

MELLIFEROUS FLORA AND APICULTURE IN THE PRE-RIF OF THE PROVINCE OF TAZA (NORTH OF MOROCCO)

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ABSTRACT

To quantify the plant diversity values in the Pre-Rif of the province of Taza (North of Morocco), as an environmental economic approach, investigations and field surveys have highlighted values of the local melliferous flora for apiculture. Honey flora, whose population pulls profit, consists mainly of 28 species and interests also itinerant beekeepers. We estimated an average of 12.1 ± 10.8 beekeepers by rural settlement or "douar", of which 66.3% are itinerant and 33.7% are sedentary, and an average of 36.3 ± 30.4 hives by apiarist. Moreover, several types of honeys are produced locally and consumed extensively as a health food. The hive yield in honey is depending on the foraged species: low for *Origanum* spp., *Thymus* spp. and *Arbutus unedo*, and high for *Anthyllis cytisoides*, *Rosmarinus officinalis*, *Ceratonia siliqua* and *Ziziphus lotus*. The direct benefits of honey flora are assessed to $14,859 \text{ MAD.beekeeper}^{-1}.\text{year}^{-1}$.

KEY WORDS

North of Morocco, honey flora, apiculture, socio-economy.

FLORA MELIFERA Y LA APICULTURA EN EL PRE-RIF DE LA PROVINCIA DE TAZA (NORTE DE MARRUECOS).

RESUMEN

Para cuantificar los valores de diversidad de plantas en el Pre-Rif de la provincia de Taza (Norte de Marruecos), como un enfoque económico del medio ambiente, investigaciones y encuestas de campo han subrayado valores de la flora melífera local para la apicultura. La flora melífera, cuya población saca beneficio, se compone principalmente de 28 especies y interesa también a los apicultores itinerantes. Se estimó un promedio de $12,1 \pm 10,8$ apicultores por asentamiento rural o "douar", de los cuales 66,3% son itinerantes y el 33,7% son sedentarios, y un promedio de $36,3 \pm 30,4$ colmenas por apicultor. Por otra parte, varios tipos de mieles se producen localmente y se consume ampliamente como un alimento saludable. La producción de miel en la colmena depende de la especie forrajera: baja para *Origanum* spp., *Thymus* spp. y *Arbutus unedo*, y alta para *Anthyllis cytisoides*, *Rosmarinus officinalis*,

PALABRAS CLAVE

Norte de Marruecos, flora melífera, apicultura, socio-economía.

INTRODUCTION

Moroccan flora would include, at the current state of knowledge, some 8,000 species. Very little information is available for groups of great ecological and socio-economic interest, and many sites of Morocco have almost never been surveyed (FAO-Morocco, 2006). Plant diversity in Morocco is one of the highest rates of endemism into the Euro-Mediterranean region. Thus, over 4500 taxa of vascular plants, native or naturalized, 800 to 951 taxa are endemic (Benrahmoune Idrissi & Dubruille, 2003; Fougrach, Badri & Malki, 2007).

Otherwise, there is a cultural expression resulting from the use and exploitation mode of the environment, and therefore, a rich culture that is expressed in a mosaic of folklore, architecture, local products, crafts and customs (Benrahmoune Idrissi & Dubruille, 2003).

Beekeeping has an ecological role, i.e. the ecological heritage, and an economic interest, e.g. hive by-products and overall agricultural production (Melin, 2011). Apiculture is an ideal activity for rural areas (Dushimimana, 2007) and also contributes indirectly to the sustainability of plant resources through the pollination process (in Ennabili, Gharnit & Elhamdouni, 2000). Entomophilous crop pollination service is therefore a prominent economic, contributing about 117 billion U.S. dollars to the world agriculture (Vaissière, 2005; in Haubruge et al., 2006).

The practice of beekeeping requires a basic knowledge of honey plants (distribution, ecology, biology ...) and environmental factors influencing it (Melin, 2011). This paper aims to identify the main melliferous plant species, and assess the current status of beekeeping in the Pre-Rif of the province of Taza (North of Morocco).

