Ethnobotanical uses and distribution status of *Arbutus unedo* in Morocco

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Databases and Inventories

Abstract

Background: *Arbutus* is a fruit tree with high ornamental, environmental, economic and medical value, because of the properties attributed to different biological parts. Given this interest, the present study is interested in describing the distribution, ecology and ethnobotanical status of natural populations.

Methods: The range of this species has been largely prospected and explored to locate their natural populations and describe their distribution and conservation. For ethnobotanical uses of *Arbutus* in Morocco, we compiled available data from literature.

Results: The prospection of the Arbutus natural distribution areas in Morocco has shown that the species is growing in different biogeographical regions. Moreover, of its ecological plasticity and phyto-association, its resistance to mutilations and its great dynamism, it is very present in the everyday uses of foresters, farmers and rural populations. The international bibliographic analysis shows that the different biological parts of Arbutus, especially fruits, have been widely used by herbalists. The related literature is generally in line with the medicinal use of the plant by Moroccan inhabitants. On the other hand, the consumption and the industrial valorization of the fruits of Arbutus are very limited in Morocco in comparison with those on the international scale.

Conclusions: It is imperative to sensitize the local population and landlocked Douars on the knowledge of the valorization of the fruit of this species, and how to develop the marketing, the conservation and the transformation of fruits and by-products, and the production of new medicines and wellness products.

Key words: *Arbutus unedo* L., ethnobotanical uses, prospection, ecology, *Arbutus* fruit.

Résumé

Contexte: L'arbousier est un arbre fruitier à haute valeur, environnementale, économique et médicale, en raison de ces propriétés attribuées aux différentes parties biologiques. Compte tenu de cet intérêt, la présente étude s'intéresse à la description de la répartition, écologie et du statut ethnobotanique des populations naturelles de cette espèce.

Méthodes: L'aire de répartition de cette espèce a été largement prospectée et explorée afin de localiser ses populations naturelles et de décrire leur répartition et leur conservation. Pour les utilisations ethnobotaniques d'Arbutus au Maroc, nous avons rassemblé les données disponibles provenant de la littérature.

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Résultats: La prospection des zones de distribution naturelle d'Arbutus au Maroc a montré que l'espèce se développe dans différentes régions biogéographiques. De plus, de par sa plasticité écologique et sa phyto-association, sa résistance

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aux mutilations et son grand dynamisme, il est très présent dans les utilisations quotidiennes des forestiers, des agriculteurs et des populations rurales. L'analyse bibliographique internationale montre que les différentes parties biologiques d'Arbutus, notamment les fruits, ont été largement utilisées par les herboristes. La littérature connexe est généralement en ligne avec l'utilisation médicinale de la plante par les habitants marocains. En revanche, la consommation et la valorisation industrielle des fruits d'Arbutus sont très limitées au Maroc par rapport à celles à l'échelle internationale.

Conclusions: Il est impératif de sensibiliser la population locale et les Douars à la connaissance de la valorisation du fruit de cette espèce et de la manière de développer la commercialisation, la conservation et la transformation des fruits et des produits dérivés.

Mots clés: Arbutus unedo L., usages ethnobotaniques, prospection, écologie, fruit d'arbousier.

