal plants with antiviral interest adopted for the ethnobotanical survey

Results and Discussion

Inventory of medicinal plants with antiviral interest

Our ethnobotanical study has identified 32 medicinal plants with antiviral properties used by the population of the Seraidi region. Table-01 provides information on the listed species, specifying the scientific names in French and Arabic, the part of the plant used, the method of preparation, and the route of administration.

Table 1 : Médicinal Plants with anti viral Properties and their route of Administration

N°	Scientific name	Family	Vernacular name	Part used	Method of preparation	Route of administration
01	*Origanum vulgare* L.	Lamiaceae	Oregano	Leaves	Decoction / Infusion / Poultice	Oral / Inhalation
02	*Thymus capitatus* (L.) Hoffmanns. & Link	Lamiaceae	Thyme	Leaves	Decoction / infusion	Oral / Inhalation
03	*Lavandula angustifolia* Mill.	Lamiaceae	Lavender	Leaves / Flowers	Decoction / Poultice/ Raw	Oral / Direct application
04	*Thymus vulgaris* L.	Lamiaceae	Thyme	Leaves	Infusion / Decoction	Oral
05	*Artemisia herba-alba* Asso.	Asteraceae	Wormwood	Leaves	Decoction / Infusion / Maceration	Oral
06	*Zingiber officinale* Roscoe	Zingiberaceae	Ginger	Rhizomes	Decoction / Infusion / Maceration / Raw	Oral
07	*Curcuma longa* L.	Zingiberaceae	Curcuma	Rhizomes	Decoction / Direct application	Oral
08	*Glycyrrhiza glabra* L.	Fabaceae	Licorice	Rhizomes	Direct application / Infusion / Decoction	Oral
09	*Cinnamomum zeylanicum* Blume	Lauraceae	Cinnamon	Rhizomes	Decoction	Oral
10	*Eucalyptus globules* Labill.	Myrtaceae	Eucalyptus	Leaves	Decoction	Oral / Inhalation
11	*Syzygiuma romaticum* (L.) Merr. & L.M. Perry	Myrtaceae	Clove	Flowers / Fruits	Essential oil / Infusion / Powder	Oral / Direct application
12	*Allium sativum* L.	Amaryllidaceae	Garlic	Bulbs	Raw / Fresh juice / Poultice / Maceration	Oral / Direct application
13	*Pistacia lentiscus* L.	Anacardiaceae	Lentiscus	Leaves / Flowers / Fruits	Essential oil / Maceration / Powder/ Infusion	Oral / Direct application
14	*Allium cepa* L.	Amaryllidaceae	Onion	Bulbs	Decoction / poultice / Raw / Fresh juice	Oral / Direct application
15	*Olea europaea* L.	Oleaceae	Olive	Leaves / Fruits / seeds	Essential oil / Raw / Decoction	Oral / Direct application
16	*Verbena officinalis* L.	Verbenaceae	Verbena	Leaves	Decoction / Infusion	Oral
17	*Citrus sinensis* (L.) Osbeck	Rutaceae	Orange	Leaves / Bark / Fruits	Decoction / Fresh juice / Raw	Oral
18	*Citrus limon* (L.) Burm.f.	Rutaceae	Limon	Fruits / Leaves	Decoction / Raw / Fresh juice	Oral
19	*Mentha spicata* L.	Lamiaceae	Menthe	Leaves	Decoction / raw	Oral
20	*Cupressus arizonica* Greene	Cupressaceae	Cypress	Leaves / Rods / Flowers	Decoction	Oral
21	*Melissa officinalis* L.	Lamiaceae	Lemon balm	Leaves	Infusion	Oral
22	*Pulmonaria officinalis* L.	Boraginaceae	Pulmonary	Leaves	Infusion	Oral
23	*Salvia officinalis* L.	Lamiaceae	Sage	Leaves	Decoction / Infusion	Oral
24	*Artemisia absinthium* L.	Asteraceae	Absinthe	Leaves	Decoction / Fresh juice	Oral
25	*Ziziphus lotus* (L.) Lam.	Rhamnaceae	Sidra	Leaves / Roots	Decoction	Oral
26	*Nigella sativa* L.	Ranunculaceae	Black bean	Seeds	Raw / Decoction / Essential oil	Oral / Direct application

27	*Pinus sylvestris* L.	Pinaceae	Pin	Leaves	Decoction	Oral
28	*Myristica fragrans*Houtt.	Myristicaceae	Nutmeg	Fruits	Decoction / Powder	Oral
29	*Urtica dioica* L.	Urticaceae	Nettle	Leaves / Roots	Decoction / Poultice / Powder	Oral / Direct application
30	*Origanum majorana* L.	Lamiaceae	Marjoram	Leaves	Decoction	Oral
31	*Brassica rapa* L.	Brassicaceae	Turnip	Rods	Fresh juice / Raw	Oral
32	*Arisarum vulgare* O.Targ.Tozz.	Araceae	Loudly	Leaves	Poultice	Direct application

The 32 species listed are grouped into 20 families, the most represented of which is the Lamiaceae family, with 25%; the rest of the families are represented by a percentage varying from 3% to 6% (Figure-02).

