Ecological insights and conservation imperatives for Laurus azorica in Morocco


*Sultan Moulay Slimane University, Beni Mellal, Morocco
**Hassania School of Public Works, Casablanca, Morocco
***National Forestry School of Engineering, Salé, Morocco
****Mohammed VI Polytechnic University, Ben Guerir, Morocco

Introduction

The laurel forest, also known as laurisilva, is an ancient evergreen forest that originated during the Tertiary period, approximately 20 million years ago, and once covered Southern Europe and Northern Africa (Jiménez et al., 1996; Morales et al., 1996). Over the course of the Quaternary period, significant climatic changes occurred, resulting in the migration of the laurel tree (Laurus L.) to regions with more favourable climatic conditions for its survival (Rodríguez-Sánchez & Arroyo, 2008). It is hypothesized that Laurus species managed to persist in isolated refugia within the Mediterranean Basin and Macaronesia during the Pleistocene glaciations (Barbero et al., 1981; Rodríguez-Sánchez et al., 2009).

Morocco is one of the regions where Laurus species has managed to survive. The Lauraceae family in Morocco consists of two spontaneous species, namely Laurus nobilis L. and L. azorica (Soler.) Franco (Benabid, 2000). The bay laurel is widely recognized and extensively used throughout the Mediterranean basin and has been intentionally planted beyond its natural range due to its diverse applications (Arroyo-García et al., 2001). Laurus azorica, on the other hand, is native to the Azores, Madeira, and Canary Islands (Brannwell & Brannwell, 1983; Jalas & Suominen, 1991), as well as Morocco (Barbero et al., 1981). It also existed in Europe in a fossil state in various locations (Roiron, 1983).

Initially, L. azorica in Morocco was considered a variety of L. nobilis and was described as L. nobilis var. ronadifólia Emberger & Maire (Alasanchez & Maire, 1932). However, Barbero et al. (1981) later documented it as a distinct species. The presence of L. azorica in Morocco was considered a variety of L. nobilis in the 2016 assessment for the IUCN (International Union for Conservation of Nature) Red List of Threatened Species, L. azorica was classified as Least Concern. However, it is important to note that the populations of L. azorica in Morocco were not included in this assessment and their conservation status remains unspecified. Furthermore, the ecological information and conservation status pertaining to L. azorica in Morocco are limi-
This plant species holds significant cultural and ecological value and is recognized as a highly uncommon plant (Fennane & Ibn Tattou, 1998). Unfortunately, the majority of individuals belonging to this species face a distressing predicament caused by the unlawful and excessive collection of leafy branches, which are subsequently sold for culinary purposes. Currently, there is no specific protection designation assigned to this species in Morocco, aside from the establishment of a biological and ecological interest site in 1996, which seeks to safeguard the distinctive and noteworthy L. azorica populations found within the country.

Officially, due to its alarming state, L. azorica is no longer exploitable in forestry land. However, its importance as an aromatic and medicinal plant has led the Water and Forest Services of the region and stakeholders in its value chain to propose effective reforestation efforts in collaboration with local communities, with an emphasis on highlighting its value chain. However, there is a lack of comprehensive ecological data on the potential habitat of L. azorica.

The present study has three main objectives. Firstly, it aims to define the ecological conditions necessary for the habitats of L. azorica by examining the ecological values of the plant communities that support its growth. This analysis will provide insights into the specific environmental factors crucial for the species’ survival and distribution. Furthermore, the research focuses on analyzing the biogeographic distribution and chorology of laurel populations to map their potential range. By studying the geographic distribution patterns, the study aims to understand the natural distribution of the species and identify suitable areas for conservation and reforestation efforts.

In addition, the study aims to diagnose and analyze various elements of the current value chain associated with L. azorica. This includes assessing the processes involved in harvesting, processing, and marketing the species, as well as understanding its economic significance and potential for sustainable utilization. By addressing these objectives, the study aims to contribute to the conservation and sustainable management of this highly valued forest species.

### Material and methods

**Study area.** The study area is situated at the junction of the Southern Middle Atlas and Central High Atlas in the Beni Mellal Khénifra administrative region of Central Morocco (Fig. 1). Geologically, the region falls within the Atlantic domain, characterized by predominantly limestone formations, and it spans an elevation range of 500 to 2300 m above sea level.