Background

The *Arbutus* (*Arbutus unedo* L.) is a fruit tree belonging to the family Ericaceae and often called strawberry tree. It is found in western, central and southern Europe, northeastern Africa, the Canary Islands and western Asia. It can also be found distributed in countries in North America, and on the Atlantic coast such as Ireland and Macaronesia (Canary Islands) (Abbas 2015, Celikel *et al*. 2008, Rodriguez 2011). In the Mediterranean, it is present in Portugal, Spain, France, Italy, Morocco, Albania, Croatia, Bosnia, Montenegro, Grec, Turkey and the Mediterranean islands (Pedro 1994, Rodriguez 2011, Torres *et al*. 2002). It's a tree that grows in acidic and calcareous soils and can reach up to 12 meters and can grow in rocky areas (Krussmann 1982, Rodriga de Sà 2010). As a Mediterranean plant, it has the ability to regenerate after forest fires (Konstantinidis *et al*. 2006). Generally, it has a height growth of shrubs ranging from about 5 meters to 12 meters, with branches that grow from the chest from 0.5 meters above the ground (Rodriga de Sà 2010, Seidemann 1995). Also known as the persistent leaf plant, the *Arbutus* canopy is rounded with elliptically shaped persistent leaves that assume a dark green color similar to that of cork, with a waxy glow on the upper surface. The flowers of this tree, white or slightly pink, are very decorative which makes it ornamental. Flowers are still considered to be of great importance to the ecosystem because they are a source of nectar for bees (Floris *et al*. 1992, Soro & Paxton 1999). All these biological properties make the *Arbutus* tree of great ecological and ornamental importance. Also, the *Arbutus* plant is now considered a source of therapeutic agents in medicine (Pawlowska *et al*. 2006, Silva-E-Alarcão *et al.* 2001). These properties come mainly from its chemical composition rich in secondary compounds with antioxidant properties, namely: phenols, vitamins C and E, carotenoids and organic acids (Fiorentino *et al*. 2007, Kivçak *et al.* 2001, Males *et al*. 2006, Pallauf *et al.* 2008). *Arbutus* leaves are used for their antioxidant, astringent, diuretic, anti-diarrheal, depurative and more recently used in the treatment of diseases such as hypertension, diabetes and inflammatory problems (Mariotto *et al.* 2008, Oliveira *et al.* 2009, Ziyyat & Boussairi 1998). In addition to its use in traditional medicine, the fruit of the *Arbutus* tree is highly sought after for its nutritional qualities. It is used for the consumption and production of alcoholic beverages, jams, jellies and marmalades (Pawlowska *et al.* 2006, Simonetti *et al.* 2008). Many epidemiological studies have noted that high fruit and vegetable consumption is associated with reduced disease risk (Boubekri 2014, Oliveira *et al.* 2011). *Arbutus* berries contain significant amounts of phytochemical compounds, including polyphenols and oligo-minerals, which are micronutrients that are particularly abundant in fruits (Ayaz *et al.* 2000, Fortalezas *et al*. 2010, Pallauf *et al.* 2008). These secondary metabolites are involved in many aspects of plant biological systems: pigmentation, growth and reproduction mechanisms, protection against predators, etc. (Fortalezas *et al*. 2010, Oliveira *et al.* 2011, Abbas 2015).

In Morocco, the *Arbutus unedo* L. remains poorly studied and known from the point of view of nutritional and therapeutic uses in medicine (Bellakhdar 1997, Meziane 2003, Sijelmassi 1993, Ziyyat & Boussairi 1998). Several scientific studies at the Mediterranean scale have demonstrated the great nutritional value of *Arbutus*, thanks to its composition in certain nutrients (carbohydrates, vitamins and minerals) and phytonutrients (polyphenols). Although the value of uses of this species in other Mediterranean countries, it remains very limited and undiversified in Morocco (Abbas 2015). The cultivation of this species is restricted as it is not consumed widely but except local population living close to the forests and they are either socially or economically backward. The exploitation of this species remains traditional (Jaradat 1995). Their loss, due to over-exploitation, could jeopardize the socio-economic development of present and future generations. Therefore, the conservation, preservation and sustainable use of these resources remain necessary. Thus, the high sustainable production in this species can contribute to reinforce its consumption as an alternative to the fruits

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available on the market or a source of bioactive compounds for food supplements necessary (Aparicio *et al*. 2008, Gomes & Canhoto 2009). Any wise program of production, breeding, and conservation should be based on reliable information about the geographical and ecological distribution, on the one hand and the other, of the variation and genetic structure of the species (Aparicio *et al*. 2008, Gomes & Canhoto 2009). At present, no study is done on the characterization of the geographical and ecological distribution potential of the *Arbutus* in Morocco. Developing and enriching the database with information on the use and geographical distribution of the *Arbutus* will be at the service of all improvement programs and genetic conservation, both nationally and internationally. In this context, the objective of this work is to describe the distribution and ecological status of natural populations, and to compile available data on the ethnobotanical uses of *Arbutus* in Morocco in comparison with other studies at the international level.