This result is consistent with ethnobotanical work carried out in Algeria, Africa and the Mediterranean basin, where we observed the dominance of the Lamiaceae family (Benlamdini *et al.*, 2014; Hseini and Kahouadji, 2007; Lahsissene *et al.*, 2009; Boutabbia *et al.*, 2011; Brahmi *et al.*, 2022; Dieye and Sarr, 2021; Kouame *et al.*, 2021; Koudouvo, 2009).

We can also note that all the species identified in the Seraidi region were mentioned in the online survey conducted by Hamdani and Houari (2020), carried out on 500 people, including 49% suffering from COVID-19, in different regions of northern Algeria.

To this end, the most recommended medicinal plants with antiviral interest for the treatment and prevention against COVID-19 infection by the population of Seraidi, and cited in the majority of research work carried out in Algeria (Helali *et al.*, 2019; Haoud and Mellali, 2021; Brahmi *et al.*, 2022; Boutabia *et al.*, 2011; Bouafia *et al.*, 2021) and in Morocco (Benlamdini *et al.*, 2014; Hseini and Kahouadji, 2007 ; Lahsissene *et al.*, 2009 ; Belhaj and Zidane, 2021; Najem *et al.*, 2022) are *Origanum vulgare*, *Thymus vulgaris*, *Zingiber officinale*, *Eucalyptus globulus*, *Artemisia herba-alba*, *Syzygium aromaticum*, *Allium sativum*, *Citrus limon*, *Melissa officinalis*, *Pulmonaria officinalis*, *Ziziphus lotus*, *Urtica dioica* and *Pistacia lentiscus*.

Recent studies (Sehailia and Chemat, 2021; Tshibangu, 2020; Tahrioui *et al.*, 2020; Asdadi *et al.*, 2020; Boughendjioua *et al.*, 2022; Tahrioui *et al.*, 2020; Belhaj and Zidan, 2021; Fouedjou *et al.*, 2021) have confirmed the efficacy of the molecules extracted from the antiviral plants cited above, as well as the recommendation of their use for the treatment of patients with SRAS-CoV-2.

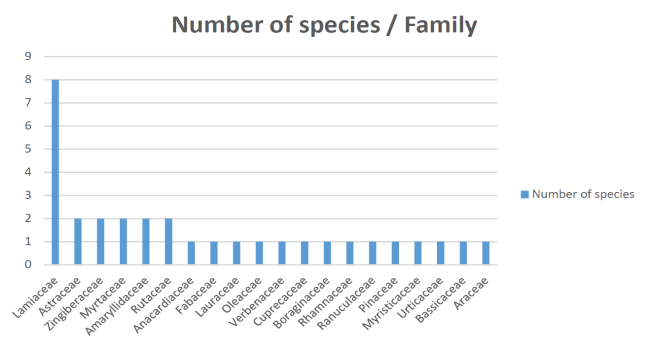

Fig. 02: Distribution of botanical families used in the treatment of viral diseases in the Seraidi.

Ethnobotanical survey:

The information collected through the answers to the quiz was analyzed and discussed using the graphs illustrated below:

Use of medicinal plants with antiviral interest according to gender:

Data analysis has shown that medical knowledge is shared between men and women, with a slight advantage going to the latter, with percentages of 57.5% for the female sex and 42.5% for the male sex **(Figure-03)**.

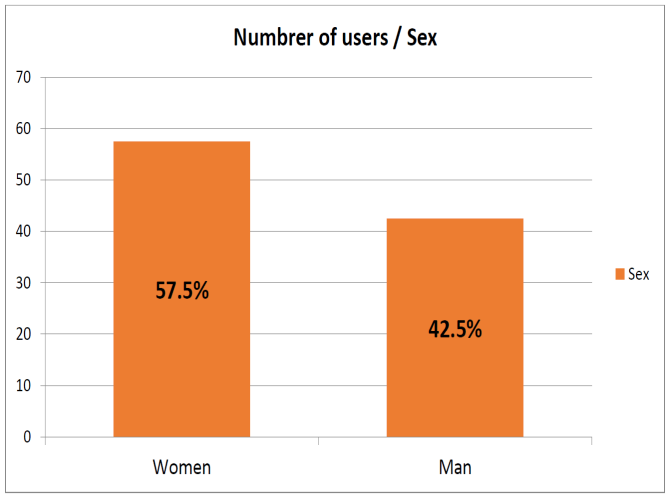

Fig. 03: Use of medicinal plants with antiviral interest according to sex

These results agree with the general rule of Mehdioui *et al.*, 2007, who affirm that women are holders of great traditional phototherapeutic knowledge inherited from mother to daughter.

Several ethnobotanical works also confirm the finding of our study, eithernationaly scale (Aribi, 2013; Boutabia *et al.*, 2011; Chermat and Gharzouli, 2015; Hamel *et al.*, 2018; Helali *et al.*, 2020; Hamdani and Houari, 2020; Brahmi *et al.*, 2022), or internationally (Koudouv, 2009; Benkhnigue *et al.*, 2011; Laarbya, 2017; Dougnon *et al.*, 2018; Rhattas *et al.*, 2016; Kouame *et al.*, 2021).