STUDY AREA

The province of Taza covers a total area of 15,020 km² (Figure 1); its population is around 720,000 inhabitants (FAO-Morocco, 2006; Taza city, 2009). It is bounded to the North, East, South and West by the provinces of Al Hoceima and Nador, the province of Taourirte, the province of Boulmane and the provinces of Taounate and Sefrou respectively (Province of Taza, 2009).

The survey area is characterized by rugged relief, constituting a constraint for its development. The main mountains are Jbel Akechars (around 2,009 m), Jbel Kouine (1,883 m) and Jbel Aberchane (1,774 m). The substrates are soft and impervious (Loukili et al., 2006). The climate is of Mediterranean type, particularly semi-continental to Mediterranean influence, humid in winter and semi-arid in summer (SEE, 2002; Province of Taza, 2009).

With 468,000 ha, forests and alfa grass occupy 42.5% of the province of Taza; 401,339 ha of which correspond to forests. Holm oak, thuja, Aleppo pine, cork oak and cedar (especially from the national park of Tazekka) overrun respectively 130,704 ha, 50,151 ha, 30,028 ha, 11,737 ha and 9,907 ha. As for the grazing and uncultivated lands, they spread on 644,000 ha, i.e. 44.7% of the province surface (Programme Natura, 2008; SEF, 2008). In addition, Man encourages the soil erosion, due to overgrazing and clearing activities (Loukili et al., 2006).

In addition to earlier works as of Emberger & Maire (1927), there are particular recent works on the vascular flora from the Northern Morocco (Ennabili et al., 1996, 2000, 2006; Josep & Ontserat, 2002; Valdés et al., 2002; Merzouki, Ed-derfoufi & Molero-Mesa, 2003; Fougrach, Badri & Malki, 2007; Tarier & Deacre, 2007).

The foothills of the Rif are among the early settlement regions, which together with the Moroccan mountains are considered as the Moroccan cradle of humanity (Binane, 1999), with an average of $10,559 \pm 5,818$ inhabitants.commune⁻¹ (N=27); the average number of douars by commune is of 18.3 ± 8.26 (N=13) (SEE, 2002; Province of Taza 2009).

Indeed, the Southern sides of eastern Rif have been long neglected and marginalized. These mountain areas are seriously subjected to natural, economic and spatial imbalance (Binane, 1999). Agriculture is a vital sector in the local economy, and occupies 80% of the rural population, in the form of cereal-based subsistence farming, livestock and arboriculture, mainly olive, almond and fig trees (SEE, 2002; FAO-Morocco 2006; Province of Taza, 2009).

METHODS

In order to document local knowledge in terms of honey plants (diversity, phenology ...) and apiculture (production and marketing of honey, beekeepers ...), we used pre-established survey forms, and plants collections for identification were carried out from April 2008 to April 2011 in 16 stations of the study area (Figure 1).

In parallel, we have identified and botanized the plants collected using the available floras (Quezel & Santa, 1962-1963; Valdés

et al., 2002; Fennane et al., 1999-2007) and a specific database (Base de Données des Plantes à Fleurs d'Afrique, 2010). The data obtained was processed and analyzed.