Material and methods

In order to describe the distribution and ecology status and the state of conservation of the populations (e.g. dense or clear, natural or planted, etc.) of *Arbutus unedo* in Morocco, prospecting missions were organized during two companies in 2016 and 2017. For this purpose, we initiated the collection of information on geographic and ecological distribution data from desk research (Aafi *et al.* 2002) and the use of existing archives at the local, regional and national levels (Forest Management Documents in Morocco). In practice, an informal consultative approach based on interviews with the competent services and facilitators has been adopted for the localization of the natural sites of the *Arbutus* (case of the services of Water and Forests and the local population including pastors and farmers of the *Arbutus*). However, we organized several outings during the years of 2016 and 2017 by browsing largely the range of *Arbutus unedo* in Morocco. Once the sites and populations of *Arbutus* localized after the prospection stage and their natural origins verified, the harvest was conducted in November 2017. The basic information on the distribution of the species is useful to choose the sampling procedure to use. Seventeen populations in geographically different regions were sampled at eight to twenty individuals per population (Fig. 1).

In terms of ethnobotanical use, we collected as much information as possible (Table 3) based on a set of antecedent ethnobotanical studies applied to the national and international strawberry tree (e.g. Favier *et al.* 1993, Correia *et al.* Rodriguez *et al.* 2011). In practice during the survey, we conducted interviews with the local population of the regions visited on the vernacular name, the parts used (leaves, fruit, root, bark), the method of preparation and the therapeutic uses practiced.

Results and discussion

Distribution and ecological status of the natural populations of the *Arbutus* tree

The prospecting carried out during the period 2016 and 2017 (unpublished data), and the collection of information from documentary research and the use of existing archives at the local, regional and national levels in Morocco, enabled us to determine the distribution area of the more or less dense natural populations of the *Arbutus unedo* L. It grows spontaneously in the scrublands of forest and periforest areas belonging to the holm oak, cork oak and high and dense maquis of the meso-mediterranean region of the Western Rif, Central Plateau, and the Middle and High Atlas (Aafi *et al*. 2002). In the light of these data, the natural distribution status of the *Arbutus* tree in the different ecological regions; namely Northwest, Central Plateau, Pre-Rif and Western Rif, High and Middle Atlas were assessed. Thus, seventeen zones have been identified with areas of natural *Arbutus* population more or less dense according to the bioclimatic gradient (Table 1, Fig.1). The densest populations in *Arbutus* are found in the Northwest (Ouezzane case), Pre-Rif (Taounate case) and Western Rif (Chefchaouen case) regions, where the climate is subhumid to humid (Table 2). The density estimate of this forest species was established only by direct observation of strawberry tree individuals in relation to a given area. However, the state of the *Arbutus* tree in some areas of the North-West (Larache) and the Western Rif (Bab Taza and Ketama cases) is threatened by forest fires in favour of the creation of agricultural land due to the good quality of the climate and soil. The Middle Atlas (case of El Ksiba (Beni-Mellal)) and Central Plateau (case of Ouelmès (Kemisset)) areas, where the climate is subhumid and humid, are characterized by moderately dense natural populations (Table 2). The bioclimatic stages of the semi-arid (Table 2) linked to the Middle (Azilal) and High Atlas (Al Haouz) areas have less dense populations in *Arbutus*. But it can sometimes be found in the sporadic state of *Arbutus* trees in the upper limit of forest vegetation, as in the case of the Souss plateau regions (Personal communication with an ecologist from the Faculty of Science of Agadir (Souss). This person is a professor of higher education who carries out scientific research and the activities of educational outings in ecology of more than 25 years). It should