Use of medicinal plants with antiviral interest according to age:

The use of medicinal plants with antiviral interest is present in all age groups, with a predominance in people over 60 years old (33.33%).Then come the age groups [50-60] and [40-50] with a percentage of 23.33% and 20.83%, respectively. The age group [30-40] corresponds to a frequencyof use of 14.16%. Among informants aged under

30, the percentage of use of plants is less important, with 8.33% (Figure-04).

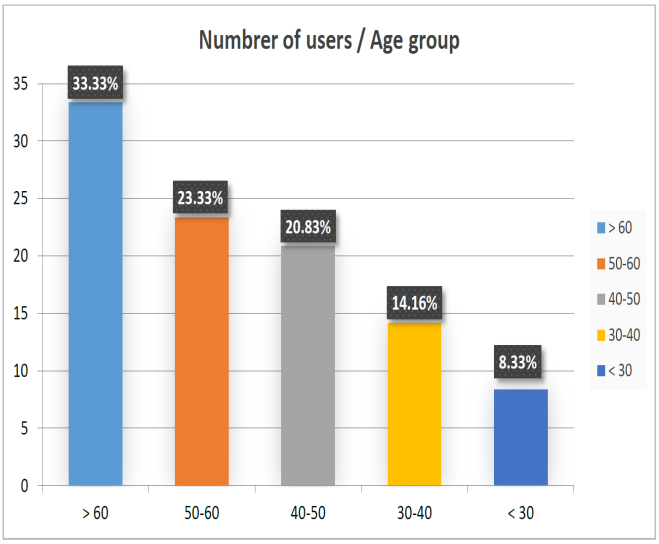

Fig. 04 : Use of medicinal plants with antiviral interest according to age

It should be noted that the elderly have a great knowledge of medicinal plants in general(local vernacular names, methods of use, parts used), thus preserving a heritage from their parents.

These results also indicate the existence of a close link between age and the degree of knowledge, confirming the reliability of the information held by the elderly, because they hold a good part of the ancestral knowledge that is part of the local tradition (Anyinam, 1995; Tamboura *et al*., 1998; Hsein and Kahouadji, 2007 ; Binkhnigue *et al*., 2011; Mahdioui *et al.,* 2007; Benlamdini *et al.*, 2014; Kouame *et al.*, 2021).

However, Helali *et al*. (2020) reported that people between the ages of 18 and 30 are the most frequent users of medicinal plants (38%), while the lowest rate is noted among people over 60, with a percentage of 6.5%. Brahmi *et al.* (2022) observed the same results in western Algeria**.** The people interviewed in the two studies cited above live in urban areas, unlike the people questioned in this work, who live in mountainous and riverside areas.

Use of medicinal plants with antiviral interest according to family situation

According to the respondents, married people (79.16%) use medicinal plants with antiviral interest much more than single people (20.84%) (Figure-05). Users in couples are more interested in the field of herbal medicine (Boughrara, 2016).

Indeed, married people are affected by the minimization of expenses and pharmacists, mainly families with dependent children (Bakiri *et al*., 2016). These families use medicinal plants with antiviral interest as first aid against viral infections in order to lower fever and avoid convulsions. This has been confirmed through the results obtained from ethnobotanical studies conducted by Boutabbia *et al.* (2011), El-Hafian *et al.* (2014), El-Hilah *et al.* (2015), Jdaidi and Hasnaoui (2016), Boughrara (2016) and Hamel *et al.* (2018).

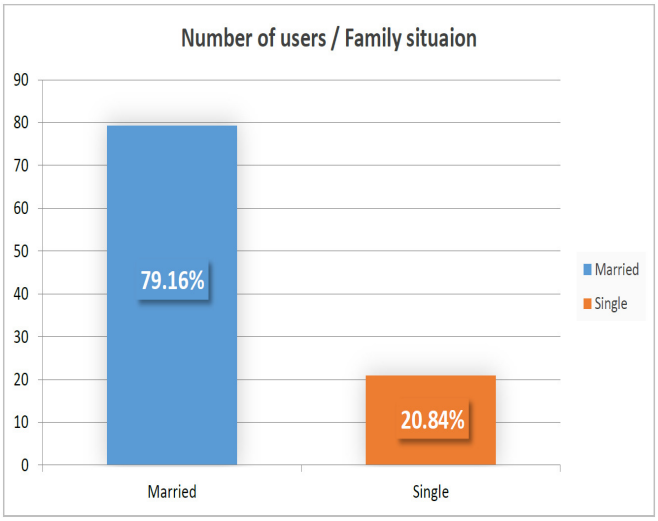

Fig. 05 : Use of medicinal plants with antiviral interest according to family situation

Use of medicinal plants with antiviral interest according to level of study :

The highest percentage of users of medicinal plants with antiviral interest was observed in the illiterate category, with a rate of 33.66%, followed by those with a level average of 30%. People with a primary level represent 15.83%. However, we noted, through the answers obtained, that high school students represent a percentage of use medicinal plants lesser, but not negligible, antiviral interest, with respectively 11.66% and 10.83% (Figure-06).

