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ARTICLES

Melliferous flora in arid regions of Algeria (case of Biksra)

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Abstract. The diversity of melliferous flora in Biskra, an arid region in South East Algeria, is revealed in the present study. Data were collected through visual inspection and information gathered from local guides at different prospective sites when we collected samples.A list of plant species valuable to honey bees was then established. The list consisted of 122 species distributed in 101 genera and 43 families, though the most represented were, in decreasing order, Asteraceae (22 species), Fabaceae (14 species), Apiaceae (8 species), Brassicaceae and Lamiaceae (7 species each), and Boraginaceae (4 species). These families alone account for a half (51.23%) of all taxa identified. However, Anacardiaceae, Resedaceae, Rosaceae and Solanaceae were represented by 3 species each. Amaranthaceae, Apocynaceae, Asphodelaceae, Cistaceae, Cleomaceae, Cucurbitaceae, Cyperaceae, Lythraceae, Nitrariaceae, Oleaceae, Plumbaginaceae, Rutaceae, Tamaricaceae and Zygophyllaceae were represented by 2 species each. One species represented the rest of the families. Therophytes (30.33%) dominated the other biological types followed by Chamaephytes (28.69%), Phanerophytes (25.41%), Hemicryptophyes (10.66%) and Geophytes (4.92%). A flowering calendar as well as apicultural value of the most common melliferous plants is given. The melliferous flora included 37.70% nectariferous and polliniferous species at the same time, 31.15% polliniferous species, 27.86% nectariferous species, 1.64% as sources of propolis, and 0.82% as sources of resin.

Keywords: Biskra, diversity, nectariferous, polliniferous, calendar.
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Introduction

Melliferous plants are those that mainly produce nectar and pollen, although those that generate propolis are also considered in this category (Araujo-Mondragón & Redonda-Martínez, 2019). Thus, understanding the major nectar- and pollen-producing plants and their flowering periods is of great advantage in maximizing the efficiency of the bees. Hence, every beekeeper is expected to be familiar with the bee floral resources near/ or around their apiary for a successful beekeeping operation (Ayansola & Davies, 2012).

The literature on the inventory of bee plants in Africa is very limited (Dongock *et al*., 2004). Accordingly, little is known about the native flora of Algeria's arid zones, which are crucial for honey production. According to Ahouandjinou *et al*. (2017), hive productivity augmentation and domestic beekeeping development require mastery of floristic potential and knowledge of melliferous plants.

In Algeria, many studies on melliferous flora have been conducted, especially in the north (Hamel & Boulemtafes, 2017; Ghorab, 2021; Bouhala, 2022). Similarly, several studies have been carried out south of Algeria. The most well-known ones are those of Laallam et al. (2011) in South West Algeria (Bechar and Naama region) and of Belli (2022) in South West Algeria (Djelfa). However, the melliferous plants vary from one area to another, depending on biotic, climatic, and ecological factors (Ahouandjinou *et al*., 2017).

The region of Biskra with a surface of 21.509.80 Km^2,is a transitional zone between the Atlasic mountainous domaine in the north and the plate and desertic areas of Septentrional Sahara in the south (ANAT, 2003). The region is home to around 9,800 hives with total honey production reaching 86,100 kg (Hitouche *et al*., 2024). A wide range of altitudes also characterizes the region. In this regard, according to Güneşdoğdu *et al*. (2024), it is important to study plant diversity across different altitudes and to evaluate

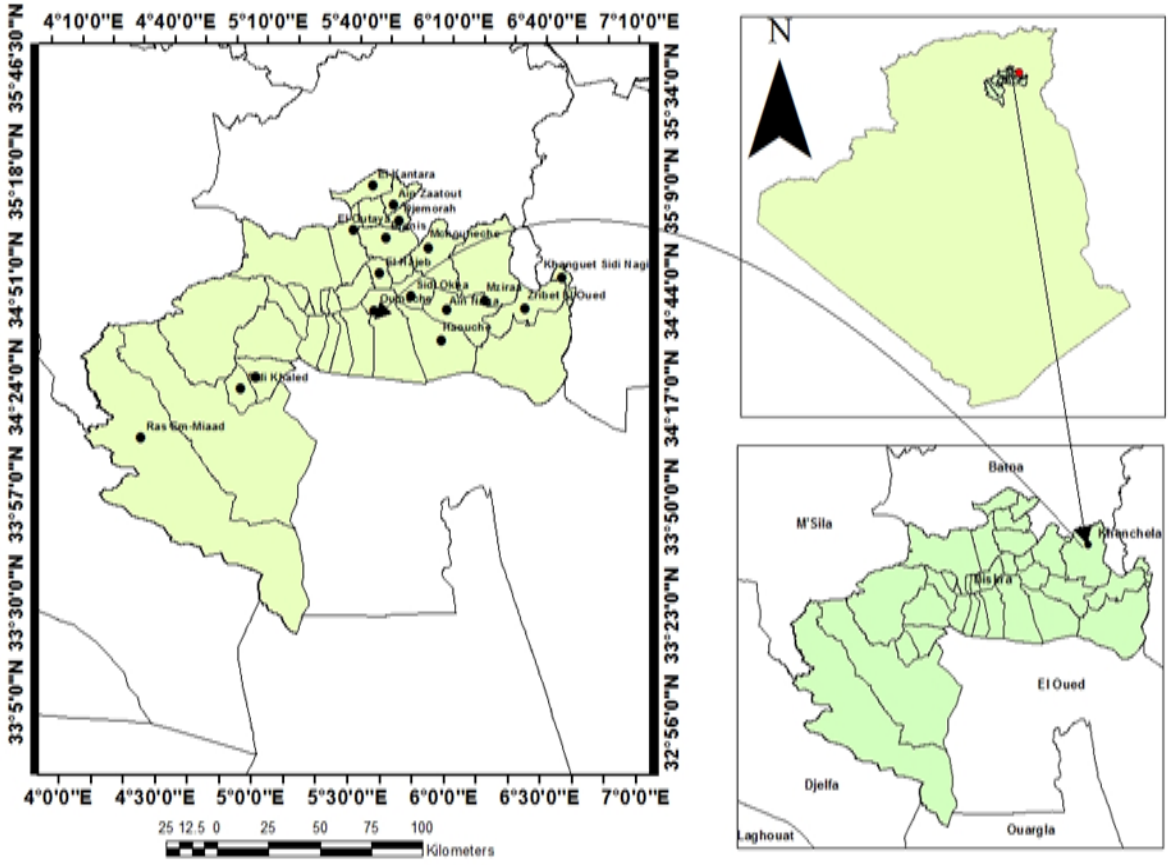

Figure 1. Prospected sites in Biskra region (Algeria).

the species and taxa important for beekeeping. However, most studies conducted in the region of Biskra treated spontaneous plants (Deghiche-Diab *et al*., 2016 & Lahmadi *et al*., 2017), adventitious flora (Deghiche-Diab, 2019), investigated floristic diversity in different sites (Selemkour *et al*., 2012; Bazri & Ouahrani, 2015; Rekis *et al*., 2023; Belhadj *et al*., 2023), or were ethno-medicinal, therapeutic studies (Saad *et al*., 2019 & Nouidjem *et al*.,2021). Hence, the lack of information about honey bee plants in the region of Biskra made it essential to fill this gap through research on melliferous flora, with particular attention to species identification, plant vernacular names, flowering time, and apicultural value (pollen, nectar, propolis, or resin provision) across different sites. Thus, our study, the first current one, was conducted to investigate local ecological knowledge of melliferous plants in Biskra, an arid southeastern region of Algeria, through collaboration and tutorship with local guides who are already beekeepers from the region.

Materials and Methods

The climate in Algeria is Mediterranean, characterized by a rainy season from September to May and a warm summer (Seltzer, 1946). Thus, the study area is located in southeast Algeria, in the arid zone characterized by a low-rainfall to dry climate and irregular precipitation below 200 mm (Dubost, 2002). Meanwhile, efficient precipitation occurs only on average 9 times per year in Biskra (Godard & Tabeaud, 2004). Rainfall records during the cool, wet winter period are up to 155mm per year, and relative air humidity levels do not exceed 60%. Meanwhile, the average maximum temperature in July and August, during the hot, dry summer period, is around 40/41°C, and the lowest relative air humidity (28%) is recorded in July (Faci, 2021).

The study was carried out through 15 prospections during 2020 and 2021, ensuring that each location benefited from one day of investigation (each number corresponds to one day of prospection for the site). The investigations took place mostly in the Northeastern and Southwestern agro-ecological zones of Biskra (Located between 35°16'33.833 and 34°33'50.802" North latitude, and 06°39'17.652 and 04°23' 5.051" East longitude). Mainly, in the mountainous area located in the North: 1. El Kantara, 2. Ain Zaatout, 3. Beni Souik (agglomeration of Djemorah). In the Northeast zone: 4. Mchounech (including Beniane), 5. Djemina and Tejmout, and 6. Mezbel forest. The plains area is represented by 7. El-Outaya, 8. M'ziraa. 9. Sidi Okba (including Seriana), and 10. Zribet El-Oued. Meanwhile, the Depression zone: 11. Essaada (El-Haouche) and 12. Ain Dabba and Esserg (Oumeche), and the plateaus area is represented in the southwestern zone by 13. Chaiba, 14. Ouled Djellal (including Sidi Khaled), and 15. Ras El Miaad (Figure 1).