Topographically, the area exhibits elongated reliefs oriented in a northeast-southwest direction, with varying degrees of slope ranging from moderate to steep.

![Fig. 1. Geographical situation of study area](image)

In terms of climate, the region experiences a semi-continental climate, with cold to very cold winters and hot to very hot summers. Precipitation and temperature show a significant spatial variability, with a pronounced gradient from the plains to the mountains. The vegetation cover in the study area is highly diverse. Predominantly, there are thermophilic species, including Pinus halipensis, Tetracodia articulata, Quercus rotundifolia, Ceratonia siliqua, Acacia gummifera, and Euphorbia resinifera. As we ascend to higher elevations, the vegetation comprises communities of *Quercus faginea* and *Laurus azorica*, which are characteristic of the upper ranges. The presence of this diverse vegetation reflects the ecological richness and complexity of the study area, highlighting the importance of examining the specific habitats and plant communities that support L. azorica within this context.

**Autoecological study.** There is limited existing literature on the presence of L. azorica in Morocco, with only a few references available (Jahandiez & Maire, 1932; Barbero et al., 1981; Benabid & Cuzin, 1997).

To fill this research gap, the study employed a phytosociological approach that incorporated the Braun-Blanquet method and its modern extensions (Dengler et al., 2008). The field sampling was carried out along transects selected based on the variation of major climatic gradients and geological structures. Along each transect, 40 relevés were conducted whenever a change in the environment was observed, primarily regarding vegetation type, soil type, slope, geological substrate, and exposure. The phytosociology of L. azorica was documented through the analysis of vegetation relevés, which were then compared with vegetation data from previous studies conducted in Morocco.

**Chorology and mapping of L. azorica locations.** To understand the distribution of L. azorica, location data for populations predominantly represented by this species were integrated and interpreted within a GIS environment. Additionally, the results of the autoecological study, corresponding to different vegetation communities, were spatialized and mapped to highlight the potential distribution area of L. azorica.

230

Biosyst. Divers., 2023, 31(2)
Analysis of the current value chain. This component is carried out through simplified surveys of stakeholders operating in L. azorica value chain to determine the links in the resource’s commercialization chain in the study area. These surveys aim to acquire information related to quantities harvested, sale prices, actors in the value chain, impacts on the resource, etc. The conducted surveys involved the water and forestry administration as the department responsible for resource management, herbalists—grocers, forest operators, and collectors (shepherds, local population).

Data analysis. The collected data, including the floristic relevé data, location data, and value chain survey responses, were subjected to data analysis. The processing of relevé data involved the creation of phytocological summary tables grouping relevés based on the dominance and physiognomy of the species within each plant community. The map data were processed and queried using GIS software to generate a status map illustrating the current distribution of laurel populations and their main range. The map, presented on a topographic background at a scale of 1:350,000, was enhanced with appropriate symbology.

In this study, we utilized two primary sources of data. Firstly, we employed the WorldClim dataset (Fick et al., 2017), which provides global climate layers in GeoTiff format with a spatial resolution of approximately 30 seconds (equivalent to approximately 1 km²). These climate layers were utilized to map various bioclimatic variables. Secondly, we obtained export statistics from the official website of the Moroccan Exchange Office. The data, available for download upon request on the International Trade Platform (https://services.oc.gov.ma/DataBase/CommerceExterieur/requete.htm), provided valuable information for our analysis.

Results

Laurus azorica plant communities. L. azorica does not typically form distinct and well-defined plant communities; instead, it exists in the form of isolated patches within larger plant communities. Currently, the species is only found in the form of scattered individuals, remnants of extensive exploitation. Therefore, understanding the autecology of L. azorica requires considering the plant communities that provide it with habitat and support. Through the fieldwork conducted, including the counting and analysis of various relevés, the study was able to identify and characterize the different plant communities that serve as habitats for L. azorica. These plant communities play a crucial role in supporting the survival and distribution of the species. By examining plant communities and their ecological characteristics, the study aims to gain insights into the specific ecological conditions required by L. azorica and the factors influencing its presence and distribution. This approach allows for a comprehensive understanding of the species’ autecology within the context of its surrounding plant communities.