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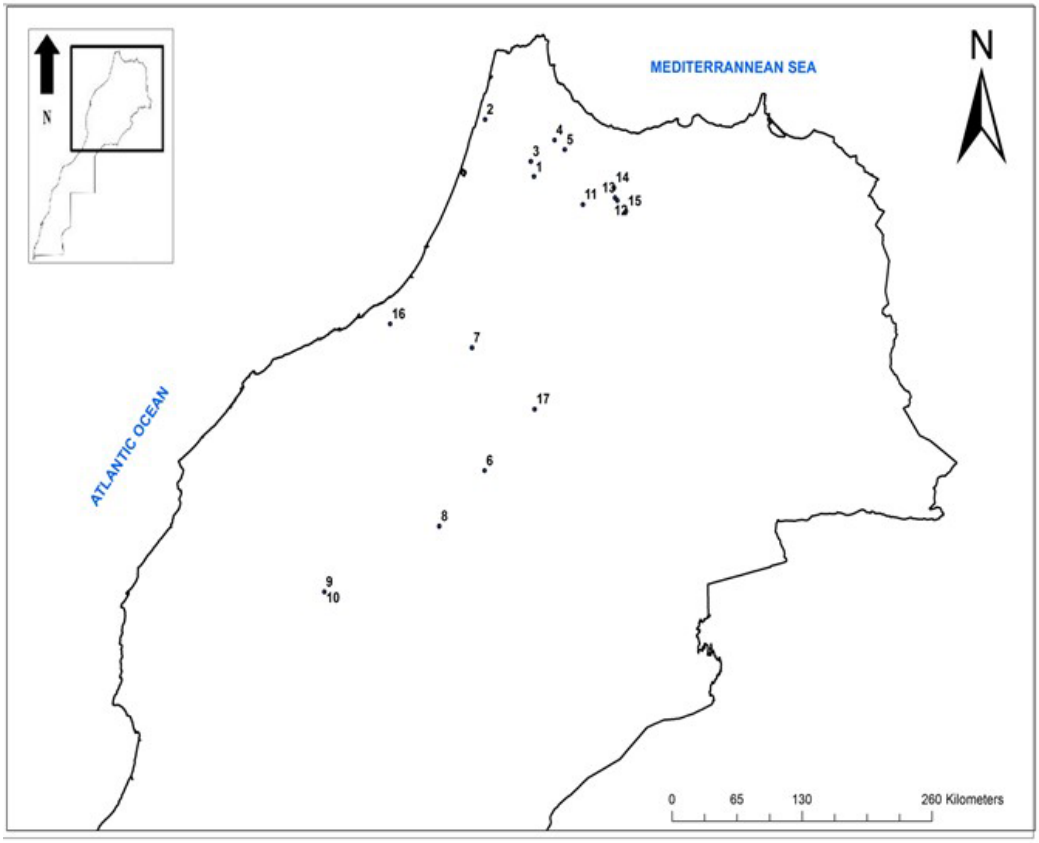
be noted that all the geographical regions of distribution of the *Arbutus* are characterized by an average annual temperature and precipitation, respectively, between 12.4°C and 18.4°C and between 337 and 1115 mm (Table 2). Its altitudinal range is between 150 m (Larache) and 1613 m (Khenifra) (Table 2). The *Arbutus* tree is widespread on all types of substrates but most often siliceous and calcareous (Aafi *et al.* 2002). This species prefers fresh, well-drained soils, and when it is in a stand, it indicates the characteristic of good fertility stations (Aafi *et al.* 2002).



1. Forêt Izaren, Zoumi, Ouezzane
2. Forêt Tcharejdid et Krimda, Sahel, Laarache
3. Forêt Izaren, Brikcha, Ouezzane
4. Dardara, Chefchaouen
5. Forêt Aabaid, Bab Taza, Chefchaouen
6. Forêt Tadaout,Taghbalout Nouhlima, Leksiba
7. Ouelmès, El khmissat
8. Douar Irizane,Bin El Ouidane
9. Ghmate, Ourika, Marrakech
10. Forêt de Toufliht, Route du col de Tichka, Marrakech
11. Forêt Aouna,Ghafsai ,Taounate
12. Forêt Chattaba, Douar El Haddada, Zrizer, Taounate
13. Douar Tabrant, Khlalfa,Taounate
14. Douar Zitouna,Ikaouen, Ketama, El Hoceima
15. Forêt Essaïed, Bouadel, Taounate
16. Aïn Tizgha, Benslimane
17. Sources Oum Errabia, Khénifra

Fig. 1: Location of the different populations with their origins from the *Arbutus* tree prospected in Morocco.

Surveys of vegetation indicative of the presence of the *Arbutus* tree, carried out during the survey, revealed a diversity of species that contribute to the individualization of forest and pre-forest ecosystems. Indeed, the forest species that contribute to the individualization of the different types of stands of the *Arbutus* tree are: *Quercus ilex, Quercus suber, Quercus pyrenaica, Pinus halepensis Tetraclinis articulata, Juniperus oxycedrus, Juniperus thurifera.* Other species such as *Pistacia lentiscus,* Cistus *(Cistus monspeliensis, Cistus villosus, Cistus ladaniferu), Myrtus communis,Crataequs, Ceratonia siliqua, Olea europaea* subsp. *europaea* var. *sylvestris, Chamaerops humils, Eucalyptus globulus, Tamarix aphylla, Daphne gnidium, Urginia maritima, Lavandula sticas, Asphodelus albus, Nerium oleander, Laurus nobilis, Asparagus officinalis and Globularia alypum.*

Due to its ecological and phyto-association plasticity, its resistance to mutilation and its great dynamism, it is very present in the daily uses of foresters, farmers and rural populations.