The altitude of the prospected sites ranged from 17 m to 1466 m asl. The most abundant soil type according to the studies of Khachai (2001) and ANAT (2003) is the calcimagnesic soil type, characterized by its richness in calcium carbonates, magnesium, or calcium sulfate, with a well-developed structure. These soils are located in the south and east of the Biskra region. Poorly evolved and infertile soil types

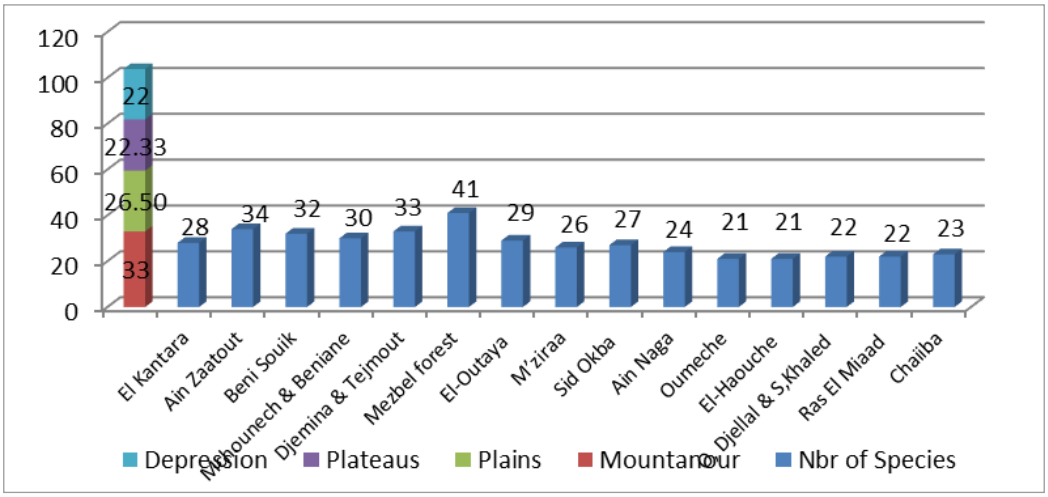

Figure 2. Number of species per site.

dominate the northern mountain chains. The soils in the plains are clay-sodium type (Eloutaya plain) or halomorphic (Ain Naga and M'ziraa).

The site selection is based mainly on information about the number of beekeepers (Ksouri, 2019), the site fame of beekeeping and richness in melliferous plants from the deceased leader of the Joint Council of Beekeepers of the region, the observations during prospections, and through discussion with beekeepers when we meet them the choice of sites was confirmed. At least three GPS points are prospected at each site; local guides select the sites, as they are reported as promising for beekeeping. Thus, sites are listed with localities and dates of prospection (Appendix 1). Our approach consisted of conducting visual observations and sampling of melliferous species; floristic surveys were carried out based on the richness and abundance of melliferous plants at each site.

Inventoried melliferous species, designed in the field during the prospection by beekeepers as being visited by honey bees and furnishing either a source of nectar, pollen, both (nectar and pollen) or a source of propolis or resin, were sampled and identified, then categorized into biological types considered are those of Raunkiaer (1934) and into bio-forms according to Ramirez (2002).

Depending on the duration of flowering, three classes of flowering were defined: Class I: one month of flowering; Class II: one month to two continuous months of flowering; Class III: more than two months of flowering (Guinko *et al*., 1992).

Identification of collected melliferous plants from the field was done by consulting the flora of Quézel & Santa (1962), Ozenda (1991), by review of literature, and information obtained from botanists in the Center of Scientific and Technical Research in Arid Regions (CRSTRA). Samples are being incorporated into the CRSTRA Herbarium. The new nomenclature has been updated for the inventoried species, taking into account recent work compiled in the synonymic and bibliographic index of the flora of North Africa (Dobignard & Chatelain, 2010–2013).

The list of melliferous plants has been compiled by family, based on their botanical characteristics. Latin Name, vernacular Name, plant habit and biological type, flower color, while nutriment exploited by bees and flowering period are given according to beekeepers in the field whenever found, Tela Botanica's eflore website [tela-botanica.org/bdtfx-nn-41475-synthesis] and a combination of literature, and information obtained from local guides who are already beekeepers. Thus, 11 local guides contributed to our work as guides to prospect sites. Their ages ranged from 41 to 78 years; most of them had at least 10 years of experience.

During field surveys, whenever plants were in the flowering period, bee activity on flowers was observed and recorded to determine whether plants were Polliniferous, Nectariferous, or both. Thus, according to Ara Begum *et al.* (2021), honeybees with their activity of extending their proboscis into the flowers and remaining calm during lapping (concentrated nectar)/sucking (watery nectar) were considered as Nectar (N) plant sources. In contrast, plants with bees showing hyperactivity along with corbicular loads were categorized as Polen (P) plants. Honeybees, with their activity of extending their proboscis into the flowers and also collecting pollen on their hind legs, were determined as NP plants.

Results

The scored melliferous plants were cited in Appendix 2. This compilation accounts for 122 species belonging to 101 genera and 43 families of trees, herbaceous plants, and shrubs.

Richness and distribution of records by sites

The highest species richness was found in the Mezbel forest, with 41 species, while the lowest was registered in Ain Dabba and Esserg (Oumeche) and Essaada (El-Haouche), with 21 species out of the total identified species. Meanwhile, it comprised 22–34 species at the remaining prospect sites (Figure 2). Thus, the mountainous zone was the richest (33 species), followed by the plains, plateaus, and depression zones, with 26.5, 22.33, and 22 recorded melliferous species, respectively. Among the 122 inventoried melliferous plants, 14 species could be considered to have a shared distribution, occurring at least 50% of the prospected sites. In contrast, 17 species were registered at least in 30% of the prospected sites (Appendix 2).

Table 1. Families of melliferous plants best represented in Biskra (Algeria)

Phylum / Family	N°. families	N°. genera	N°. species
GNETOPSIDA	1	1	1
Ephedraceae		1	1
LILIOPSIDA	4	4	5
Asparagaceae		1	1
Asphodelaceae		1	2
Cyperaceae		1	1
Poaceae		1	1
MAGNOLIOPSIDA	35	92	113
Amaranthaceae		2	2
Anacardiaceae		2	4
Apiaceae		8	8
Apocynaceae		2	2
Arecaceae		1	1
Asteraceae		17	22
Boraginaceae		2	4
Brassicaceae		6	7
Cactaceae		1	1
Capparaceae		1	1
Caryophyllaceae		1	1
Cistaceae		1	2
Cleomaceae		1	2
Cucurbitaceae		2	2
Euphorbiaceae		1	1
Fabaceae		9	14
Fagaceae		1	1
Plantaginaceae		1	1
Lamiaceae (Labiatae)		7	7
Lythraceae		2	2
Nitrariaceae		2	2
Oleaceae		2	2
Orobanchaceae		1	1
Oxalidacées		1	1
Plumbaginacea		2	2
Polygonaceae		1	1
Resedaceae		1	3
Rhamnaceae		1	1
Rosaceae		3	3
Rutaceae		2	2
Solanaceae		3	3
Tamaricaceae		1	2
Thymelaeaceae		1	1
Urticaceae		1	1
Vitaceae		1	1
Zygophyllaceae		2	2
PINOPHYTA	2	2	3
Pinaceae		1	1
Cupressaceae		1	2

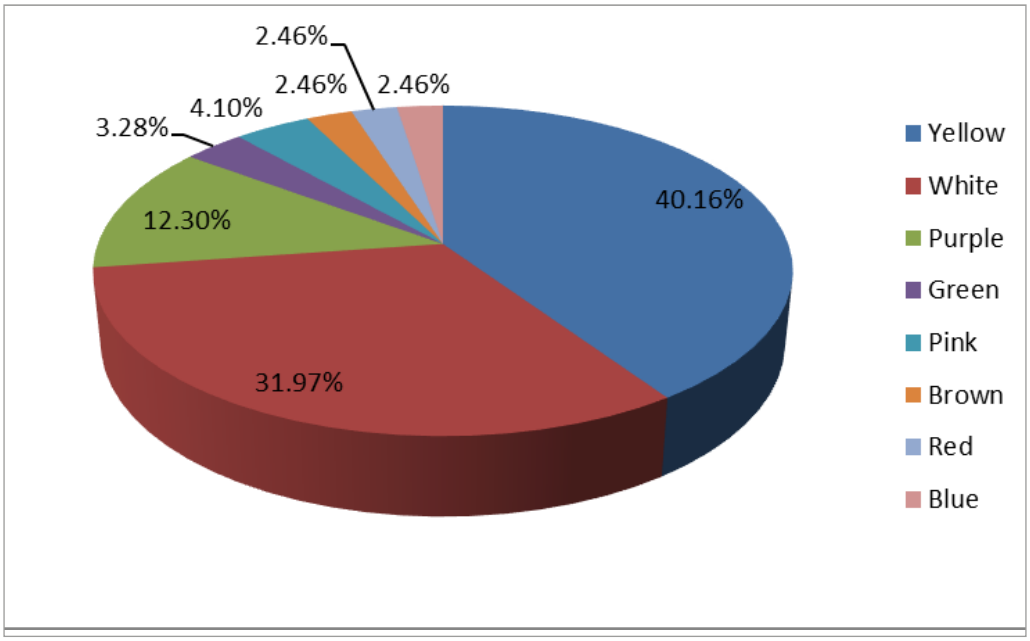

Figure 3. Melliferous species distribution according to flower color.