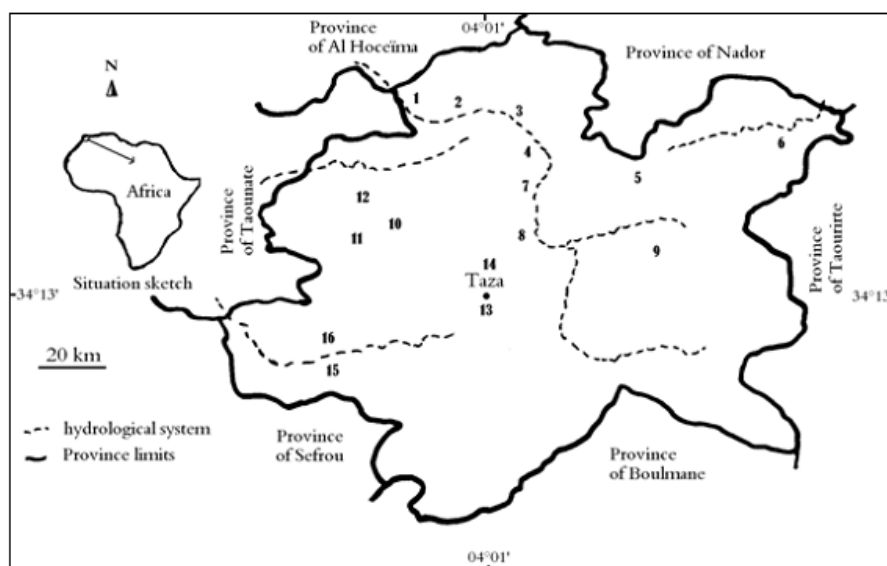


Figure 1. Location of sites surveyed in the Pre-Rif of the province of Taza. Source: Région de Taza-Al Hoceïma-Taounate (2004). **Caption:** 1-Boured; 2-Ajdir; 3-Ain hamra; 4-Aknoul; 5-Tizi ouqli; 6-Sidi Ali Bourkba; 7-Bouhdoud; 8-Jbarna; 9-Mezgitem; 10-Bni Fteh; 11-Had Msila; 12-Tainaste; 13-Taza; 14-Sebt Boukalal; 15-Oued amlil; 16-Had Oulad Zbayr.

RESULTS AND DISCUSSIONS

Melliferous flora

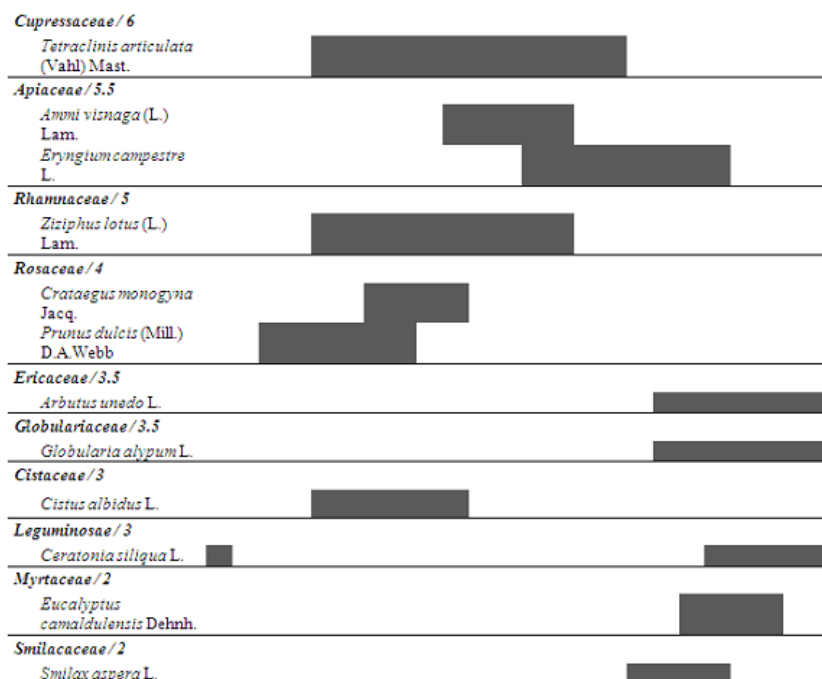
We inventoried 28 plant species typical of beekeeping, that belong to 14 botanical families (Table 1), vs. 78 and 21 melliferous species respectively from Mokrisset-Chefchaouen and the Province of Taounate, Northern regions of Morocco (Ennabili, Gharnit & Elhamdouni, 2000; Libiad, Khabbach & Ennabili, 2011). Moreover, number of plants involved significantly in honeydew or in pollen intake remains limited when compared to the total number of flowering plants, usually having a secondary role in beekeeping (Melin, 2011). The spontaneous honey species are herbaceous (35.7%), shrubby (39.3%) or arborescent (25%); the cultivated ones correspond particularly to monocultures of *Prunus dulcis*.