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Table 1. Characteristics of the administrative regions of *Arbutus* populations prospected and collected in Morocco.

Popul-ations	Administrative regions	Provinces	Circles	Caïdats	Communes
1	**Tanger- Tétouan-AL Hoceima**	Ouazzane	Mokrisset	Zoumi	Zoumi
3		Ouazzane	Mokrisset	Brikcha	Brikcha
2		Laarache	Oued El Makhazine	Khmiss Sahel	Sahel
4		Chefchaouen	Bab Taza	Tanaqoub	Dardara
5		Chefchaouen	Bab Taza	Béni Ahmed	Bab Taza
14		Al Hoceima	Ketama	Ikaouen	Abd Elghaya Souahel
6	**Béni Mellal-Khénifra**	Béni Mellal	El Ksiba	Aït Ouirra	Taghbalout Nouhlima
8		Azilal	Ouaouizeght	Ouaouizeght	Bin El Ouidane
17		Khénifra	Khénifra	Khénifra	Oum Errabia
7	**Rabat-Salé-Kénitra**	Khémisset	Ouelmès	Ouelmès	Ouelmès
9	**Marrakech- Safé**	Al Haouz	Aït Ourir	Ghmate	Ghmate
10		Al Haouz	Touama	Tazart	Tazart
11	**Fès-Meknès**	Taounate	Ghafsai	Ourtzag	Ghafsai
12		Taounate	Taounate	Bouhouda	Zrizer
13		Taounate	Taounate	Bouhouda	Khlalfa
15		Taounate	Taounate	Bni Oulid	Bouadel
16	**Casablanca-Settat**	Benslimane	Aïn Tizgha	Ziaïda	Aïn Tizgha

Table 2. The geographical and ecological characteristics of the natural populations of the Arbutus tree prospected and collected in Morocco.

Pop	Geographic Region	Latitude (N)	Longitude (W)	Altitude (m)	T (°C)	Pr (mm)	Bioclimatic zone
1	North West	34°48’	5°29’	422	17,9	889	Sub-Humid
2	North West	35°15’	6°21’	150	17,9	700	Sub-Humid
3	North West	34°55’	5°31’	200	18,4	883	Sub-Humid
4	Western Rif	35°51’	5°16’	450	17,6	835	Sub-Humid
5	Western Rif	35°11’	5°91’	745	15,3	1135	Humid
14	Central Rif	34°43’	4°37’	654	12.4	831	Sub-Humid
11	Pre-Rif	34°35’	4°57’	450	18,4	735	Sub-Humid
12	Pre-Rif	34°37’	4°35’	645	18,2	613	Sub-Humid
13	Pre-Rif	34°38’	4°36’	709	16,0	662	Sub-Humid
15	Pre-Rif	34°32’	4°29’	709	16,6	612	Sub-Humid
6	Middle Atlas	32°31’	6°11’	1338	16,4	718	Sub-Humid
8	Middle Atlas	32°05’	6°29’	1313	17,6	490	Semi-arid
17	Middle Atlas	33°01’	5°29’	1613	13,2	702	Sub-Humid
7	Central Plateau	33°28’	6°91’	983	13,6	756	Sub-Humid
16	Central Plateau	33°39’	7°21’	275	17,4	463	Semi-arid
9	High Atlas	31°33’	7°42’	967	17,7	337	Semi-arid
10	High Atlas	31°29’	7°24’	867	18,0	360	Semi-arid

Pop: populations; **T** (°C): Average annual temperature in °C; **Pr** (mm): Average annual precipitation in mm.

Ethnobotanical use of *Arbutus unedo* L. in Morocco

Since time immemorial, man has endeavored to exploit nature for his medical and food needs, and during the development of ancient civilizations the exploitation of plants for medicinal use has developed their knowledge and experimentation in this field (Lahsissene *et al.* 2009, Rhattas *et al.* 2016). Thus, various studies have been published over the past few decades that have provided information on the vernacular names, the types of

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diseases treated, parts used and the preparation method of the *Arbutus* tree (Table 3).