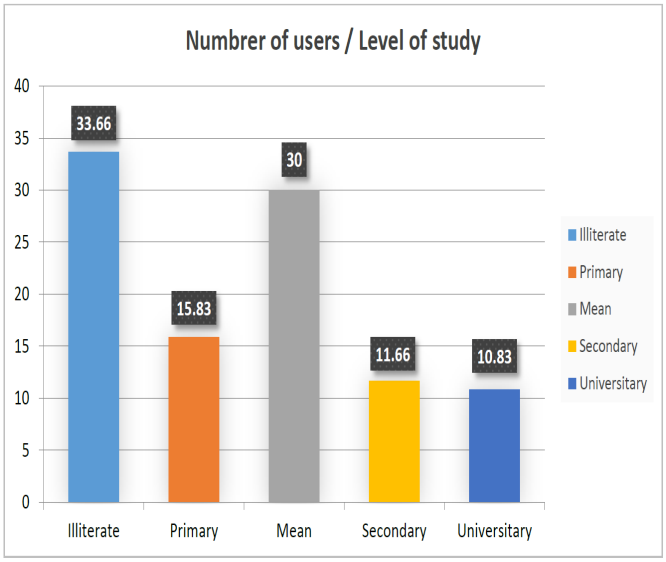

Fig. 06 : Use of medicinal plants with antiviral interest according to level of study

The observed percentages of users of medicinal plants with antiviral interest, according to the level of study correlate perfectly with the percentages in relation to age, where the age groups [> à 60ans] and [50 – 60ans] correspond to people not having benefited from high-level studies (maximum college). However, high school students and university students whose age groups are less than 30 years old, correspond to the category of people whose use of plants is less important (< 9%).

These results reflect the socio-cultural level of the local population of the Seraidi region, which has an agricultural vocation, thus favoring the development of local products(beekeeping, development of Aromatic and Medicinal Plants, breeding of cattle and goats, market gardening, ….etc.), on the one hand. On the other hand, we can see that the population has retained their knowledge regarding the use medicinal plants as a remedy for the various pathologies encountered, through the elderly.

These results are encountered in the work of Benlamdini *et al.* (2014), in Morocco, in the eastern High Atlas (High Moulouya), with a large percentage of illiterate users, medicinal plants with antiviral interest. Academics, on the other hand, are wary of the consumption of medicinal plants, for fear of confusion, since they have no knowledge of their identifications, their virtues and especially their toxicities.

However, our results contradict those reported by Helali *et al.* (2020), Hamdi and Houari (2020) and Brahmi *et al.* (2022), where the majority of users of herbal medicine have a university level, with the percentage varying from 60 à 90%, while people with an average, primary or illiterate level represent rates below 20%, this can be explained by the fact that the people interviewed are in urban areas, far from any contact with nature (Brahmi *et al.* 2022).

Use of medicinal plants with antiviral interest according to the different parts of plant

Our survey of medicinal plants with antiviral activity shows that the leaf is the most used organ (48.88%), followed by the fruits, which represent 8.88% each. The other parts, namely the stems, the roots, the seeds, and the bulbs, occupy a rate, of 3.84%. The bark is the least used part, with 2.22% **(Figure-07)**.

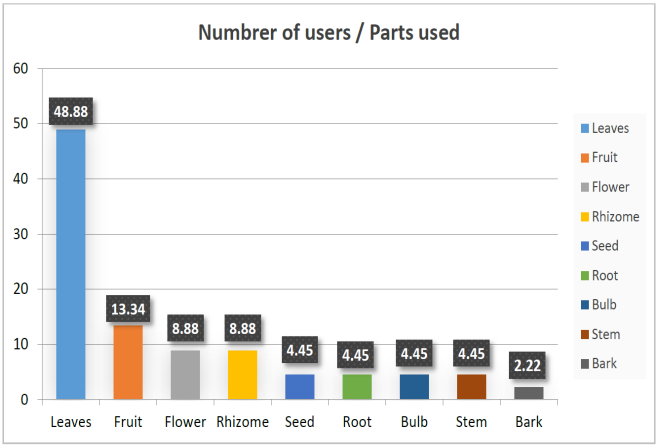

Fig. 7 : Distribution of plants according to parts used

The extensive use of the leaves is explained by the ease and speed of harvesting (Bitsindou, 1986), but also by the fact that they are the seat of photosynthesis and the storage of secondary metabolites responsible for the biological activities of plants in certain species (Bigendakou-polugeni and Lejoly, 1990). This is also reported in other works such as Ouattara (2006), Benkhnigue *et al.* (2010-2011), Boutabia *et al.* (2011), Zerbou *et al.* (2011), Tahri *et al.* (2012), Diatta *et al.* (2013), Chermat and Gharyouli (2015), Jdaidi and Hasnaoui (2016) and Kouame *et al.* (2021).

The roots areamong the parts of the plant least used in the preparations of therapeutic remedies, because the removal of the roots actively contributes to the destruction of the species (Koné, 2009 ; Bouayyadi, 2015; El Amrani, 2010 ; Slimani, 2016), knowing that the harvests are carried out in a spontaneous and uncultivated state. However, we observed root consumption of *Ziziphus lotus* and *Urtica dioica*. The use of bulbs is encountered in the genus *Allium*, *Allium cepa* and *Allium sativum*.

Use of medicinal plants with antiviral interest according to the method of preparation:

Users prepare phytomedicines with several methods. The decoction is the most frequent method with 26.59%, followed by the infusion with 21.52%, the powder with a percentage of 15.19%, the maceration at 10.12%, the poultice at 8.86%, the fresh juice at 6.33%, and the form gross at 6.33%. While the least used, being the use of essential oils, representing 5.06% (Figure-08).