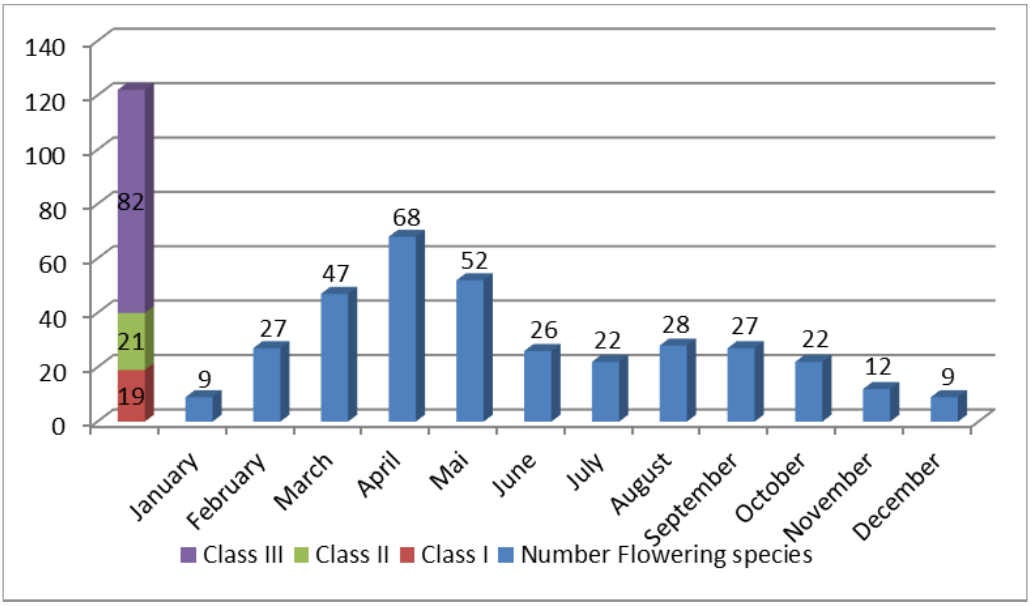

Figure 4. Classes of duration of flowering and number of flowering species per month.

Taxonomic richness

The melliferous flora of Biskra was represented in this assortment by one species of Gnetopsida: Ephedra major, three species of conifers (Pinophyta), five monocotyledonous species (Liliopsida), and 113 species of flowering plants (Magnoliopsida). The greatest richness of genera and species corresponds to dicotyledons (113 species, 91 genera), followed by monocotyledons (five species, four genera) and genetopsida (one species, one genus). Dicots were wealthier in families (35) than monocots (4 families) and Gnetopsida (1 family; Table 1).

The best-represented families were Asteraceae (22 species, 17 genera), Fabaceae (14 species, 9 genera), Apiaceae (8 species, 8 genera), Lamiaceae (7 species, 7 genera), and Brassicaceae (7 species, 6 genera; Table 1). These families comprised more than 50% of species and 45% of the genera. Highlighting the Asteraceae family with 17 genera: *Artemisia*, *Atractylis*, *Calendula*, *Carlina*, *Centaurea*, *Cotula*, *Dittrichia*, *Echinops*, *Endopappus*, *Hertia*, *Launaea*, *Pallenis*, *Reichardia*, *Scolymus*, *Sonchus*, *Sylibum* and *Volutaria*. Amongst the 102 genera, only three genera were represented by three taxons: *Atractylis*, *Reseda* and *Vicia* (Appendix 2).

Biological types and Bio-Forms

Recorded species in this study (Appendix 2) were classified into different biological types. Thus, Therophytes constituted 30.33% of the inventoried species, while Chamaephytes represented 28.69%, Phanerophytes accounted 25.41%, Hemicryptophytes made 10.66%, and Geophytes were the least with 4.92%. Accordingly, Bio-forms

were dominated by herbaceous species (80), which accounted for the highest representation (66.11%), followed by 29 shrub species (23.96%). Meanwhile, 13 tree species were less abundant (10.74%) in the region of Biskra.

Distribution, flower color and flowering period of melliferous plants

Ten flower colors were noted in the fifteen studied stations. The yellow color was dominant, with 49 species (40.16%), followed by white, with 39 species (31.96%). However, the purple color is moderately represented with 15 species (12.29%). The other colors were weakly represented; the pink color with 5 species (4.09%), the green colors with 4 species (3.27%). Meanwhile, the brown, red and blue colors with 3 species (2.45%) for each color (Figure 3).

The chronology of the main period of flowering plant species is illustrated in Figure 4. The peak blooming period was recorded in April, followed by May, then March, then February, August, September, October, and November. Meanwhile, December and January recorded the lowest number of flowering melliferous species in the Biskra region.

Based on flowering duration, most inventoried melliferous species (82) belonged to Class III (67.21%), with more than two months of continuous flowering; 21 species belonged to Class II (17.21%), with two months of continuous flowering. Class I (15.57%) consisted of 19 species with only one month of flowering (Figure 4).

Flowering calendar of the most shared melliferous species between sites

A flowering calendar was established, which showed that the study region had significant honey resources, allowing bees to forage throughout the year (Table 2). Thus, nectariferous and polliniferous plants were abundant throughout the year; however, nectariferous species showed a cut in abundance during August and September, whereas polliniferous species showed a significant flow period from February to December.

Table 2. Flowering calendar of most shared melliferous species. Abbreviations and colors are: P, polliniferous species (pink); N, nectariferous species (yellow); NP, nectariferous and polliniferous species (orange).

N°	Scientific Name	Sites	Flowering period (month) J F M A M J J A S O N D	Apicultural value
1	*Phoenix dactylifera* L.	15 : all sites		P
2	*Echinops spinosissimus* Turra.	12 : Edakhla, El Kantata, Seriana , Beniane Beni Souik , Ain Zaatout, Djemina –Tejmout Foret Mezbel, El-Outaya, Ettarf-Branis, El Maadher, Sidi Okba		NP
3	*Astragalus armatus* Willd.	11 : Edakhla, Choucha-Ain Daba , El Kantata, Beniane, Beni Souik, Ain Zaatout Djemina –Tejmout, Foret Mezbel, Ettarf-Branis , El Maadher		N
4	*Artemisia herba alba* Asso.	9 : Edakhla, El Kantata, Mchounech, Beniane Beni Souik, Ain Zaatout, Djemina – Tejmout Foret Mezbel, Ettarf-Branis-		P
5	*Vicia faba* L.	9 : Mziraa, K S, El Kantata, Seriana, Beniane, Beni Souik, Ain Zaatout, El-Outaya, Ettarf-Branis, Sidi Okba et		N
6	*Ziziphus lotus* (L.) Lam.	9 : Hmada, Choucha, El Kantata, Mchouneche Beniane, Ain Zaatout, Foret Mezbel, Ettarf-Branis, El Maadher		N
7	*Ballota hirsuta* Benth.	8 : Edakhla, El Kantata, Mchouneche, Beniane, Beni Souik, Ain Zaatout, Djemina – Tejmout, Ettarf-Branis		N
8	*Juniperus communis* L.	8 : Edakhla, El Kantata, Mchounech, Beniane Beni Souik, Ain Zaatout, Djemina – Tejmout Foret Mezbel		P
9	*Ononus angustissima* Lam.	8 : Edakhla, Choucha, El Kantata, Mchounech, Beniane, Djemina – Tejmout Foret Mezbel, Ettarf-Branis		NP
10	*Rhus tripartita* (Ucria.) Grande.	8 : Edakhla, Choucha, El Kantata, Mchouneche, Beniane, Beni Souik, Djemina- Tejmout, Foret Mezbel		PN
11	*Teucrium polium* L.	8 : Hmada, El Kantata, Mchouneche, Beniane Ain Zaatout, Djemina – Tejmout, Foret Mezbel Ettarf-Branis		NP
12	*Thymelaea hirsuta* (L.) Endl.	8 : Edakhla, Choucha, El Kantata, Mchouneche, Djemina – Tejmout, Foret Mezbel Ettarf-Branis, El Maadher		NP