The flowering period lasts throughout the year and varies depending on the weather and species: from 2 to 11 months for *Smilacaceae* and *Myrtaceae*, and *Lamiaceae* in the same order (Table 1). Considering the classification of Akoegninou et al. (2009) and various features of honey plants (distribution, density, blooming abundance ...), three melliferous plants groups could be distinguished:

- Species highly foraged: *Rosmarinus officinalis*, *Anthyllis cytisoides*, *Ammi visnaga*, *Ceratonia siliqua*, *Eucalyptus camaldulensis*, *Ziziphus lotus* and *Prunus dulcis*.
- Species moderately foraged: *Origanum compactum*, *Globularia alypum*, *Arbutus unedo*, *Dittrichia viscosa*, *Lavandula stoechas*, *Moricandia suffruticosa*, *Calicotome villosa*, *Thymus zygis*, *Carlina lanata* and *Artemisia herba-alba*.
- Species lowly foraged: *Medicago sativa*, *Mentha pulegium*, *Smilax aspera*, *Tetraclinis articulata*, *Ajuga iva*, *Eryngium campestre*, *Achillea odorata*, *Marrubium vulgare*, *Cytisus arboreus*, *Crataegus monogyna* and *Cistus albidus*.

Table 1. Flowering period of melliferous plants inventoried

Taxa / flowering period (month)	January	February	March	April	May	June	July	August	September	October	November	December
Lamiaceae / 11												
<i>Ajuga iva</i> (L.) Schreb.												
<i>Lavandula stoechas</i> L.												
<i>Marrubium vulgare</i> L.												
<i>Mentha pulegium</i> L.												
<i>Origanum compactum</i> Benth.												
<i>Rosmarinus officinalis</i> L.												
<i>Thymus zygis</i> L.												
Asteraceae / 7.5												
<i>Achillea odorata</i> L.												
<i>Artemisia herba-alba</i> Asso												
<i>Carlina lanata</i> L.												
<i>Dittrichia viscosa</i> (L.) Greuter												
Fabaceae / 6												
<i>Anthyllis cytisoides</i> L.												
<i>Calicotome villosa</i> (Poir.) Link												
<i>Cytisus arboreus</i> (Desf.) DC.												
<i>Medicago sativa</i> L.												
Brassicaceae / 6												
<i>Moricandia suffruticosa</i> (Desf.) Coss. & Dumie												



Moreover, a melliferous resource map could be established depending on blooming, beekeepers and weather circumstances, and “species / blooming period / station” combinations or honeydew periods were spatially highlighted (Table 2). To increase honey production, itinerant apiarists opt for other stations not depending on the study area, including:

- Berkine and Maghrawa Communes, and Middle Atlas (Province of Taza) for *Rosmarinus officinalis*,
- Midar and Laaroui Driouch (Province of Nador) for *Peganum harmala* and *Ziziphus lotus* during the “May – July” period,
- Gueldamane and Rass Elma (Province of Taza) for *Arbutus unedo* and *Smilax aspera*,
- Marnissa (Province of Taounate) for *Ceratonia siliqua*,
- Ranate (Province of Guercif), Resslane and Sidi Bouhria (Province of Taourirte), Oujda, Sidi Slimane and Jorf Al Malha for *Eucalyptus* spp.,
- Jbel Bouyblane (Province of Taza) for *Bupleurum spinosum*, or El Jadida for *Euphorbia* spp. during the “August – September” period,
- and Tafoughalt (Province of Berkane) for *Eriobotrya japonica* and *Citrus sinensis* respectively in “November – January” and “March – May” periods.