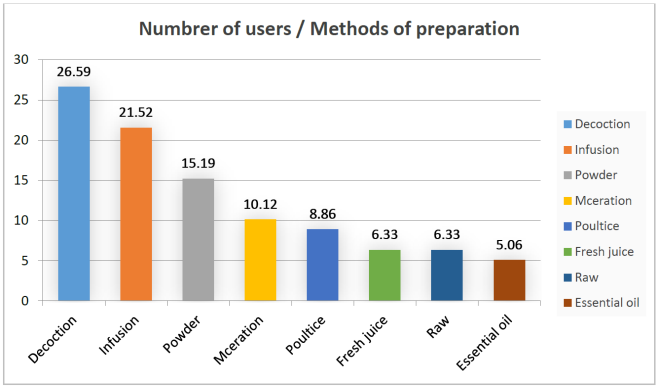

Fig. 08 : Distribution of plants according to method of preparation

Information on how to use medicinal plants and their therapeutic properties may differ from person to person (Serine, 2008). The preparation of medicinal plants by the method of decoction not only makes it possible to warm the body and disinfect it (Tahri *et al.*, 2012), but also makes it possible to reduce toxicity when mixed with other plants, or even to cancel it altogether (Salhi *et al.*, 2010).

Use of medicinal plants with antiviral interest according to the route of administration :

The plant preparations used for the treatment in a traditional way are often administered orally, inhaled or by direct application. The oral route is the most used with a frequency of 71.56%, direct application represents 23.33% and 5.11% of the plants are used in the form of inhalation (Figure-09).

Oral administration correlates with the method of preparation, by decoction, infusion, or maceration. This form of preparation can only be administered orally. This explains the high percentage of users of medicinal plants with antiviral interest by oral administration (Helali *et al.*, 2020; Hamdi and Houari, 2020 ; Brahmi *et al.*, 2022 ; Boutabia *et al.*, 2011; Kouame *et al.*, 2021; Chraibi *et al.*, 2018).

The direct applications of medicinal plants with antiviral interest are found in turmeric, which is also considered, as a condiment, highly appreciated in the Algerian kitchen, and licorice, recommended as natural dental care.

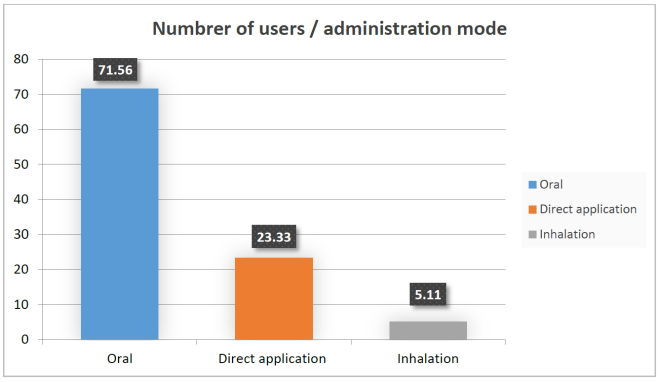

Fig. 09 : Distribution of plants according to route of administration

Conclusion

The ethnobotanical survey carried out in the region of Seraidi (state of Annaba, North-East Algeria), relating to the traditional use of medicinal plants with antiviral interest by the local population, has brought us very considerable information that can be exploited in the field of the valorization of medicinal plants having antiviral activities. A number of 32 species have been identified by healers, herbalists, rural women's cooperatives, as well as local people as medicinal plants used for their antiviral activities and the treatment and prevention against COVID-19. These 32species are grouped into 20 families, of which the Lamiaceae family is the most represented with 25%.

The collection and analysis of the data collected from the interviewees showed that older women use medicinal plants with antiviral interest more than men. In addition, the frequency of use of these plants according to intellectual level has shown that people who have not purdued higher education have a better knowledge of medicinal plants. The leaves represent the most used part of the plant, administered orally after maceration, decoction, or infusion. The other parts of the plant are consumed to lesser degrees.

This ethnobotanical work oriented us towards a sharp selection of antiviral medicinal plants, with the aim of in-depth phytochemical study, which will be presented through other scientific and research publications.

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References

Aboudou A.D. et Koffi K. (2021) Enquête ethnobotanique sur les plantes médicinales utilisées dans la prise en charge traditionnelle des maladies infectieuses dans la région sanitaire Lomé-Commune du Togo. European Scientific Journal, ESJ, 17(21) : 46 – 58.

Angiosperm Phylogeny Group, An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III, Botanical Journal of the Linnean Society, Wiley-Blackwell, Linnean Society of London et Oxford University Press, vol. 161, n° 2, 2009, p. 105–121 (ISSN 0024-4074 et 1095 8339, DOI 10.1111/J.1095-8339.2009.00996.X)

An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. The Angiosperm Phylogeny Group. The Linnean Society of London, Botanical Journal of the Linnean Society, 2016. DOI: 10.1111/boj.12385

Anyinam, C. (1995). Ecology and ethnomedicine: exploring links between current environmental crisis and indigenous medical practices. *Soc. Sci. Med.*, 40(3) : 321-329. DOI : https://doi.org/10.1016/0277-9536(94)E0098-D

Aribi, I. (2013). Etude ethnobotanique de plantes médicinales de la région de Jijel : étude anatomique, phytochimique, et recherche d'activités biologiques de deux espèces. Mémoire de magister, Univ. Houari Boumediène (USTHB), Algérie, pp. 69-71.