N°	Scientific Name	Sites	Flowering period (month) J F M A M J J A S O N D	Apicultural value
13	*Thymus vulgaris* L.	8 : Edakhla, El Kantata, Beniane, Beni Souik Ain Zaatout, Djemina – Tejmout, Foret Mezbel Ettarf-Branis		NP
14	*Fagonia glutinosa* Delile.	7 : Hmada, Choucha, Mziraa, K S, Seriana Mchouneche, Beni Souik, Djemina – Tejmout		P
15	*Globularia alypum* L.	7 : Edakhla, Hmada, El Kantata, Mchounech Beniane, Djemina –Tejmout, Foret Mezbel		P
16	*Limoniastrum guyonianum* (Durieu.) Boiss	7 : Choucha, Ain Daba, Mziraa, K S, Beniane Djemina – Tejmout, Ettarf-Branis, Sidi Okba		P
17	*Rosmarinus officinalis* L.	7 : Edakhla, Mchouneche, Beniane, Beni Souik, Ain Zaatout, Djemina – Tejmout, Foret Mezbel		NP
18	*Tamarix gallica* L.	7 : Hmada, Choucha, Ain Daba, Mchouneche Beniane, El-Outaya, Ettarf-Branis-Djemora		NP
19	*Deverra scoparia* Coss. & Durieu.	6 : Edakhla, Hmada, El Kantata, Seriana, Beniane, El Maadher		NP
20	*Diplotaxis harra* (Forssk.) Boiss.	6 : Edakhla, Hmada, El Kantata, Mchounech, Beniane, Djemina – Tejmout		NP
21	*Hedysarum naudinianum* Coss. & Durieu.	6 : Hmada, Mziraa, K S, Beniane, Djemina –Tejmout, El-Outaya, Ettarf-Branis-		NP
22	*Launaea lanifera* Pau.	6 : Edakhla, El Kantata, Mchounech, Beni Souik, Djemina – Tejmout, Ettarf-Branis		P
23	*Lavandula multifida* L.	6 : Edakhla, El Kantata, Mchouneche, Beni Souik, Djemina – Tejmout, Ettarf-Branis		N
24	*Artemisia campestris* L.	5 : Edakhla, Choucha, El Kantata, Ain Zaatout, Foret Mezbel		P
25	*Diplotaxis virgata* (Cav.) DC.	5 : El-Hamada, Choucha , Mziraa, Ain Daba El-Outaya		NP
26	*Launea nudicaulis* (L.) Hook.f.	5 : Hmada, Seriana, Djemina – Tejmout, El-Outaya		P
27	*Opuntia ficus-indica* (L.) Mill.	5 : El Kantata, Mchounech, Beni Souik, Ain Zaatout, Ettarf-Branis		NP
28	*Pseuderucaria teretifolia* (Desf.) O.E.Schulz.	5: Edakhla, Hmada, Ain Daba, Mziraa, K S Beniane		NP
29	*Reseda alphonsii* Müll.Arg.	5 : Edakhla, Mziraa, K S, Seriana, Ettarf-Branis, Djemina – Tejmout		N
30	*Retama raetam* (Forsk.)Webb & Berthel.	5 : Edakhla Choucha, El Kantata, Djemina –Tejmout, Ettarf-Branis		N

Pollen/nectar Major/minor sources

The beekeeping interest of recorded plants was noted through personal observation (when plants were in flower during prospections), information from local guides who are already beekeepers, and available literature. Thus, 34 species (27.86%) were nectariferous plants, 38 species (31.15%) were polliniferous plants and 46 species (37.70%) were nectariferous and polliniferous plants at the same time. *Nerium oleander* and *Pergularia tomentosa* (1.64%) were sources of propolis, *Pinus halepensis* (0.82%) was the source of resin (Figure 5).

Discussion

Knowledge of melliferous plants in Algeria's arid regions remains incomplete and partial. The most well-known inventory of melliferous plants in South West Algeria (Naama and Bechar) is that of Lallam et al. (2011), who listed 66 species across 33 families (2007–2008), with Asteraceae predominating. Since then, works to survey beekeeping plants have continued, with the study by Belli (2022) in the South of Algeria, who reported the presence of 103 melliferous plants belonging to 28 families, with the predominance of the Asteraceae family in Serssou

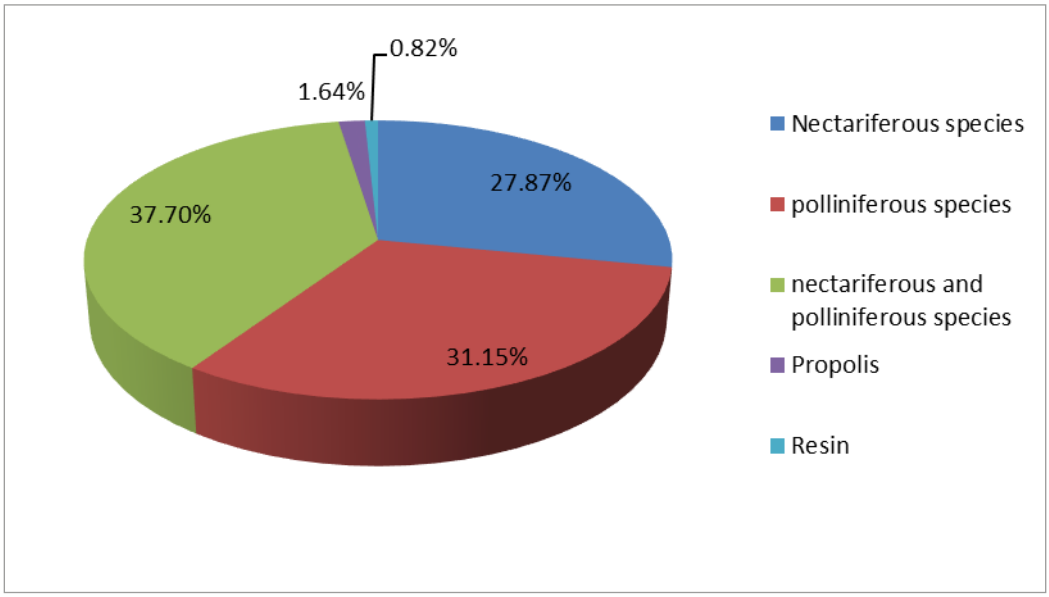

Figure 5. Melliferous plants distribution in percentage of Nectariferous and Polliniferous species.

at Ain Oussara (Djelfa, Algeria). Meanwhile, Bakour *et al*. (2021) identified 102 species of melliferous plants based on information from beekeepers in the Fez-Meknes region, located in the Northern center of Morocco. However, in the Biskra region, our study enabled us to list 122 melliferous species. Thus, the recorded number of species is higher than that recorded in the previous studies. However, it was inferior to that reported by Hamel *et al*. (2019), as their study was conducted on a larger area (five Northeastern provinces). As in previous studies, the Asteraceae family dominated the others. Conversely, Taha *et al.* (2019) recorded 110 plant species visited by honey bees, dominated by the Fabaceae family, in the Kafer Isheukh province in northern Egypt.

Some of the plants found in our study had also been identified from the Edough peninsula (North-East Algeria) mainly: *Pistacia lentiscus*, *Daucus carota*, *Dittrichia viscosa*, *Cistus monspeliensis*, *Lotus corniculatus*, *Marrubium vulgare*, *Olea europaea* and *Vitis vinifera* (Hamel & Boulemtafes, 2017), in Numidia (five provinces Northeast Algeria): *Pistacia lentiscus*, *Scolymus hispanicus*, *Melilotus indicus*, *Globularia alypum*, *Reseda alba*, *Eriobotrya japonica*, and *Vicia faba (*Hamet *et al*., 2019), in the region of Messaad (Djelfa, Algeria) *Pistacia atlantica*, *Artemisia herba-alba*, *Retama raetam*, *Teucrium polium*, *Peganum harmala* and *Ziziphus lotus* (Daoud *et al*., 2022). Meanwhile, other plant species similar to our findings were reported in South West Algeria (Bechar and Naama), specifically *Ferula vesceritensis*, *Cotula cinerea*, *Echinops spinosus*, *Pergularia tomentosa*, *Echium humile*, *Moricandia arvensis*, *Diplotaxis harra*, *Cleome amblyocarpa*, *Rosmarinus officinalis*, *Asphodelus tenuifolius*, *Fagonia glutinosa*, *Phoenix dactylifera*, *Prunus armeniaca*, *Daucus carota*, and *Vicia faba* (Laallam *et al*., 2011).

The remarkable point is that our results presented species already recorded in the Northern region of Algeria and other species recorded in the steppe and arid regions, which manifested the richness and diversity of Biskra province, in addition to the large surface of the district, to several factors, including mainly the different landforms(mountainous area, plain area, Hammada area and plateaus area). Thus, according to Dongock*et al. (2004), the bee flora of an area is influenced by several factors: ecological environment, area extent, duration, and timing*. All this would explain the differences between our results and those reported in the literature. Mostly, the species were Asteraceae, Fabaceae, Apiaceae, Brassicaceae and Lamiaceae. Beekeepers highly value some species; this is true of *Euphorbia bupleuroides* and *Anchusa azurea.*

Meanwhile, other species were less reported as melliferous flora, such as Cleomaceae and Apocynaceae. Thus, Gess & Gess (2006) reported that Lamiaceae are generally considered to be bee flowers, few Euphorbiaceae observed appeared to be attracting visits from solitary wasps and bees, although Apis mellifera visited several of the succulent, yellow 'flowered' species in the southeastern Nama Karoo and Namaqualand. The authors also reported that *A. mellifera* is recorded visiting Cleomaceae and Boraginaceae. Similarly, in our research, the most attractive plants to bees were yellow-colored flowers, followed by white.

The difference in the richness of melliferous flora between sites could be attributed to many factors, such as ecology, the zone's surface, and the season in which the site was investigated, as reported by Dongock *et al*. (2007).The melliferous plants vary from one area to another according to biotic, climatic, and ecological factors, as noted by Ahouandjinou *et al*. (2017). Thus, elevation could be the main factor determining the distribution of melliferous species in our case, unlike Ramirez (2002), who reported that the number of species decreases with altitude and that habitat heterogeneity increases along the altitudinal gradient. Accordingly, the highest richness was recorded in the mountainous zone, mainly in Mezbel forest and Ain Zaatout, which are the highest sites in our study. Actually, because this area still benefits from natural vegetation and anthropic interventions are still limited, as found by Coulibaly *et al*. (2020).