Table 2. Honeydews spatialization in the study zone

Species	Honeydew period (Table 1)	Stations (Figure 1)
<i>Rosmarinus officinalis</i> and <i>Globularia alypum</i>	October – March	4-7 and 8 (Aoulade Hadou and Siwane)
<i>Thymus zygis</i> , <i>Cistus albidus</i> , <i>Artemisia herba-alba</i> , <i>Moricandia suffruticosa</i> , <i>Ajuga iva</i> and <i>Achillea odorata</i>	February – May	4-7 and 8 (Siwane)
<i>Anthyllis cytisoides</i>	March – June	4-5 and 7-8
<i>Calicotome villosa</i> , <i>Thymus zygis</i> and <i>Moricandia suffruticosa</i>	February – April	8, 10 and 14
<i>Ziziphus lotus</i> and <i>Medicago sativa</i>	May – July	5-6 (Bab Djaj and Ain Zora) and 9 (Fehama and Msoun)
<i>Anmmi visnaga</i>	June – July	8, 10, 13, 14 (Bab Mrouj and Aine Tlate) and 15-16 (douar Aabour)
<i>Origanum compactum</i> and <i>Eryngium campestre</i>	July – September	2-3, 4 (Malal) and 5-6 (Sidi Ali Ben Issa)
<i>Origanum compactum</i> and <i>Dittrichia viscosa</i>	July – November	4 (Malal, douar Saghour and douar Tachrbant)
<i>Carlina lanata</i>	August – October	8, 11 and 14
<i>Arbutus unedo</i> and <i>Smilax aspera</i>	September – November	1-2, 4, 7, 12, 11 and 15
<i>Ceratonia siliqua</i>	October – December	15
<i>Eucalyptus</i> spp.	March – May and October – November	plantation islets throughout the study area
<i>Tetraclinis articulata</i>	July - October	5 (Oulade Ziyane and El Kifane forests)
<i>Cytisus arboreus</i> and <i>Lavandula stoechas</i>	February - April	4 (Malal, Ain Aouka forests and Nkia)
<i>Prunus dulcis</i>	February - April	3 (Ain hamra), 4 (Aknoul), and 2 (Aidir)

Marrubium vulgare, *Ajuga iva*, *Crataegus monogyna* and *Achillea odorata* are weakly foraged, and their distribution and low flowering abundance could not distinguish a specific honeydew periods. *Tetraclinis articulata* is considered by local beekeepers as the basis of honeydew production, constituting a source of a sweet *Hemiptera* and *Homoptera* (aphids, mealybugs, psyllids and cicadas) dejection (Melin, 2011).

Beekeepers

Based on surveys, 177 "station-plant species-interviewee" combinations were established. The interviewees (90.9% male) have an average age of 46 ± 12.6 years (58.9 ± 22.1 years for women and 44.7 ± 10.4 years for men). Local beekeepers have also a masculine tendency, and are young when compared with other Moroccan areas (CBTHA, 2004). The rate of beekeepers by douar is 12.1 ± 10.8 (N=53), and 66.3% itinerant, unlike another region of the Northern Morocco, where beekeepers are generally sedentary (Ennabili, Gharnit & Elhamdouni, 2000).

The apiary size is on average of 36.3 ± 30.4 hives per beekeeper (N=50), against just 7 hives. beekeeper⁻¹ in the South side of the High Atlas, Morocco (CBTHA, 2004). However, hives number per apiary vary depending on beekeeper categories: 2-22 hives for the traditional beekeepers, 4-150 hives for the sedentary modern ones, and 100-300 for the itinerant apiarists visiting the survey area. Modern apiaries represent 78.6%, vs. 21.4% for the traditional ones, an opposite pattern when compared to the South side of the Moroccan High Atlas: 62, 24 and 14% of traditional, modern and mixed apiaries in the same order (CBTHA, 2004).