Low elevation thermophilic holm oak woodland (Fig. 2). Laurus azorica is exceptionally rare within this plant community, which is located at an altitude range of 1200 to 1300 meters. This community is primarily found on the north, northwest, northeast, and west-facing slopes but is limited in extent, being observed only along the oceanic foothills from Forn El Amser to above Zawyat Ech Cheikh. From a bioclimatic perspective, this plant community exists within a sub-humid bioclimatic zone with a temperate to fresh variant. It predominantly thrives on fersiallitic red soils, which possess a well-defined humiferous horizon. These soils have developed on colluvial and alluvial deposits. Among the companion species found alongside L. azorica in this plant community, there are Tetracnitis articulata, Juniperus oxycedrus, Phillyrea latifolia, and Smilax aspera. These species coexist with the holm oak (Quercus rotundifolia) within this particular community, which can be associated with the Smilac maurusiticae-Quercetum rotundifoliae Barbéro, Benahbida, Quézel & Rivas-Martínez, 1981, as described by Barbéro et al. (1981). This plant community exemplifies distinct ecological characteristics and a unique species composition, showcasing the presence of L. azorica in limited abundance alongside other associated plant species.

Mesophilic mid-altitude holm oak woodland (Fig. 3). At an elevation ranging from 1400 to 1600 meters, there is a second group characterized as a mesophilic mid-altitude holm oak community, which exhibits the widest distribution in the Beni Mellal Atlas. This forest group is generally well-preserved and densely populated by holm oak woodland, thriving in favourable conditions along the oceanic facade. The mesophilic mid-altitude holm oak woodland can be observed across various altitudinal levels, including Mesomediterranean, Supramediterranean, and locally Mountain Mediterranean. It occupies diverse exposures and occurs on different geological substrates and soil types. Similarly, to the first group, the presence of L. azorica in this plant community is in the form of isolated islands or individual specimens. The floral composition of this community includes species such as Balsamia gibraltarina, Phillyrea latifolia, Arbutus unedo, Viburum tinus, Quercus faginea, Acer monspessulanum, Juniperus oxycedrus, Lonicer a arborea, and Phlomis samia. These species, along with L. azorica, contribute to the overall biodiversity and ecological dynamics of the community.

Fig. 2. Smilac maurusiticae-Quercetum rotundifoliae plant community

The mesophilic mid-altitude holm oak woodland here is classified within the Balsamoa gibraltarinae-Quercetum rotundifoliae association, as described by Barbéro, Quézel, and Rivas-Martínez in 1981 in the Middle Atlas of Morocco. This plant community is also reported in the Rif mountains (Taleb & Fennane, 2019), demonstrating its presence in multiple locations. In the study area, the occurrence of this plant community has been documented by Ouchbani & Romane (1996), emphasizing its ecological significance and distribution within the area. Laurus azorica is typically restricted to steep slopes or inaccessible rocky areas such as cliffs within this plant community (Fig. 3b).

Quercus faginea plant community. It is found on the oceanic slopes of the Aït Quirwa pass and Bou Izerefe mountain, with limited occurrences on the Koumch massif, at elevations ranging from 1600 to 1800 meters. This plant community primarily consists of a Quercus faginea woodland, and alongside L. azorica, it is characterized by species such as Quercus rotundifolia, Acer monspessulanum, and Crataegus luciniata. These species thrive in optimal conditions, aside from the challenges posed by human activities and grazing on L. azorica individuals. Additionally, there are localized endemic species present in this community, including Linaria gattosefensi, Delphinium favagerii, and Trachystema ballii. The Quercus faginea community is situated within the Mesomediterranean and Supramediterranean levels, displaying a sub-humid to humid climate with temperate and cold variants. From an edaphic perspective, this group occupies the deepest soils within the study area, indicating its preference for specific soil characteristics. This plant community corresponds to the Paeonio maroccanae-Quercetum fagineae, as described by Barbéro, Benahbida, Quézel, and Rivas-Martínez in 1981. It highlights the coexistence of Quercus faginea and L. azorica, among other species, and their ecological interactions within the plant community.