Most of the inventoried melliferous plants in the Biskra region were flowering plants (Magnoliopsida:

Dicotyledons), dominated by Asteraceae and Fabaceae. Similarly, Daoud *et al*. (2022) reported the dominance of these two families in the Mesaad region (Algeria). These two families are general characteristics of natural plant formations in semi-arid regions (Macheroum *et al*., 2021) and arid regions of Algeria, just as noted by Hanafi *et al*. (2024), Behadj *et al*. (2023), Mounib & Chenchouna (2021), Azri & Cherroun (2019), Benryala & Benkadi (2012), Djilah (2019), Benseghier (2018), and Salemkour *et al*. (2012). Meanwhile, Therophytes dominance registred during our study was also reported by Boughani *et al*. (2009) in Ghoufi Gorges a region of Saharian Atlas (Batna, Algeria), Arabi *et al*. (2015) in Saida a semarid region west Algeria, Adi *et al*. (2016) in Southwest of Algeria, by Habib *et al*. (2020) in Djelfa region and Daoud *et al*. (2022) in Messaad, Guemou *et al.* (2023) in Tissemsilt, Northwest of Algeria, Abd El-Ghani *et al*. (2017) in the Eastern Desert of Egypt, Dhief et al (2022) in arid and Saharan zones of southern Tunisia, and Ben Lekbir *et al.* (2024) in the territory of Sidi Ifni, a semi-arid and arid sector of Central Western Morocco. Our results regarding the biological types spectrum (Therophytes > Chamaephytes > Phanerophytes > Hemicryptophytes > geophytes) concurred closely with those of Haddad (2011), who studied nine stations in the region of Biskra. Meanwhile, Belhadj *et al*. (2023) reported that Therophytes were dominant in Wadi beds, while Chamephytes dominated eolian formations and saline accumulation rangelands in the region of El-Haouch, south Biskra. According to Shaye et al. (2020), who found similar results in the Riyadh region, Central Saudi Arabia, the predominance of therophytes and chamaephytes over other life forms is a response to a hyperarid climate with insufficient rainfall. Thus, the dominance of therophytes characterizes the arid and semi-arid regions (Aidoud, 1984; Miara *et al*., 2016). This therophyly is an essential feature of vegetation in arid zones (Daget, 1980). The therophyte phenomenon is an adaptation strategy for unfavorable conditions and a form of resistance to severe climate (Negre, 1966; Daget, 1980).

The honey flora of the Biskra region was divided into Trees, Shrubs, and Herbs, with herbs dominant. Similarly, dos Reis *et al.* (2023) reported the dominance of the herb layer over the tree, shrub, subshrub, and liana layers in the Mid-Northern semi-arid region of the State of Bahia (Brazil). Thus, Lobreau-Callen & Damblon (1994) stated that, in Mediterranean regions, most species in the stratum of flowering herbs during the dry season were melittophiles and produced very abundant nectar (*Thymus*, *Rosmarinus*, *Asphodelus*). In contrast, the arboreal one was relatively neglected in the regions. The tree stratum was in bloom in the spring, so at the end of the wet season, it was mainly made up of anemophilous species (Cupressaceae, *Pinus*, *Quercus*, *Populus*). A relatively small number of amphiphilic species were, however, booty from the anthesis (*Olea*, *Argania*, *Phillyrea*, *Pistacia*, *Rhamnus*, *Salix*, *Tamarix*, *Vitis*).

However, in the region of Biskra, *Acacia* sp., *Olea europaea*, *Ziziphus lotus and Eriobotrya japonica* are considered major resources for bees, and the last one is a resource during winter. Our results were similar to those of Ur-Rehman (1997), who reported the genera *Acacia*, *Olea*, *Ziziphus*, and *Eriobotrya* as major resources for bees.

Ten flower colors were noted at the fifteen studied stations, with yellow as the dominant color, followed by white.Though Gumbert (2000) indicates that bees clearly prefer white (50% of flowers visited) and yellow (26% of flowers). Thus, naive honey bees showed a preference for stimuli reflecting between 410 nm (“UV-blue”) and 530 nm (“Green”), rendering evidence that different colors have indeed different meanings for bees (Giurfa et al., 1995).

Concerning the flowering classes, species that have more than two months of flowering (Class III) were more numerous than species belonging to Class II and Class I. This offers a good opportunity to improve beekeeping activities in the region of Biskra. Similar findings were reported by Diatta *et al*. (2020).

The flowering period lasted from one to nine months throughout the year. Meanwhile, Khabbach *et al*. (2013) reported that the flowering period lasted throughout the year and varied depending on the weather and species from 2 to 11 months in the Pre-Rif of the province of Taza (North of Morocco). Al-Ghamdi *et al*. (2023) also reported a pollen flow period from two to nine months in arid and semi-arid areas of Al-Baha Region, southwestern Saudi Arabia. Similar to our findings, the previous authors reported that spring and winter are the most valuable seasons for honey bees. The fact is that the research location has varied geographic and climatic conditions that could explain the variation in the diversity of flowering plants over time. Thus, Ara Begum *et al*. (2021) reported that honeybees rely exclusively on pollen- and nectar-producing plants to strengthen their Colonies and produce honey in Khyber Pakhtunkhwa (KPK), Pakistan.

During the wet winter season, the bees were few in number, partially overwintered, and foraged as much as possible on the flowers of some trees and shrubs, such as Euphorbia, Rhus, Argania, or the orchards of Citrus (Lobreau-Callen & Dambolon, 1994).

In contrast, Bouhala (2022) reported that April, March, and May were the most important months for bees to stock up, as most honey plants flourish in these months. However, the months of January and December were times of scarcity for honeybees, since there was no flowering plant in January and only a single plant (*Daphne gnidium*) at the end of its flowering in December. However, the region of Biskra presents during these two months (January and December) 9 species (5 nectariferous and polliniferous at the same time species and 4 nectariferous species), and 6 species (3 nectariferous and polliniferous at the same time species, 2 polliniferous species and one nectariferous species) flowering species in January and December, respectively (Table 2). The dominance of nectariferous and polliniferous at the same time species was similar to the results of Hamel & Boulemtafs (2017). However, in our study, this type of melliferous species is followed by polliniferous rather than nectariferous species. Pollen is the principal source of proteins, amino acids, minerals, fats, starch, sterols and vitamins for

bees (Eckhardt *et al*., 2014). Thus, this region could be exploited as a wintering area. According to Masry & Abdelaal (2016), under arid land conditions, there are positive correlations between stored honey area, stored pollen area, and temperature. Therefore, beekeepers can overwinter their colonies in arid land and manage them for the next foraging season. Egyptian and Italian honeybee colonies produced more worker broods during spring and winter.

Complementary studies on pollen analysis and the physicochemical analysis of honey from the region are of great importance to the development of the beekeeping sector in this region.

Finally, we can assume that Biskra, as an arid region with a dry climate, provides suitable conditions for beekeeping. Our statement is in accordance with that of Balagueman *et al*. (2017) who concluded that the dry zone offers a favorable environment for the development of beekeeping. This is basic information necessary for any program aimed at sustainable beekeeping.

A stable diversity of floral resources characterized the Biskra region. This diversity varied qualitatively from one site to another. In terms of the number, a total of 122 bee plant species were recorded. Species were distributed across 43 families, with Asteraceae as the dominant family, and a flowering calendar for the 30 most abundant species had been documented. Herbs were the most abundant. Nectar-pollen-producing plants were more numerous. The results of our study are an important asset; however, additional studies on pollen analysis and honey physicochemical analysis from the region are essential for the practice of modern beekeeping in the area.

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Authorship

All authors have contributed significantly to the conception, design, analysis, and interpretation of the study data that resulted in the article. They have also contributed to the writing or the revision of it. All authors have approved the final version of the text submitted.

Conflict of interest

None

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Appendix 1. Sites names, surfaces, dates of prospection and geographical coordinates. On some sites where the GPS did not work,we have use the coordinates of the A-E Z: agro-ecological zones, CN(ADMA): County Name (Administrative Attribution), (S; DP): Surface & date of Prospection.