The results of previous ethnobotanical studies applied to the *Arbutus* tree show that leaves are the most commonly used plant parts, followed by the underground part and fruits (Table 3). The rest of the plant parts (flowers, stems, seeds, and bark) are used less. The predominance of use of one organ over another in the therapeutic field stems from its concentration in active ingredients. Thus, leaves are the most commonly used because they are a site of photochemical reactions and a reservoir of organic matter that results from them (Bammoui *et al.* 2015, Cunningham 1996).

In order to facilitate the administration of the active ingredients of each part of the plant, several modes of preparation are used, namely decoction, infusion, powder, fumigation, poultice, maceration. In Morocco, the method of preparation of the leaves and/or roots of the *Arbutus* tree, in powder or raw form, is decoction, which is administered mainly by mouth (Table 3). The frequent use of decoction can be explained by the extraction of a non-concentrated dose of the active ingredients while reducing the toxic effect of certain compounds.

And according to each organ, the decoction of the *Arbutus* plant is used in many therapeutic actions (Table 3):

Leaves: Herbal tea made from the leaves of the *Arbutus* tree has often been used to lower blood pressure, and to protect against colds, diabetes and other respiratory diseases (Meziane 2003, Orch *et al.* 2015). Other studies (Dallahi 2017, Lahsissene *et al.* 2009, Rhattas *et al.* 2016, Sijelmassi 1993) have shown that *Arbutus* leaves have astringent, diuretic, antiblennorragic, antispasmodic, anti-inflammatory, renal antiseptic properties. These properties are due to the presence of tannin, gallic acid and certain glucosides (case of Arbutoside) (Bizouard & Favier 1992, Favier *et al.* 1993).

Fruit: consumption of *Arbutus* fruits is seasonal and responded in the Western Rif region among the "Jbalas" population (Table 3). Seasonal marketing of fruit remains local and linked to its natural distribution area. They are brought by rural people to city markets or sold by the roadside in small baskets made of palmier nain or reed. Fruit valuation is still timid and limited to beekeeping for the production of *Arbutus* honey from Jbal Moulay Abdessalam (Chefchaouen region (Table 1)), or to the use for the production of jams and pastries by a "Talassemtane" cooperative located in the Western Rif of Morocco (Rhattas *et al.* 2016). Concerning the therapeutic effect of the fruits of the *Arbutus* tree, the population of "Jbalas" considers that taking some fruits in infusion to treat digestive diseases and diarrhea. On the other hand, if taken in excess, the infusion of fruits on fasting has a purgative or intoxicating effect. The prospects propose the enhancement of the ways in which the fruits of this species are used as food supplements.

Root: It is used in the treatment of diabetes, digestive diseases, respiratory diseases, rheumatic diseases, and also has anti-inflammatory and osteo-articular action (Orch *et al.* 2015, Rhattas *et al.* 2016, Slimani 2016).

Bark: It is reputed to be astringent, diuretic, hypertensive, anti-diarrheal and treats gastric pain (Lahsissene *et al.* 2009, Rhattas *et al*. 2016).

Table 3. Synthetic list of the ethnobotanical uses of the *Arbutus* tree in the different regions of Morocco.

Regions	Vernacular name	Used parts of the plant	Preparation method	Route of adminis-tration	Therapeutic action	References
Regional Natural Park of Bouhachem (Rif of Morocco); Taza Province (North of Morocco)	Bakhenou, El Matroun; Sasnou	Root	Decoction /Powder	Oral	Treatment of asthma and stomach	(Bachar *et al.* 2016, Khabbach *et al.* 2012)
Oujda Region	Sasnou		Decoction	Oral	Used in respiratory tract disorders, as an anti-inflammatory and hyperglycemic agent	(Meziane 2003, Ziyyat *et al.* 2002, Bezanguer *et al.* 1990)