Deciduous broadleaf mountain plant communities. These plant communities are located at higher altitudes, succeeding the previous one. They thrive in a humid bioclimatic environment. The vegetation consists of low and scattered tree communities dominated by deciduous broadleaf species such as Crataegus luciniata, Berberis hispanica, and Fraxinus dimorpha. Within this plant community, L. azorica finds refuge on the cliffs, taking advantage of the rugged terrain. This particular plant community is likely a result of the degradation of the holm oak forest. It corresponds to the Berberido hispanicae-Fraxinetum dimorphae community (Fig. 5a), as described by Quézel and Barbéro in 1981. At higher elevations, there is another new distinct plant community observed along the cliffs of the Laabid River and its tributaries, spanning from Boutferda in the northeast to Tiffirt N’Aït Hamza in the southwest. We describe it as Lauro azoricae - Fraxinetum dimorphae. This new plant community colonizes the fertile, humid, and cool soils found in the crevices of the cliffs. Laurus azoricae
within this one are typically shrubs or small trees and are well-preserved, except for a few individuals accessible to goats that may be partially damaged (Fig. 5b). Other common species in this plant community include Quercus rotundifolia, Fraxinus dimorpha, Clematis cirrhosa, and Jasminum fruticans. It exhibits a preference for cliffs exposed to the north, northwest, and west directions.

Fig. 3. Balansaeo glaberrimae-Quercetum rotundifolii plant community (b) and Laurus azorica within the community (a)

Fig. 4. Paeonio maroccane-Quercetum fagineae plant community (b) and Laurus azorica within the community (a)

Fig. 5. Berberido hispanicae-Fraxinetum dimorphae plant community (a) and Laurus azorica within the community (b)

Cytisus balansae plant community (Fig. 6). It is observed in certain areas of the summit portion of the entire oceanic facade of the study area. However, it is limited to very small patches characterized by very cold and humid bioclimatic conditions. This plant community thrives on rocky soils and is found at the Mountain Mediterranean range. It corresponds to the Centaureo triumfetii-Cytisetum balansae community, as described by Benabid in 1988 (also known as Cerastio gibraltarici-Cytisetum balansae). Within the areas where this plant community occurs, a few L. azorica trees can be observed growing on the walls of small cliffs.

Ecological requirements. The results indicate that L. azorica populations are primarily found in scattered locations exclusively on the oceanic-facing slopes of the ridges overlooking the cities of Beni Mellal, El Ksiba, and Zaouiat Ech-Cheikh (Fig. 7). There are very few other populations occurring in specific ecological conditions to the east of this ridge line. The dominant geographical feature in this region is the North-North-West-West reverse, which constitutes a medium mountain range with rugged reliefs. These reliefs are characterized by the presence of robust Upper Jurassic and Cretaceous rock formations, including sandy dolomites, dolomite stones, dolomitic limestone, and alternating layers of marlstone and limestone.

Fig. 6. Cytisus balansae plant community
The reverse is further shaped by deep ravines and torrents formed by occasional floods. It is within the ecological context of this specific geographic region, with its oceanic exposure and geological features, that *L. azorica* populations thrive and establish their habitats.

After examining the spatialized precipitation data (Table 1 and Fig. 8), it is evident that the stations located at the foot of the oceanic exposure, such as Elkisba, Tagzirte, and Zaouiat Ech-Cheikh, receive significantly higher rainfall compared to other stations that are more continental and protected from atmospheric disturbances originating from the west. Based on these data and the findings of the autecological study, the laurel zone experiences annual rainfall ranging from 500 to 800 mm. The higher rainfall in the laurel zone can be attributed to the influence of the oceanic climate in this region. Furthermore, the tops of the laurel zone, which mark the eastern boundary, are characterized by much colder temperatures (Fig. 9). Despite the variation in elevation and exposure, the oceanic influence helps moderate the thermal differences on the western reverse, contributing to a more consistent and milder climate within the laurel zone. These climate conditions, characterized by higher rainfall and moderate temperatures, play a crucial role in creating suitable habitats for *L. azorica* populations in the study area. The *Laurus azorica* zone in the study area is characterized by the dominance of a sub-humid and humid bioclimatic. This bioclimatic exhibits different variants depending on the altitudinal levels. At lower and medium altitudes, the bioclimate is cool, while at higher altitudes, it becomes cold. The mountain tops within the laurel zone experience a very cold bioclimatic (Fig. 9).