A-E Z	CN(ADMA)+ (S;DP)	Prospected Sites		
		Site 1	Site 2	Site 3
Mountanous	El-Kantara (239km^2;17/01/2021)	Alt575m:35°14'38.279N 05°41'13.649E	Alt640m:35°14'54.000N 5°40'52.319E	Alt704m:35°15'10.325N 05°40'50.135E
	AinZaatout (171.19Km^2;14/03/2021)	Alt1254m:35°12'33.293N 05°50'59.448E	Alt1340m:35°12'18.000N 05°51'19.487E	Alt1466m:35°12'28.70N 05°53'07.632E
	BeniSouik (Djemorah) (07/03/2021)	Alt 542m: 35°05'17.927N 05°51'31.332E	Alt583m:35°06'01.812N 05°52'48.563E	Alt613m:35°06'19.788N 5°53'24.318E
	Mchounech (506.9 km^2 ; 21/02/2021) Beniane (MChounech 28/02/2021)	Alt 838m: 34°55'46.074N 06°05'05.544E Alt 523m: 35°02'22.416N 06°02'27.144E	Alt1248m: 34°57'19.134N 06°09'34.007E	Alt1371m:34°58'15.89N 06°09'04.355E
	Djemina & Tejmout (Z.El-O;21/03/2021)	Alt 326m: 34°53'57.084N 06°21'55.433E	Alt614m:34°56'25.230N 6°24'23.393E	Alt851m:34°58'41.123N 06°24'49.364E
	Mezbelforest(3100km^2; 28/03/2021)	Alt1069m: 35°01'29.183N 06°26'41.130E	Alt1269m: 35°02'54.341N 06°23'28.487E	Alt1463m:35°01'59.075N 06°23'53.621E
Plains	El-Outaya (30/03/2021)	Alt:199m: 34°55'40.43''N 05°38'53.27''E	Alt:203m: 34°55'36.3'' N 05°38'54.0'' E	Alt:263m:34°55'41.73"N 05°38'5986" E
	Mziraa (965.5km2- (15/11/2020)	Alt 47m: 34°45'31.7N 06°13'37.1E	Alt 96m: 34°47'51.9N 06°16'57.3E	Alt 202m: 34°52'26.4N 06°19'17.9E
	Sidi Okba (15/11/2020)	Alt: 52m: 34°47'05.518N 05°47'17.742E	Alt: 57m:34°47'55.506N 05°48'05.147E	Alt: 60m: 34°47'05.045N 05°47'17.693E
	Seriana(S.Okba) (173.39km2;07/02/2021	Alt 97m : 34°49'39.162N 5°53'13.992E	Alt 111m : 34°49'45.101N 5°54'21.227E	Alt:203m: 34°55'36.3'' N 05°38'54.0'' E
	Zribet Eloued (501.4 Km^2;22/10/2020)	Alt 41m: 34°41'37.176N 06°26'48.834E	Alt 43m: 34°41'18.726N 06°33'42.168E	Alt 102m: 34°44'15.246N 06°39'17.652E
Plateau	Chaiba* (1 696,00 km^2)	Alt:272m:34°44'57.804" N 04°43'36.966" E	/	/
	OuledDjallal* (326.6km^2)	Alt 196 m:34° 25' 44" N 5° 3' 51" E	/	/
	SidiKhaled*(212.6 km^2;22/11/2020)	Alt 207 m:34° 22' 60" N 4° 58' 60" E	/	/
	RasEl-Miaad (4878Km^2;22/11/2020)	Alt:384m:34°18'40.388"N 04°27'15.442"E	Alt388m:34°19'52.580" N 04°26'12.341" E	Alt:412m:34°20'58.781" N 4°23'33.701" E
Depression	Ain naga (Sidi Okba, (15/11/2020)	Alt-17m: 34°38'36.918N 06°12'12.378E	Alt 20m: 34°43'34.20N 06°12'24.00 E	Alt 22m: 34°43'37.6N 06°12'30.5E
	El-Haouche (Essaada) 20/12/2020)	Alt:10m: 34°40'12.894N 05°52'46.224E	Alt 15m: 34°39'07.356N 05°52'12.972E	Alt: 24m : 34°40'21.395" N 05°51'30.719" E
	Ain Dabba & Esserg Oumache: 06/12/2020)	Alt:19m : 34°37'12.804"N 05°47'50.909" E	Alt:33m: 34°44'02.669"N 05°45'19.404" E	Alt:45m: 34°43'53.904" N 05°44'18.900"E

Appendix 2. List of melliferous species in Biskra with scientific names, vernacular (common local names) as well as plant habit, flower color, nutrient (sampled food by bees), flowering period (2020/2021) and number of sites in which species were reached (Nr of sites).

N	Family	Scientific Name	Common Name (French)	Vernacular Name(s)	Plant Habit	Flower color	Nutrient	Flowering Period*	Nr of sites
01	Amaranthaceae	*Arthrocnemum macrostachyum* (Moric.) K. Koch	Hesra salicorne glauque	(هاسرة)	Herb (CH)	Pale yellow	P (IG)	End of Aug	4
02		*Caroxylon imbricatum*(Forssk.) Moq.	Lamet, ghassel soude imbriquée	لامط غسال	Shrub (CH)	Pale yelow	P (IG)	Aug-Sept	2
03	Anacardiaceae	*Pistacia atlantica* Desf.	Botma Pistachier de l'Altlas	البطمة	Tree (PH)	Pale yellow	P (♂:1) N (IG)	Mid Febr/mid March	2
04		*Pistacia lentiscus* L.	Fatis, Dharou Pistachier, lentisque	فاتيس الضرو	Tree (PH)	Red	P (IG)	April-June	2
05		*Rhus tripartita* (Ucria.) Grande.	Hethbekhth Luck Dhmakh Ebène	هاثبخث اللك الذمخ	Shrub (PH)	Yellowish white	NP (IG)	Late Autumn full bloom in Nov	8
06		*Schinus molle* L.	Fuful kedhib faux-poivrier	الفلفل الكاذب	Tree (PH)	Pale yellow	NP (2)	May-July	1
07	Apiaceae	*Coriandrum sativum* L.	Kosbor coriandre	الكسبر	Herb (TH)	White	NP (IG)	September	4
08		*Daucus carota* L.	Senariya Carotte sauvage	سنارية	Herb (HE)	White	NP (IG, PO&3)	March-Oct	2
09		*Deverra scoparia* Coss. & Durieu	Hattakth heilekt Deverra en balai	هاطكث هايلكت	Herb (HE)	White	NP (IG, PO&4)	Febr-Oct (Nov)	6
10		*Foeniculum vulgare* Mill.	Besbes berr Fenouil sauvage	بسباس بري	Herb (HE)	Yellow	N(IG &3)	June-Sept	2
11		*Ferula vesceritensis* Coss. & Durieu ex Batt.	Derias bounafaa férule de Vescerit	درياس أدرياس بونا فع	Herb (HE)	Yellow	NP (IG, *F. Communis* : 3)	Mar-May	4
12		*Pimpinella anisum* L.	Hebet hlaoua	حبةحلاوة	Herb (TH)	White	N (IG)	June-Aug	1
13		*Thapsia garganica* L.	Kelkh Anis vert	الكلخ	Herb (HE)	Yellow	NP (IG)	April-May	2
14		*Visnaga daucoides* Gaertn.	Kbeba Herbe au cure-dent	كبَّابة قبابة	Herb (TH)	White green	N (IG)	May-Oct	1
15	Apocynaceae	*Nerium oleander* L.	Defla Laurier rose	الدفلى	Shrub (PH)	Pink	Prs (IG)	May-Sept	4
16		*Pergularia tomentosa* L.	Helazerth Halib Daba, Ekghalga Pergulaire, tomenteuse	هلازرث حليب الدابة الغلقة	Herb (CH)	White	Prs (IG &5)	Feb-Mar-Apr	4
17	Arecaceae	*Phoenix dactylifera* L.	Nakhil Palmier dattier	النخيل	Tree (PH)	Cream white	P (IG &5)	March-June (Cultivar)	14
18	Asparagaceae	*Asparagus albus* Web & Berth.	Akhamen Bouya AAch Elbouya Hadharmith asperge blanche	آخامن بوية عش البوية هاضرميث	Shrub (CH)	White	N (*Aparagus*:6)	March-April	4