According to some interviewees, the modern hive used locally is Langstroth (Les Ruches Voirnot, 2011). The traditional hive is made of *Ficus carica* stems and *Arundo donax* thatchs. Hives made of *Quercus suber* cork, *Agave americana* stumps, *Arundo donax* thatchs, and stems of *Vitex agnus-castus*, *Myrtus communis* and *Olea europaea* are traditionally used in the Northern Morocco (Ennabili, Gharnit & Elhamdouni, 2000).

Modern beekeepers buy the populated hives from other regions (Larache, Sidi Slimane ...), while traditional beekeepers raise bees, named locally "baldi", and capture wilds warms. In Morocco, *Apis mellifera* is exclusively raised, with three native breeds: *A. mellifera intermissa*, *A. mellifera sahariensis* and *A. mellifera major*. The Gharb region (around Kenitra) is the main bee Center of Morocco, based on the *A. mellifera intermissa* variety, feeding mostly on *Eucalyptus camaldulensis* and *E. gomphocephala* (Dahssi et al., 2004).

Populated hives are generally placed in apiaries away from homes, considering plants abundance, water proximity, sunlight and wind. Apiaries are regularly managed with every processing operation (76.3%). However beekeepers are still complaining more problems such apiarist training and bees treatment lack, weather conditions (dry and strong wind or "chergui", sharp decline of temperature or "jriha"), aphids competition, bee pests like rats and frogs ...

Sensitization of young professionals in this regard (use of modern hives, good practices ...) would contribute to improving of local production of honey, since many beekeepers join associations and cooperatives.

Bee products

Due to the diversity of the local melliferous flora, various types of honey are produced according to collection frequency per year and apiaries proximity to plant associations dominated by *Rosmarinus officinalis* (honey of Azir), *Origanum compactum* (honey of Zaatar, acrid taste), *Arbutus unedo* (honey of Sasnou or Mrouna), *Anthyllis cytisoides* (honey of Thargouith), *Ziziphus lotus* (honey of Sedra), *Eucalyptus* spp. (honey of Kaliteus), *Ceratonia siliqua* (honey of Kharoub), *Bupleurum spinosum* (honey of Santase), *Dittrichia viscosa* (honey of Bayramane) or *Globularia alypum* (honey of Taslgha, very spicy taste). While traditional beekeepers distinguish only three honey types: summer, spring and autumn honeys.

Honey is widely consumed at the local and is considered as a health food. Some beekeepers separate pollen of some plants for traditional medicine use (against allergy and liver diseases respectively for *Dittrichia viscosa* and *Globularia alypum*), and wax, sold or used for cosmetic purposes. However, other apiculture products such propolis, larva of bees, venom and royal frost could be exploited by using selected colonies of bees (Ennabili, Gharnit & Elhamdouni, 2000; Imdorf, Ruoff & Fluri, 2010; CRA, 2011).

The unit price of honey is very high when compared to living standard of the local population, reaching 400 MAD.L⁻¹, and fluctuates from 145±33.9 to 269±77.1 MAD.L⁻¹ in terms of honey types. The cost production of honey varies also from 30±24.5 to 80±28 MAD.L⁻¹ (Table 3). The honey collected from traditional hives is produced mainly from several plants (two collections a year) and highly demanded.

Table 3. Selling and cost prices (MAD.L⁻¹) of honey produced in the province of Taza. MAD, Moroccan dirham.