Regarding soil characteristics, *L. azorica* populations are found exclusively on forest mull soils. These soils are distinguished by a significant amount of organic matter, particularly near the surface, where it is well-mixed with mineral components. Forest mull soils are known for their fertility and good drainage properties, providing favourable conditions for the growth and development of *L. azorica*. It is important to note that the specific soil requirements of *L. azorica* contribute to its restricted distribution within the study area, as it primarily occurs in areas where forest mull soils are present.

*Laurus azorica* value chain analysis. The value chain diagnosis reveals that *L. azorica* is currently facing a critical situation due to uncontrolled and abusive exploitation. Historically, the leaves of *L. azorica* were legally harvested and sold through public tenders by the Water and Forest Administration until 2006. The average annual quantity of leaves exploited and sold during this period was 269 tons, with an average unit price of 16 MAD/kg (1.6 Dollars/kg). However, public sales were discontinued in 2006 due to resource depletion. Since then, an illegal and unregulated circuit has emerged, replacing the previous long value chain involving multiple actors.

The current chain is significantly shortened and involves only three links: gatherers, local herbalists-grocers, and local consumers. The gatherers, who are mostly unauthorized individuals such as shepherds, engage in anarchic withdrawals of *L. azorica* to supply the herbalists-grocers in urban centers. This abusive exploitation has further intensified the negative impacts already caused by the previous legal harvesting system. The local herbalists-grocers confirm that their only suppliers of local aromatic and medicinal plants, including *L. azorica*, are the unauthorized gatherers. They report a decline in the availability of *L. azorica* and other local plants in the market. The herbalists purchase the laurel at prices ranging from 20 to 30 MAD/kg (2 to 3 Dollars/kg) and sell it to consumers at prices ranging from 40 to 60 MAD/kg (4 to 6 Dollars/kg). The local consumers, mainly residents of urban centers bordering the laurel zone, constitute the primary market for *L. azorica*. The quantities obtained through unauthorized harvesting are insufficient to supply other cities in Morocco. This situation indicates a worrisome trend towards the total disappearance of the *L. azorica* resource, even in its once inaccessible cliff habitats. It highlights the urgent need for effective conservation and management measures to protect this valuable plant species from further exploitation and ensure its long-term sustainability.

According to the graph (Fig. 11), the quantities of laurel leaves exported have shown fluctuations from year to year. It indicates that there have been increases in exports starting from 2004, followed by a sharp decline in 2016. This suggests that the export market for laurel leaves has been unstable. In terms of selling prices, there seems to be an inverse relationship with the quantity exported. The graph shows that the selling price of laurel leaves increased from 27 to 93 MAD/kg (2.7 to 9.3 Dollars/kg), and then stabilized at 67 MAD/kg (6.7 Dollars/kg) in 2020. This indicates that the monetary value of laurel leaves has improved over time. It is important to note that the graph represents the exports of laurel leaves in general, including the two species, and may not solely reflect the specific situation of *L. azorica*. The fluctuations in quantity and price could be influenced by various factors, including market demand, availability of the resource, and regulatory measures.
Table 1
Bioclimatic parameters of stations closest to the *L. azorica* zone

<table>
<thead>
<tr>
<th>Climate station parameters</th>
<th>Zaouiat Ech-Chelk</th>
<th>Ououizaght</th>
<th>El Ksiba</th>
<th>Tagzirte</th>
<th>Tahanouacht</th>
<th>Boutferda</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation, m</td>
<td>707</td>
<td>940</td>
<td>1000</td>
<td>600</td>
<td>1450</td>
<td>1500</td>
</tr>
<tr>
<td>m, °C</td>
<td>2.9</td>
<td>1.5</td>
<td>1.1</td>
<td>2.8</td>
<td>0.4</td>
<td>–1.2</td>
</tr>
<tr>
<td>M, °C</td>
<td>32.8</td>
<td>33.7</td>
<td>31.8</td>
<td>33.2</td>
<td>33.3</td>
<td>31.5</td>
</tr>
<tr>
<td>P, mm</td>
<td>662</td>
<td>527</td>
<td>639</td>
<td>586</td>
<td>558</td>
<td>557</td>
</tr>
<tr>
<td>Q₂</td>
<td>75.9</td>
<td>56.1</td>
<td>71.4</td>
<td>66.1</td>
<td>58.2</td>
<td>58.4</td>
</tr>
</tbody>
</table>