N	Family	Scientific Name	Common Name (French)	Vernacular Name(s)	Plant Habit	Flower color	Nutrient	Flowering Period*	Nr of sites
19	Asphodelaceae	*Asphodelus creasifera* Parl.	Barouag Asphodèle-cerise.	أبرواق البرواق	Herb (GE)	White	N(IG 3)	Feb-March	3
20		*Asphodelus tenuifolius* Cav.	Tazia Asphodèle à petites feuilles	تازيا	Herb (GE)	White	N (IG &7)	Feb-March	2
21	Asteraceae	*Artemisia campestris* L.	Tgouft Armoise, hampêtre	تقوفت	Herb (CH)	Yellow	P (IG)	July-Sep	5
22		*Artemisia herba alba* Asso.	Shih Armoise blanche	الشيح	Herb (CH)	Yellow	P (IG)	Aug-Octr	9
23		*Atractylis caespitosa* Desf.	Guennouda atractyle en touffe	قنودة	Herb (HE)	Purple	P(IG&*A. delicatula*: 5)	June	3
24		*Atractylis serratuloides* Sieber ex Cass.	Essar Atractyle à feuilles de scrophulaire	الصر	Shrub (CH)	Yellow	P(IG &*A. delicatula* : 5)	April-May	1
25		*Atractylis carduus* (Forssk.) C. Chr.	Chaouk Bounegar chardon jaune	شوك بونقار	Herb (HE)	Yellow	P(IG &*A.delicatula* : 5)	April-June	1
26		*Calendula arvensis* (Vaill.) L.	Ain hadjla Souci des champs	عين الحجلة **عينالحجلة**	Herb (TH)	Yellow	NP (IG &3)	Apr-Oct	2
27		*Calendula tripterocarpa* Rupr.	Nouara safra souci à trois ailes	النوارة الصفراء	Herb (TH)	Orange	NP (IG)	April-May	2
28		*Carlina involucrata*Poir.	Asenane Amelal Eshaouk elabiyadh Carline involucrée	أسنان أملال الشوك الابيض	Herb (CH)	Yellow	NP (*C. corymbosa*&*C. Gummefera*:8)	June	1
29		*Centaurea hyalolepis* Boiss.	Centaurée à bractées hyalines		Herb (CH)	Yellow	NP(*C. cyanus*:9)	Apr-May-June	1
30		*Cotula cinerea* Delile.	Gartoufa Camomilledu Sahara	قرطوفة	Herb (TH)	Yellow	NP (IG &5)	Mar-April	2
31		*Dittrichia viscosa* (L.) Greuter	Sofsak Magramen Inule visqueuse	صفصاق ماقرمان	Shrub (PH)	Yellow	P (IG)	Sept-Nov	3
32		*Echinops spinosissimus* Turra.	Tesekra Hesekra Chouk jamal L'oursin épineux	تاسكرة هاسكرة شوك الجمل	Herb (HE)	White to blue grey	NP (8)	April -June	12
33		*Endopappumacrocarpus* Sch. Bip.	Babounj Hezlghgouketh	بابونج هزلغقوكهث	Herb (TH)	White	P (IG &5)	Jan-March	2
34		*Hertia cheirifolia* (L.) Kuntze	Abeloidho	أبلواظو	Herb (CH)	Yellow	NP (IG & PO)	Marc-April	1
35		*Launaea lanifera* Pau	Aghramou Bouchikh	آهراموث آغرامو بوشيخ	Herb (CH)	Yellow	P (IG& PO)	March-Mai	6
36		*Launea nudicaulis* (L.) Hook.f.	Rokeim Launea à tige nue	الرقيم	Herb (TH)	Yellow	P (IG)	Feb-April	4
37		*Pallenis cuspidata* Pomel.	Rebian Pallenis	ربيان	Herb (TH)	Yellow	P (IG)	March-May	1
38		*Reichardia tingitana* (L.) Roth	Morr	المر	Herb (TH)	Yellow	P (IG)	March-Oct	3
39		*Scolymus hispanicus* L.	Guernina Scolyme d'Espagne	القرنينة	Herb (HE)	Yellow	N (PO&)	May(July-Sep)	1

N	Family	Scientific Name	Common Name (French)	Vernacular Name(s)	Plant Habit	Flower color	Nutrient	Flowering Period*	Nr of sites
40		*Sonchus oleraceus* L.	Tilfef Ghouzaiz Laiteron maraicher	تيلفاف غزيز	Herb (TH)	Yellow	P (IG +PO)	Feb-March-April	4
41		*Silybum marianum* (L.) Gaertn.	Guernouna Taoura Chardon marie	قرنونة تاورة	Herb (TH)	Purple-White	N (IG & PO)	April-July	4
42		*Volutaria saharae* (L. Chevall.) Wagenitz	Elyetim	اليتيم	Herb (TH)	Purple	P (IG)	Feb-March-April	4
43	Boraginaceae	*Anchusa azurea* Mill.	Bouchnef Boglosse d'Italie	بوشناف	Herb (HE)	Blue	NP(IG)	March	2
44		*Nonea vesicaria* (L.) Rchb.	Lcene Thaour Nonea vésiculeuse	لسان الثور	Herb (HE)	Pink	N (IG)	March	1
45		*Echium humilie* Desf.	Louchem Nemch Vipérine humble	الوشام النمش	Herb (TH)	Purple	N(*E.vulgare*: 6)	February	2
46		*Echium horridum* Batt.	Viperine épineuse		Herb(TH)	Red	N(3)	March	1
47	Brassicaceae	*Diplotaxis harra* (Forssk.) Boiss.	Elharra Elebzagha Abzegh Diplotaxis des rochers	الحارة البزاغة آبزاغ	Herb (TH)	Yellow	NP (IG)	Dece-May	6
48		*Diplotaxis virgata* (Forssk.) Boiss.	Bessel Lechnef Diplotaxis à tige grêle	باسل لشناف	Herb (TH)	Yellow	NP (IG)	March to Nov (observed in Dec)	5
49		*Farsetia aegyptiaca ovalis* Turra	Eloud labiadh Farsetia d'Egypte	الأبيض العود	Herb (CH)	White Cream/ purplish	P (IG)	March -April	3
50		*Hutchinsia procumbens* (L.) Desv.	El-Ghoraira Hutchinsie couchée	الغريرة	Herb (TH)	White	N (IG)	Jan-March	4
51		*Moricandia arvensis* (L.) DC.	Elbejigh Adhchach Elkromb Moricande des champs	البجيغ آذشاش الكرمب	Herb (TH)	Purple	P (IG)	March-Jan	4
52		*Pseuderucaria teretifolia* (Desf.) O.E. Schulz			Herb (TH)	White	N (IG)	Nov-Dec	5
53		*Rapistrum rugosum* (L.) All.	Lebsem Rapistre rugueux	لبسام	Herb (TH)	Yellow	NP (3)	Sep-Nov(obs Dec)	2
54	Cactaceae	*Opuntia ficus-indica* (L.) Mill.	Etine Chaouki Figuier de Barbarie	الشوكي التين	Shrub cactus (PH)	Yellow	NP (3)	May-July	5
55	Capparaceae	*Capparis spinosa* L.	El Kebar Heylalouth Câprier épineux	الكبار هايلالوث	Herb (CH)	White	NP (11)	Jun-August	2
56	Caryophyllace	*Gymnocarpos decandrus* Forssk.	Eldjefna Ras eldjdi Ashou Gymnocarpos à dix étamines	الجفنة راس الجدي آشو	Shrub (CH)	Purple	N (IG)	April-May	3
57	Cistaceae	*Cistus monspeliensis* L.	Ciste de Montpellier		Herb (CH)	White	NP (3)	March-May	2
58		*Cistus creticus* subsp. *creticus* L.	Nenae Berri Raihene Ciste velu	نعناع بري الريحان	Shrub (PH)	Pink	P (*C. albidus*: 3)	May -June	2

N	Family	Scientific Name	Common Name (French)	Vernacular Name(s)	Plant Habit	Flower color	Nutrient	Flowering Period*	Nr of sites
59	Cleomaceae	*Cleome arabica* L.	Nouteina Cleome d'Arabie	النتينة	Herb (TH)	Tip purple, base yellow	P (IG)	Feb-Mar-May	4
60		*Cleome amblyocarpa* Barratte & Murb.	Cleome à fruit émoussés		Herb (TH)	purple-black	P (IG)	Feb-March -Mai	3
61	Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	Elhdaj Coloquinte	الحدج	Herb (TH)	Yellow	NP (IG)	May-Sep	4
62		*Ecballium elaterium* (L.) A. Rich.	Fegous lehmir Concombre d'âne	فقوس الحمير	Herb (TH)	Yellow	P (IG)	June-Oct	3
63	Cupressaceae	*Juniperus oxycedrus* L.	Ettaga Genévrier cade	الطاقة	Shrub (PH)	Yellow	P (3& IG + Prs)	Feb-May	2
64		*Juniperus phoenicea* L.	Arar Genévrier de Phénicie	عرعار	Shrub (PH)	Yellow	P(3& IG)	Feb - May	8
65	Cyperaceae	*Scirpoides holoschoenus* (L.) Soják	Bolboschoenus glauque	/	Herb (GE)	Brown	P (3)	May-Sep	1
66	Ephedraceae	*Ephedra major* Host.	Akesma Ephedra fragile	آكسما	Shrub (PH)	Yellow	N (IG)	April- June	3
67	Euphorbiaceae	*Euphorbia bupleuroides* Desf.	Elloubeina Tenghout Euphorbe à feuilles de buplèvre	اللبينة تانغوت	Herb (CH)	Green Yellowish	N (G + PO)	June	3
68	Fabaceae	*Astragalus armatus* Willd.	Lekded Ougemith Astragale vulnérant	لكداد أوجميث	Shrub(CH)	White	N (IG+ OP)	Jan- March	11
69		Genista capitellata Durieu. & Coss.	Azou Genêt à tête petite	آزوو	Shrub (CH)	Yellow	N (IG)	April-May-June	5
70		*Genista cinerea* (Vill.) DC.	Aghis Genêt cendré	آرغيس	Shrub (CH)	Yellow	P (3)	March	2
71		*Hedysarum naudinianum* Coss. & Durieu	Silla, Sainfoin	السلة	Herb (TH)	Purple	NP (IG &*H. coronarium*: 3)	Feb- April	6
72		*Hedysarum pallidum* Desf.	Soulla Sainfoin palle	السولة	Herb (TH)	White	N (*Hedysarum*:6)	March-April	6
73		*Lotus corniculatus* L.	Ratmia Lotier corniculé	الرطمية	Herb (HE)	Yellow	N (3)	March	1
74		*Melilotus indicus* (L.) All.	Melilot à petites fleurs		Herb (TH)	Yellow	NP(*Melilotus* sp:6)	March	1
75		*Ononus angustissima* Lam.	Fiza Burgane à feuilles étroites	فيزة	Herb (CH)	Yellow	NP(IG &3: *O. naxtris*)	Feb- April	8
76		*Retama raetam* (Forssk.) Webb	Rtem, Genêt blanc	الرتم	Shrub (PH)	White	NP (12)	Feb-April (obs.Jan)	5
77		*Retama sphaerocarpa* (L.) Boiss.	Rétama à fruits sphériques		Shrub (PH)	Yellow	N (13)	May-July	2
78		*Vachellia seyal* (Delile) P.J.H. Hurter	L'Acacia Attalh	الاكاسيا	Shrub (PH)	Yellow	P (IG)	February	3
79		*Vicia faba* L.	Full Fève	الفول	Herb (TH)	White	N (IG &6)	Feb-March	9
80		*Vicia monantha* Retz.	Jembela La vece à fleurs solitaires	جمبالة	Herb (TH)	Purple	N (*Vecia* spp:6&14)	March-May	1
81		*Vicia sativa* L.	Vesce commune		Herb (TH)	Purple		March	1