Characteristic species	Selling price	Cost price
<i>Rosmarinus officinalis</i>	165±38.8 (N=15)	54.2±25.8 (N=6)
<i>Origanum compactum</i>	269±77.1 (N=23)	78.6±37.5 (N=7)
<i>Thymus zygis</i>	167±43.7 (N=3)	50±17.6 (N=17)
<i>Anthyllis cyrtoides</i>	145±33.9 (N=10)	30.7±15.4 (N=7)
<i>Arbutus unedo</i>	219±98.3 (N=6)	37±34.2 (N=6)
<i>Ziziphus lotus</i>	155±29.8 (N=17)	55.5±24.1 (N=10)
<i>Eucalyptus camaldulensis</i>	160±27.1 (N=4)	30±24.5 (N=4)
<i>Calicotome villosa</i>	212±53.1 (N=2)	-
<i>Anmi visnaga</i>	253±173 (N=4)	50 (N=2)
<i>Tetraclinis articulata</i>	162±26 (N=2)	50 (N=1)
<i>Dittrichia viscosa</i>	150 (N=1)	50 (N=1)
<i>Ceratonia siliqua</i>	175±35.4 (N=2)	80±28 (N=2)

Honey production is marketed locally "hand to hand". However, some beekeepers opt for nationwide destinations (Fez, Meknes, Al Hoceima, Oujda, Agadir, Nador, Rabat and Tangier) or overseas ones. Honey produced is usually sold right after harvest, given the limited income available for the local people. Based on years, drought and vegetation decline, including overexploitation of medicinal plants (*Origanum* spp. ...), can cause a deficit of honey production.

Through a production of 3.25±1.50 to 13.5±2.12 L.hive⁻¹, modern beekeeping generates income from 4,216±3,225 to 28,000 MAD.beekeeper⁻¹.year⁻¹, and an average benefit of 14,860±10,150 MAD.beekeeper⁻¹.year⁻¹ (N=6) (Table 4). The contribution of apiculture to the local economy is estimated to 6-10%. According to the available data of "Centres des Travaux Agricoles de Tainaste & Taza", the annual production of honey is about 73,434 L.year⁻¹, with a total value estimated at 13,658,724 MAD.year⁻¹ for the Province of Taza, representing a notable component of subsistence farming in mountainous areas (cereals, arboriculture ...), and a part of the indirect values of the native flora, besides other incomes (medicinal plants ...).

Table 4. Honey production (L.hive⁻¹) and apiculture income (MAD.beekeeper⁻¹.year⁻¹) in the Province of Taza. MAD, Moroccan dirham.

Characteristic species	Honey production	Apiculture income
<i>Rosmarinus officinalis</i>	7.53±4.21 (N=14)	10,957±13,562 (N=7)
<i>Origanum compactum</i>	3.34±1.80 (N=22)	7,635±7,415 (N=16)
<i>Anthyllis cyrtoides</i>	6.33±2.88 (N=9)	11,983±6,764 (N=6)
<i>Arbutus unedo</i>	3.25±1.50 (N=6)	-
<i>Ziziphus lotus</i>	7.76±3.34 (N=6)	26,833±23,691 (N=6)
<i>Eucalyptus camaldulensis</i>	4.62±2.24 (N=4)	-
<i>Calicotome villosa</i>	3.75±0.35 (N=2)	-
<i>Peganum harmala</i>	6 (N=1)	-
<i>Anmi visnaga</i>	5.62±3.09 (N=4)	4,216±3,225 (N=3)
<i>Tetraclinis articulata</i>	5.5±0 (N=2)	-
<i>Dittrichia viscosa</i>	5.5±0.71 (N=1)	-
<i>Ceratonia siliqua</i>	8.25±3.88 (N=2)	-
<i>Smilax aspera</i>	3.5±0.71 (N=2)	-
<i>Citrus ×aurantium</i>	13.5±2.12 (N=2)	28,000 (N=1)

Even though the region offers a great potential for beekeeping, allowing the transhumance practices, the sector suffers numerous problems and constraints. An accompanying policy of beekeeping is necessary to allow an optimum utilization of natural resources and a revitalization of this sector in order to improve living standards of the local people. The creation of professional associations would be of great importance for beekeeping development and local products promotion.

Moreover, beekeeping helps to maintain the local ecosystems balance, and presents an aspect of indirect uses of natural resources (Sbai, 1998; Programme Natura 2008; Arnaud, Clermont-Ferrand & Reims, 2009).

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