| Bioclimat                 | Cool sub-humid    | Cool semi-arid | Cool sub-humid | Cool semi-arid | Cool sub-humid | Cold sub-humid |

Note: Q₂ – Emberger Pluviothermic ratio (Emberger, 1955); m – min temperature of coldest month; M – max temperature of warmest month.

![Fig. 8. Annual precipitations map](image8)

![Fig. 9. Minimum temperature of coldest month map](image9)
Discussion

This study focuses on deepening our understanding of the ecological and biogeographic significance of *L. azorica* in Morocco, an aromatic and medicinal plant facing intense human pressure. While native to the Canary Islands, Madeira, and the Azores (Bramwell & Bramwell, 1983; Jalas & Suominen, 1991), *L. azorica* has been identified in the Atlas Mountains of North Africa (Barbero et al., 1981; Benabid & Cuzin, 1997).

Indeed, it is developing within the forestry and pre-forestry plant communities, or even locally in those of the matatorlas, but often within those of the cliffs of the entire oceanic exposure of the Beni Mellal Atlas between Tazenkoute mountain and the borders of the Khenifra province, which mark the limit of the oceanic exposure favourable to the development of the species. It is also found outside its potential area, in a relatively more continental zone, on the borders of Hlasias water sources, and on cliffs exposed to the North, North-West and West of the gorges in Laahid River as well as on those of the Chito and Abbudine mountains, Northeast of the Bine El Ouidane Dam (High Central Atlas). In all three cases, the permanent presence of water ensures freshness and a high level of atmospheric humidity in these relatively more continental areas where the oceanic influence is well attenuated. This is a real compensation for the atmospheric moisture deficiency of these areas. These *L. azorica* habitats correspond to those previously described by Médail and Quézel in Southwestern Morocco. These authors underlined that *L. azorica*, a species dispersed by ornithochory, occupies mid altitude cliffs (Medall & Quézel, 1999).

The *L. azorica* zone records annual rainfall between 500 and 800 mm. It benefits from high atmospheric humidity which gives rise to a large number of foggy days and mist per year, which considerably attenuate the summer drought. Outside this oceanic zone, the laurel still occupies sheltered places in the cliffs that benefit sufficiently from the oceanic atmospheric humidity coming from the West, due to the absence of significant landforms. This climate has been reported by several authors before (Ceballos & Ortúñho, 1951; Bramwell & Bramwell, 1983; Santos, 1983; Rivas-Martínez, 1987), it is similar to that which bathes laurisilva in the archipelagos of Macaronesia. This allowed them to confirm that *L. azorica* populations are found in the Atlantic islands, in humid mountainous areas with abundant fog (Rodriguez-Sánchez, 2011). In general, *L. azorica* exhibits greater similarities to plants native to humid subtropical regions rather than those found in Mediterranean climates characterized by sclerophyllous vegetation (Morales et al., 2001). *Laurea azorica* prefers only rich, humiferous, thick, black, rich, light-textured, lumpy, and well-drained soils. These soils develop on the ledges and in the cracks of the cliff’s walls in exposure North, North-West and West, and on the rocks downstream of the cliffs. Everywhere, the soils of all the biotopes of *L. azorica* are always very humiferous. These edaphic conditions are particularly indispensable to the species. This typical behaviour of *L. azorica* is similar to that observed in mesic, humid and hyper-humid laurelphilic forests in the Azores islands (Dias et al., 2005), where laurel grows on permeable soils on basaltic substrate or impermeable soils on pumice-stone drop deposits (Elias et al., 2016).