Bakiri, N.; Bezzi, M.; Khelifi, L. and Khelifi-Slaoui, M. (2016). Enquête ethnobotanique d'une plante médicinale *Peganum harmala* L., dans la région de M'sila, Revue Agriculture. *Numéro spécial*, 1 : 38 – 42.

Belhaj, S. and Zidane, L. (2021). Medicinal plants used to boost immunity and decrease the intensity of infection caused by SARS-COV-2 in Morocco. *Ethnobotany Research and Applications*, 21: 1-17. https://doi.org/10.32859/era.21.41.1-17

Benkhnigue, O.; Zidane L.; Fadli M.; Elyacoubi H.; Rochdi A. and Douira A. (2010-2011). Ethnobotanical study of medicinal plants in the Mechraâ Bel Ksiri region of Morocco. *Acta Bot. Barc.*, 53 : 191–216.

Benlamdini N.; Elhafian M.; Rochdi A. et Zidane L. (2014) Etude floristique et ethnobotanique de la flore médicinale du Haut Atlas oriental (Haute Moulouya). Journal of Applied Biosciences, 78:6771–6787.

Bigendako-Polygenis, M.J. et Lejoly, J. (1990) La pharmacopée traditionnelle au Burundi. Pesticides et médicaments en santé animale. Pres. Univ. Namur. 425-442.

Bouafia M.; Amamou F.; Gherib M.; Benaissa M.; Azzi R. and Nemmiche S. (2021). Ethnobotanical and ethnomedicinal analysis of wild medicinal plants traditionally used in Naâma, southwest Algeria. Vegetos, 34 : 654–662. DOI https://doi.org/10.1007//s42535-021-00229-7.

Bouayyadi, L.; El-Hafian, M. and Zidane, L. (2015). Étude floristique et ethnobotanique de la flore médicinale dans la région du Gharb, Maroc. *Journal of Applied Biosciences,* 93:8760-8769.

Boughendjioua, H.; Aiouaz, S.; Medkour, L.; Meramria, M. and Metnani, Z. (2022). Chemical composition (a New Chemotype) of Algerian mugwort (*Artemisia Herba-Alba Asso*) Essential oil and his possible potential against COVID-19. HERMED-D-22-00266.http://dx.doi. org/10.2139/ssrn.4085464.

Boughrara, B. (2016). Inventaire et étude ethnobotanique et chimique des plantes à intérêts thérapeutiques et nutritif du Parc National El Kala. Thèse de Doctorat Es-Sciences, option : Phytochimie, Université Badji Mokhtar–Annaba.

Boutabia, L.; Telailia, S. and Menaa, M. (2011). Utilisation thérapeutiques traditionnelles du *Marrubium vulgare* L. par les populations locales de la région de Haddada (Souk Ahras, Algérie)

Bouzid-Ouelaa, S. (2019). Caractérisation et écologie des peuplements d'Amphibiens dans le Nord-Est Algérien. Thèse de Doctorat Es-Sciences, option : Biodiversité, évolution et écologie de la santé, Université Badji Mokhtar–Annaba-

Brahmi, F.; Iblhoulen, Y.; Issaadi, H.; Elsebaï, M.F.; Madani, K. and Boulekbache-Makhlouf, L. (2022). Ethnobotanical survey of medicinal plants of bejaia localities from Algeria to prevent and treat coronavirus (COVID-19) infection shortened title: phytomedicine to manage COVID-19 pandemic. ADV TRADIT MED (ADTM) (2022). https://doi.org/10.1007/s13596-022-00649-z

Chermat, S. and Gharzouli, R. (2015). Ethnobotanical Study of Medicinal Flora in the North East of Algeria-An Empirical Knowledge in Djebel Zdimm (Setif). *Journal of Materials Science and Engineering* A, 5(1-2): 50-59. DOI:10.17265/2161-6213/2015.1-2.007.

Cragg, M.G. and Newman, J.D. (2002). Drugs from nature: achievements, future prospects. Ethnomedicine and Drug Discovery. Iwu M, Wootton J (Eds). Elsevier, New York, USA, 23–37. DOI : 10.1016/S1572-557X (02)80010-1.

Chraibi, M.; Fikri-Benbrahim, K.; Amrani, M.; Farah, A.; Bari, A. BenzianeOuaritini, Z. (2018) Etude ethnobotanique sur l'utilisation de *Mentha pulegium*, *Mentha piperita* et *Pelargonium graveolens* au Nord du Maroc (Taounate) et évaluation de leur pouvoir antimicrobien. *European Scientific Journal*. 14(24) : 113-133. DOI : https://doi.org/10.19044/ esj.2018. v14n24p113.

Ditta, C.D.; Gueye, M. and Akpo, L.E. (2013). Les plantes médicinales utilisées contre les dermatoses dans la pharmacopée Baïnounk de Djibonker, région de Ziguinchor (Sénégal). *Journal of Applied Biosciences*, 70: 5599–5607.