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Talassemtane National Park (Occidental Rif of Morocco)	Arbousier		Decoction / Raw	Oral	Used against hypertension, as an anti-inflammatory, and against rheumatism	(Rhattas *et al.* 2016)
Zerhoun region	Sasnou, Bakhnou		Decoction/ Infusion	Oral	Treatment of the Osteo-articular, metabolic, and digestive tract	(Slimani 2016)
Izarene region (North of Morocco)	Sasnou		Decoction	Oral	Treatment of high blood pressure and diabetes	(Orch et al. 2015, Abdalla *et al*. 1994)
Achach Forest (Central Plateau of Morocco)	Lenj, Bakhenû, Arbousier		Decoction	Oral	Used for high blood pressure and liver aches	(Kahouadji 1995, Bammi *et al.* 2002)
Izarène region (North of Morocco)	Sasnou	Leaves	Decoction	Oral	Treatment of high blood pressure and diabetes	(Orch *et al.* 2015)
Zaër region (Occidental Morocco)	Sasnou, Arbousier		Decoction	Oral	Used against urinary stones	(Lahsissene *et al*. 2009)
Oujda Region	Sasnou		Decoction	Oral	Diuretic effect, urinary antiseptic	(Meziane 2003, Aarons *et al.*1977, Abadome 1998)
Sibe of Kharrouba (Central Plateau of Morocco)	Sasnou		Decoction	Oral	Anti-inflammatory, antispasmodic and anti-blennorrhagic Depurative, antiseptic, astringent, anti-inflammatory, and diuretic effect	(Dallahi 2017, Sijelmassi 1993)
(Occidental Rif) of Morocco)	Arbousier	Bark	Decoction / Raw	Oral	Diuretic effect	(Rhattas *et al*. 2016)
Zaër Region	Sasnou		Decoction	Oral	Recommended for gastric pain	(Lahsissene *et al.* 2009)
Oujda Region	Sasnou		Decoction	Oral	Diuretic and hypertensive effect	(Meziane 2003, Agoumi 1983, Aït Igri *et al.* 1990)
Central Plateau of Morocco	Sasnou		Decoction	Oral	Depurative, antiseptic, astringent, anti-inflammatory, and diuretic effect	(Dallahi 2017, Sijelmassi 1993)

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Occidental Rif of Morocco	Sasnou	Fruit	Gross		Jam and pastry making	(Rhattas *et al*. 2016, Orch *et al.* 2017)
Rabat, Zaërs, Chaouïa; Essaouira Region	Lenj, Bakhenû; Azoubar		Raw	Oral	Treatment of digestive diseases	(Bammi *et al*. 2002, Mehdioui *et al.* 2007)
Jbala, Talambot And Ghomara	Metrûn, Unnis (for the fruit),Qâtil abihi, Bojj, Jînâ,Qatlab, Asir Ddob		Raw	Oral	Taking a few fruits stops diarrhea, but in excess, it would be purgative	(Bellakhder 1997)
Oujda Region; (Occidental Rif of Morocco)	Sasnou		Raw	Oral	Depurative and anti-diarrheal effect	Rhattas *et al.* 2016, Orch *et a*l. 2017, Meziane 2003, Akhmisse 1991)
Moulay Abdessalam Ben Mchich	Sasnu, Boukhanou		Raw		Production of "Jbal Moulay Abdessalam" *Arbutus* honey from fruit	(MAPM 2014)

Use of the *Arbutus* tree in other countries

The distillation of the *Arbutus* fruit and their marketing dates back to 1815 in Corsica in the Bastia region. In Italy, Fruit liqueur is marketed by small companies (Bizouard & Favier 1992, Favier *et al.* 1993). Over time, the value of the use of fruit is becoming more and more progressive for the production of alcoholic beverages due to its high fermentable sugar content. In Portugal, the most important activity associated with the fruit of this species is the production of "Medronho" wine liqueurs and brandies (Correia & Oliveira 2002). The wine of the *Arbutus* fruit contains 40 to 60% alcohol (Doukani 2015, Haciseferogullari & Özcan 2007). Due to its high pectin content, *Arbutus* fruit is also used in the production of jellies, jams, marmalades, yoghurts and other traditional desserts (Pallauf 2008, Pawlowska *et al.* 2006, Silva-E-Alarcão *et al*. 2001, Simonetti *et al.* 2008, Tardio *et al.* 2002). It is also incorporated in cereal and meat products because of carbohydrates accumulated during the immature and mature stages of the fruit (Silva-E-Alarcão *et al*. 2001). Its sugar content is about 0.47 g/g dry base in sachharose (87.7 ± 0.6 g per kg of dried fruit) and fructose (208 ± 2 g per kg of dried fruit) (Silva-E-Alarcão *et al*. 2001). Dry fruit is used to make tea, flavors and colors in the industry (Demirosy *et al.* 2007). In the last decade, several food products have been processed and marketed in powder form, but scientific studies on this subject for *Arbutus* fruit remain insufficient despite their importance in the field of engineering (Murietta *et al.* 2012). Studies on the properties of whole fruit tablets are very limited. However, an Italian study shows that Sardinian bitter honey, which contains a high proportion of strawberry nectar, has important antibacterial and antiviral properties (Floris & Prota 1989). Bees do not collect *Arbutus* pollen, which is one of the primary sources of food for the fall generation of the land bumblebee (*Bombus terrestris*) (Rasmont 2005). In addition, the *Arbutus* fruit can therefore be considered as a food supplement since it is rich in nutrients such as minerals (calcium, phosphorus, potassium) and vitamins (vitamin C) (Devla *et al.* 2011, Ziyyat & Boussairi 1998). Also, the *Arbutus* fruit is a good source of antioxidants (Tawaha *et al.* 2007) including carotenoids, anthocyanins and elagic acid. Proanthocyanides represent more than 80% of total fruit flavonoids (Ayaz *et al.* 2000, Silva-E-Alarcão *et al.* 2001, Tawaha *et al.* 2007). In this regard, Rodriguez *et al* (2011) reported that the high antioxidant potential of *Arbutus* is attributed to the activity of various bioactive components including vitamin C. In this respect, the antioxidant power of these berries has been found to be one of the highest among the fruits studied by Allane and Benamara