N	Family	Scientific Name	Common Name (French)	Vernacular Name(s)	Plant Habit	Flower color	Nutrient	Flowering Period*	Nr of sites
82	Fagaceae	*Quercus ilex* L.	Belot Chêne vert	البلوط	Tree (PH)	Yellow	P(3)	Apr-May	3
83	Lamiaceae	*Ballota hirsuta* Benth.	Elghosas Tizer Imezryen Ballote hirsute	الغصاص تيزر إمزرين	Herb (CH)	Pink	N (IG)	April-June	8
84		*Lavandula multifida* L.	Elkhozema Elhelhel Zoureika Ebzelim	الخزامى الحلحال آبزليم زريقة	Herb (CH)	purple	N (IG &3)	Jan-April	6
85		*Marrubium vulgare* L.	Merioua Meriouth Temerout Marrub commun	مريوة مريوث تامروت	Herb (CH)	White	NP (IG &3)	April-Sep	4
86		*Rosmarinus officinalis* L.	Iklil eldjebel Azir Romarin	إكليل الجبل أزير	Herb (CH)	Blue	NP (3)	Oct-March	7
87		*Salvia aegyptiaca* L.	Amezoudj Souge du Sahara	آمزوج	Herb (CH)	White- blue smudged	NP (*S. officinalis* : 3)	May	4
88		*Teucrium polium* L.	Elkhayata Tizerth Imezreyen Germandrée tomenteuse	الخياطة تيزر ث إمزرين	Herb (CH)	Yellow	NP (IG&3)	March-Novr	8
89		*Thymus vulgaris* L.	Zeitra Imzouchene Thym	زعيترة إمزوشن	Herb (CH)	White-purple	NP (3)	March-May	8
90	Lythraceae	*Punica granatum* L.	Eromene Grenadier	الرمان	Tree (PH)	Red	NP (IG)	May-Aout	6
91		*Lawsonia inermis* L.	Elhena Henné	الحناء	Shrub (PH)	White	N (15)	May-Nov.	2
92	Nitrariaceae	*Nitraria retusa* (Forssk.) Asch.	Ekgharked Nitraire à feuilles rétuses	الغرقد	Shrub (PH)	White	N (IG)	April-May	3
93		*Peganum harmala* L.	Elharmel Rue de Syrie	الحرمل	Herb (TH)	White	N (IG)	April	4
94	Oleaceae	*Fraxinus excelsior* L.	Touzelt Frêne	توزالت	Tree (PH)	Brown	P (9)	April-May	1
95		*Olea europaea* L.	Zeitoun berri Azeboudj	الزيتون البري أزبوج	Tree (PH)	White cream	P (IG &3)	April-June	5
96	Orobanchaceae	*Cistanche phelypaea* (L.) Cout.	Eljâefil Cistanche	الجعفيل	Herb (GE)	Yellow	N (IG)	March	1
97	Oxalidaceae	*Oxalis pes-carpae* L.	Elhomeidh Oxalis piesd de chèvre	الحميض	Herb (GE)	Yellow	NP(IG 3)	Dec -May	2
98	Pinaceae	*Pinus halpensis* Mill.	Elsanaouber elhalabi Pin d'Alep	الحلبي الصنوبر	Tree (PH)	♂kittenYellow ♀flowers pink-purpl	Rsi (IG)	April-May	1
99	Plantaginaceae	*Globularia alypum L.*	Tisselgha Globulaire buissonnante	تسلغة	Shrub (CH)	Blue	P (IG &3)	Feb-April	7
100	Plumbaginaceae	*Limoniastrum guyonianum* Boiss.	Ezeita	الزيتة	Shrub (CH)	Purple	P(IG)	April-Dec	7
101		*Limonium pruinosum* (L.) Chaz.	Elmelha Statice pruinée	المالحة	Herb (CH)	Pinkish white	NP (*Limonium*: 6)	April-Dec	3

N	Family	Scientific Name	Common Name (French)	Vernacular Name(s)	Plant Habit	Flower color	Nutrient	Flowering Period*	Nr of sites
102	Poaceae	*Macrochloa tenacissima* (L.) Kunth	Elhalfa Alfa	الحلفاء	Herb (GE)	Green	P (IG)	April-Sep	5
103	Polygonaceae	*Calligonum comosum* L'Hér.	Azel	أزال	Shrub (CH)	White	NP (IG)	April-May	1
104	Resedaceae	*Reseda alba* L.	Belezmer Réséda blanc	بلزمر	Herb (TH)	White	NP (16)	April	2
105		*Reseda alphonsii* Müll. Arg.	Theil lekhrof	ذيل الخروف	Herb (TH)	Yellow	N (IG)	Oct-Feb	5
106		*Reseda arabica* Boiss.	Belezmer Reseda d'Arabe	بلزمر	Herb (HE)	White	NP (*R. Lutea*: 3)	Feb-April	2
107	Rhamnaceae	*Ziziphus lotus* (L.) Lam.	Sedra Jujubier	السدرة	Shrub (PH)	Greenish yellow	N(IG &10)	April-May	9
108	Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl.	Zerour Neflier	الزعرور	Tree (PH)	White	NP(IG &3)	Oct-Dec	3
109		*Prunus armeniaca* L.	Michmech Abricotier	المشمش	Tree (PH)	White	NP (IG &9)	Feb-April	6
110		*Rosa canina* L.	Zeroura Tebgha Eglantier	زعرورة تابغة	Shrub (PH)	Pinkish-white	NP (3)	May-July	1
111	Rutaceae	*Citrus limon* (L.) Brum.f.	Leimoune Kares Citronnier	االليمون القارص	Tree (PH)	White	N (IG+ PO)	March–June	7
112		*Ruta graveolens* L.	Faijel Awermi Rue	الفيجل أورمي	Herb (CH)	Yellow	N (3)	May–Oct	3
113	Solanaceae	*Hyoscyamus albus* L.	Hchichet Younes Hinguidh Jusquiane blanche	حشيشة يونس هينقيض	Herb (TH)	Yellow	NP (*H. niger*: 3)	April	3
114		*Lycium shawii* Roem. & Schult.	Aousej Sekouma Sekmeth Lyciet	العوسج السكومة السكماث	Shrub (PH)	Purple	NP(*L.barbarum*: 3)	April (obs.in Jan)	3
115		*Solanum nigrum* L.	Anb edhib Morelle noire	عنب الذيب	Herb (TH)	White	NP (17)	March	1
116	Tamaricaceae	*Tamarix gallica* L.	Torfa Tamaris commun	الطرفة	Shrub (PH)	Pink	NP (IG)	July-Nov.	7
117		*Tamarix boveana* Bunge.			Shrub (PH)	White	P (IG)	Sept-April	3
118	Thymelaeaceae	*Thymelaea hirsuta* (L.) Endl.	Methnene Aghrar Passerine hérissée	المثنان آغرر	Shrub (CH)	Creamy white	NP (IG &3)	Oct-May	8
119	Urticaceae	*Urtica urens* L.	Horeigue Ortie brulante	الحريق	Herb (TH)	Green yellow	P (IG)	March-Sep	2
120	Vitaceae	*Vitis vinifera* L.	Dalia Vigne	الدالية	Tree (PH)	Yellow green	NP (IG,PO&3)	April-June	7
121	Zygophyllaceae	*Fagonia glutinosa* Delile.	H'sirat lardh Ajerthilentmourth	الارض حصيرة آجرثيلنتمورث	Herb (CH)	Purple	P (IG)	March-Sep	7
122		*Zygophyllum album* L.f.	Bougriba Zygophile	بوقريبة	Herb (CH)	White	N (18)	Feb-Apr	5

1:Yaakobi, 2009, 2: Porvs, 1922, 3: Gombault *et al* ., 2019, 4: Hamel and Boulemtafes, 2017, 5: Laallam *et al*., 2011, 6: Chabot, 1948,7: Ammari & Khadir, 2018, 8: Bouhala, 2022, 9: Van Daele, 2011, 10: Bessi, 2020, 11: Albaba, 2015, 12: Elkhalili, 2014, 13: Rodríguez-Riaño, 1999, 14: MAA, 2017, 15:Ur-Rehman, 1997, 16:Djebbar & Ounadi, 2017, 17: Mamoudou *et al*., 2021, 18 : Bouaka & Elkhalil, 2014. * If differences exist concerning the flowering period between the literature references and the information mentioned above. These are not errors; the flowering periods in the table above are those recorded during prospections. IG: information from local guides. CH: chamaephyte, GE: Geophyte HE: Hemicryptophyte, PH: Phanerophyte, TH : Therophyte. N: Nectar, P: Pollen, PO: Personal Observation, Prs: propolis, Rsi: Resin.