It was stipulated that climate change during the Quaternary Era led to a gradual decline in laurel populations over their entire range (Elias et al., 2016). These laurel forests were exuberant forest communities requiring relative humidity and being very sensitive to low temperatures. Most species were extinct before the Pleistocene, but some have managed to survive and persist today in remnant populations in the Mediterranean basin (Rodriguez-Sánchez, 2011). However, in Morocco the heavy use of the plant as an aromatic and medicinal species and its high level of palatability to goats, have led the species to a critical situation. Inaccessible individuals confined to the cracks and ledges of the cliffs are well preserved, as they are relatively free from human and livestock pressure. In the latter case, these are real self-preservation sites where *L. azorica* manages to remain itself by vegetative reproduction due to its power of asexual regeneration (Elias & Dias, 2009). The bioclimatic and edaphic data thus collected, namely areas exposed to oceanic air masses and well-watered in precipitation (between 500 and 800 mm) and minimum temperatures around 0 °C and deep soils indicate the optimal conditions for any rehabilitation of this species in its environment.

It is important to note that this dramatic state of *L. azorica* is getting worse, despite the absence of any regular selling for several years. This makes it possible to argue that informal cutting by a large number of unauthorized harvesters, which led to this serious deterioration, must have become very frequent, and extended to all accessible laurel populations, and therefore proved devastating due to the large quantities of biomass collected to satisfy the high demand for leaves. Consequently, most *L. azorica* trees fail to attain the necessary biomass for optimal photosynthesis and flowering. This hinders the natural regeneration process, considering that the spatial arrangement of trees, seedlings, and saplings of *L. azorica* relies heavily on asexual regeneration through basal sprouts and environmental conditions (Arêvalo & Fernáñdez-Palacios, 2003). It should be noted that the species is not subject to any protection legislation, nor to any regulatory provisions governing how it is exploited and used.
The current value chain of L. azorica is very limited and does not allow for sustainable value creation, considering the availability of the raw material. Indeed, the significant degradation of the resource and the low level of valorization (lack of drying, packaging, and distillation units) have not led to a true valorization of the resource.

In order to secure the long-term survival of L. azorica, a set of recommendations is proposed. Firstly, it is crucial to establish a comprehensive legal framework that addresses the conservation and sustainable management of this species. This framework should encompass regulations for evaluating resources, promoting responsible harvesting practices, and ensuring habitat protection. The effective implementation and enforcement of these laws necessitate collaboration among government authorities, local communities, and conservation organizations. Furthermore, efforts should be concentrated on habitat restoration and safeguarding measures, including the identification and designation of protected areas, the implementation of habitat restoration programs, and the management of human activities to minimize disturbances.

Community engagement and raising awareness play a pivotal role in the conservation of L. azorica. Engaging local communities and stakeholders through awareness campaigns, training programs, and the provision of alternative livelihood opportunities is of utmost importance. By emphasizing the ecological significance of L. azorica and the benefits of its sustainable management, a sense of ownership and responsibility can be fostered among local communities. Additionally, it is recommended to continue research and monitoring programs to gather additional data on the species' ecology, population dynamics, and response to environmental and changes. This information will contribute to the development of evidence-based conservation strategies and adaptive management approaches. Overall, implementing these recommendations will contribute to the preservation and sustainable management of Laurea azorica, ensuring its ongoing existence and the conservation of its unique habitats in Morocco.

Conclusion

This study underscores the critical state of L. azorica in Morocco, as a result of indiscriminate and unregulated harvesting practices leading to the depletion of its biomass and inadequate natural regeneration. The ecological habitats of this species are inherently fragile and have been further compromised by human activities. Urgent measures are required to prioritize the conservation and ecological restoration of L. azorica habitats, with the aim of safeguarding Morocco’s unique floristic biodiversity. Effective action should be taken promptly to ensure the long-term survival of this significant aromatic and medicinal plant. Furthermore, it is imperative to establish appropriate regulations governing the sustainable harvest and utilization of this resource, fostering the development of a responsible and environmentally conscious value chain. Active engagement and collaboration among various stakeholders, including governmental bodies, local communities, and consumers, are vital in preserving L. azorica and its associated ecosystem for future generations.

Our heartfelt thanks and appreciation are addressed to the late Prof. Abdelnour Benabd as for his fruitful collaboration and his effective contribution to this study.

References