Dieye, P.I. and Sarr, S.O. (2021). Lutte contre la COVID-19 : la phytothérapie africaine au secours de la médecine moderne en panne. *Afrique SCIENCE*, 18(3) :13–21.

Dougnon, V.; Legba, B.; Yadouléton, A.; Agbankpe, J.; Koudokpon, H.; Hounmanou, G.; Amadou, A.; Fabiyi, K.; Assogba, P.; Hounsa, E.; Aniambossou, A.; Déguenon, E.; De Souza, M.; Bankolé, H.S.; Dougnon, J. and Baba-Moussa, L. (2018). Utilisation des plantes du Sud-Bénin dans le traitement de la fièvre typhoïde : rôle des herboristes. *Ethnopharmacologia*, 60(11) : 60-74.

El-Amrani, F.; Rhallab, A.; Alaoui, T.; El-Badaoui, K. and Chakir, S. (2010). Étude ethnopharmacologique de quelques plantes utilisées dans le traitement du diabète dans la région de Meknès-Tafilalet (Maroc). *Phytothérapie*, 8: 161-165.

El-Hafian, M.; Benlamdini, N.; Elyacoubi, H.; Zidane, L. and Rochdi, A. (2014). Étude floristique et ethnobotanique des plantes médicinales utilisées au niveau de la préfecture d'Agadir-Ida-Outanane (Maroc). *Journal of Applied Biosciences*, 81: 7198-7213.

El-Hilah, F.; Ben Akka, F.; Dahmani, J.; Belahbib, N. and Zidane, L. (2015). Étude ethnobotanique des plantes médicinales utilisées dans le traitement des infections du système respiratoire dans le plateau central marocain. *Journal of Animal & Plant Sciences*, 25(2): 3886-3897.

Fouedjou, R.T.; Chtita, S.; Bakhouch, M.; Belaidi, S.; Ouassaf, M.; Djoumbissie, L.A.; Tapondjou, L.A. and Qais, F.A. (2021). Cameroonian medicinal plants as potential candidates of SARS-CoV-2 inhibitors. *Journal of Biomolecular Structure and Dynamics*. DOI: 10.1080/07391102.2021.1914170

Hamdani, F.Z. and Houari, N. (2020). Phytothérapie et Covid-19. Une étude fondée sur une enquête dans le nord de l'Algérie. *Phytothérapie*, 18(5): 248–254. DOI https://doi.org/10.3166/phyto-2020-0241

Hamel, T.; Sadou, N.; Seridi, R.; Boukhdir, S. and Boulemtafes, A. (2018). Pratique traditionnelle d'utilisation des plantes médicinales dans la population de la péninsule de l'Edough (nord-est algérien). *Ethnopharmacologia*, 59: 65-71.

Haoud, K. and Mellali, S. (2021). La phytothérapie et les produits naturels au secours de la médecine conventionnelle dans le traitement et la prévention de la COVID-19. *Algerian Journal of Health Sciences*. 3(3): 79-87.

Helali, A.; Mokhtari, C.; Ghoul, M. and Belhadef, M.S. (2020). Prévenir l'infection par le COVID-19 : Quelle place pour les plantes médicinales selon la population algérienne ? *Algerian Journal of Pharmacy*, 3(1) : 2602–2795.

Hseini, S. and Kahouadji, A. (2007). Etude ethnobotanique de la flore médicinale dans la région de Rabat (Maroc occidental). LAZAROA 28: 79-93.

Jdaidi, N. and Hasnaoui, B. (2016). Etude floristique et ethnobotanique des plantes médicinales au nord-ouest de la Tunisie: cas de la communauté d'OuledSedra. *Journal of Advanced Research in Science and Technology,* 3(1): 281-291.

Koné, D. (2009). Enquête ethnobotanique de six plantes médicinales maliennes : extraction, identification d'alcaloïdes-caractérisation, quantification de polyphénols : étude de leur activité antioxydante. Biologie végétale. Université Paul Verlaine - Metz, 2009. Français. NNT : 2009METZ014S.

Kouame, K.B.; Annem B.J.; Yaom S.S.; Dianem K.M.; Diplom T.F.; Ouattaram A.; Gollym K.J.; Coulibalym K.J.; Konem M.W. and Dosso, M.J. (2021). Enquête sur le niveau de connaissance des plantes médicinales utilisées contre la maladie à Coronavirus, la grippe et le rhume auprès des voyageurs venus pour le test COVID-19 à l'Institut Pasteur de Côte d'Ivoire. *Appl. Biosci*., 168: 17456–17467.

Koudouvo, K. (2009). Contribution à la recherche sur les plantes médicinales à propriété antipaludique du Togo. Thèse de Doctorat Unique de l'Université de Lomé en Biologie de Développement. Option: Ethnobotanique et Pharmacologie des Substances Naturelles, 182p.

Lahsissene, H.; Kahouadji, A.; Tijane, M. and Hseini, S. (2009). Catalogue des plantes médicinales utilisées dans la région de zaër (Maroc occidental). Lejeunia, *Revue de Botanique*, 186 : 1 - 30.