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(2010).

The *Arbutus* fruit is classified as a medicinal (Bammi & Douira 2002, Rahman 2007). Several therapeutic values are attributed to this fruit, which explains its ancient use in traditional and popular medicine (Mariotto *et al.* 2008). These are: gastrointestinal disorders (Cornara *et al.* 2009), dermatological problems as antiseptics (Pallauf *et al.* 2008), cardiovascular application (Leonti 2009), urological problems (El Hilaly *et al.* 2003), and antimicrobial activity (Kivçak *et al*. 2001). Heinrich *et al.* (2005) studied extracts of this fruit species on different parameters such as enzymatic inhibition tests and inhibition of cytokine induced cell activation. This proves the ability of these fruits to inhibit DNA synthesis and cell proliferation. When used in low concentrations, *Arbutus* fruit does not cause any adverse effects; the fruit could even have a beneficial effect. The fruit of the strawberry tree is therefore edible, provided that reasonable quantities are ingested. On the other hand, for subjects with oxalic lithiasis, *Arbutus* fruit with its high amount of calcium oxalate, or oxalic acid, should eventually be discouraged (Bizouard & Favier 1992).

Flowering seems interesting for beekeepers and does not have the defect of some Ericaceae (in particular Andromeda polifolia) whose flowers make bees produce toxic honey (Bizouard & Favier 1992, Favier *et al.* 1993). But it must be recognized that it favors the secretion of wax rather than honey in bees. In any case, the flowers of the *Arbutus* tree produce abundant nectar whose main interest is to constitute an early food source for bees, which use it among other things to start the brood.

The strawberry tree's wood is relatively easy to work with, and the stump is used to make pipes appreciated by professionals. Carbonization provides excellent charcoal in Greece, (Bizouard & Favier 1992, Favier *et al*.1993) Bark is still used for tanning leather (Bizouard & Favier 1992, Favier *et al.*1993).

Conclusion

The survey of the *Arbutus* tree's natural distribution areas in Morocco has shown that the species grows in semi-arid bioclimates with hot to cool per-humid variants in the thermo-mediterranean and meso-mediterranean on limestone and siliceous soils. It is mainly associated with *Quercus ilex* and sometimes with *Pinus halepensis* and *Tetraclinis articulata*. It is located in different biogeographical regions that could contribute to such high genetic diversity. It is economically very important to study and determine the genetic and ecological properties of the *Arbutus* tree for medicinal and ornamental purposes.

The related literature is generally in line with the medicinal use of the plant by Moroccan inhabitants especially for the treatment of diabetes, digestive diseases, respiratory diseases, rheumatic diseases, anti-inflammatory, osteo-articular, hypertensive, and diarrheal diseases. On the other hand, the consumption and industrial valuation of *Arbutus* fruits remain very limited in Morocco compared to those at the international level. It is imperative to raise awareness among the local population and enclaved town of the knowledge for the valorization of the fruit of this species, how to develop the marketing, the conservation and the transformation of fruits and by-products, and the production of new medicines and wellness products.

Declarations

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