Leonti, M.; Stafford, G.I.; Dal, C.M.; Cabras, S.; Castellanos, M.E.; Casu, L. and Weckerle, C.S. (2017). Reverse ethnopharmacology and drug discovery. *Journal of Ethnopharmacology*, 198 : 417-431. DOI : 10.1016/ j.jep.2016.12.044.

Najem, M.; Ibijbijen, J. and Nassiri, L. (2022). Phytotherapy in response to COVID-19 and risks of intoxication: A field study in the city of Meknes (Morocco). *Journal of*

Pharmacy & Pharmacognosy Research, 10 (3) : 357-386.

Mehdioui, R. and Kahouadji, A. (2007). Etude ethnobotanique auprès de la population riveraine de la forêt d'Amsittène : cas de la Commune d'Imi n'Tlit (Province d'Essaouira). Bulletin de l'Institut Scientifique, Rabat, section Sciences de la Vie. 29 : 11-20.

MNHN & OFB [Ed]. (2003-2022) Inventaire National du Patrimoine Naturel (INPN), site web : https:// inpn. mnhn.fr. Mise à jour le 15 Juillet 2022.

Rhattas, M.; Douira, A. and Zidane, L. (2016). Étude ethnobotanique des plantes médicinales dans le Parc National de Talassemtane (Rif occidental du Maroc). *Journal of Applied Biosciences*, 97: 9187–9211.

Rivière, C.; Nicolas, J.P.; Caradec, M.L.; Desirea, O.; Hassan, D.A.; Rémy, G. and Dupont, F. (2005). Importance de l'identification botanique dans la démarche ethnopharmacologique; cas d'une Bignoniaceae malgache, *Perichlaena richardii* Baill. Acta Botanica Gallica, 152(3): 377-388.

Saadi, H. (2013). Les facteurs du dépérissement des subéraies de l'Edough (Séraidi). Etude des ravageurs des feuilles et des glands du chêne-liège (*Quercus suber* L.). Mémoire en Vue de l'Obtention du Diplôme de Magistère en Biologie Environnementale, Option : Biologie Animale, Université Mohamed Chérif Messadia, Souk Ahras.

Salhi, S.; Fadli, M.; Zidane, L. and Douira, A. (2010). Études floristique et ethnobotanique des plantes médicinales de la ville de Kénitra (Maroc). *Lazaroa*, 31: 133-146.

Sehailia, M. and Chemat, S. (2021). In-silico Studies of Antimalarial-agent Artemisinin and Derivatives Portray More Potent Binding to Lys353 and Lys31-Binding Hotspots of SARS-CoV-2 Spike Protein than Hydroxychloroquine: Potential Repurposing of Artenimol for COVID-19. ChemRxiv. Cambridge: Cambridge Open Engage; this content is a preprint and has not been peer-reviewed.

Slimani, I.; Najem, M.; Belaidi, R.; Bachiri, L.; Bouiamrine, H.; Nassiri, L. and Ibijbijen, J. (2016). Étude ethnobotanique des plantes médicinales utilisées dans la région de Zerhoun-Maroc. *International Journal of Innovation and Applied Studies,* 15(4): 846-863.

Soh, N.P. and Benoit-Vical, F. (2007). West African plants, a source of future antimalarial drugs. *Journal of ethnopharmacology*, 114(2): 130-140.

Tahri, N.; El-Basti, A.; Zidane, L.; Rochdi, A. and Douira, A. (2012). Étude ethnobotanique des plantes médicinales dans la Province de Settat (Maroc). Kastamonu Ünі.; OrmanFakültesiDergisi, *Journal of Forestry Faculty*, 12(2): 192-208.

Tahrioui, A.; Ortiz, S.; Azuama, O.C.; Bouffartigues, E.; Benalia, N.; Tortuel, D.; Maillot, O.; Chemat, S.; Kritsanida, M.; Feuilloley, M.; Orange, N.; Michel, S.; Lesouhaitier, O.; Cornelis, P.; Grougnet, R.; Boutefnouchet, S. and Chevalier, S. (2020). Membrane-Interactive Compounds FromPistacialentiscus L. Thwart Pseudomonas aeruginosa Virulence. Front. Microbiol., 11: 1068.

Tamboura, H.; Kaboré, H. and Yaméogo, S.M. (1998). Ethnomédecine vétérinaire pharmacopée traditionnelle dans le plateau central du Burkina Faso : cas de la province du Passoré. *Biotechnol. Agron. Soc. Environ*., 2(3): 181-191.

Toubal–Boumaza, O. (1989). Les ressources phytogénétiques du Massif de l'Edough (Algérie Nord-Orientale). *Ann. Inst. Nat. Agron. El-Harrach*, 13: (106–125).

Tshibangu, D.S.T.; Matondo, A.; Lengbiye, E.M.; Inkoto, C.L.; Ngoyi1, E.M.; Kabengele, C.N.; Bongo, G.N.; Gbolo, B.Z.; Kilembe, J.T.; Mwanangombo, D.T.; Mbadiko, C.M.; Mihigo, S.O.; Tshilanda, D.D.; Ngbolua, K. and Mpiana, P.T. (2020). Possible Effect of Aromatic Plants and Essential Oils against COVID-19: Review of Their Antiviral Activity. *Journal of Complementary and Alternative Medical Research*, 11(1): 10-22.