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Main European unifloral honeys: descriptive sheets[1]

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1. INTRODUCTION

In Europe more than 100 botanical species are known to produce unifloral honey (Persano Oddo et al., 2004). Most of them are produced occasionally or are only of local interest, whereas others are part of the import-export market between different European countries.

In the International Honey Commission of Apimondia (IHC), a working group was constituted in 1998, with the participation of 28 researchers specialized in honey analysis from 20 different laboratories (11 countries), with the aim of collecting analytical data related to the main European unifloral honeys and of elaborating them to provide the quality criteria for each important honey type.

2. MATERIALS AND METHODS

2.1. Data bank

The list of members of the IHC participating in the working group is integrally reported in the online version (Appendix5.pdf). They provided the information and the analytical data available in the respective laboratories, related to physicochemical, organoleptic and melissopalynological parameters of a number of authentic unifloral samples (participants were responsible for the authenticity of unifloral samples).

More than 61 000 raw data were supplied, related to 6719 honey samples produced in 21 countries of the European geographical area, and analysed for more than 30 physicochemical parameters.

For the characterisation work, 15 honey types were selected, as the most important in terms of abundance of production or commercial relevance in European countries. Among the set of parameters,

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Table I. List of parameters selected for the description of European unifloral honeys.

Sensory analysis	Visual
	Olfactory
	Taste
Melissopalynological analysis	Qualitative
	Quantitative
Physicochemical analysis	Colour
	Electrical conductivity
	Specific rotation
	Water
	Diastase
	Invertase
	Proline
	pH
	Free acidity
	Lactones
	Total acidity
	Fructose
	Glucose
	Sucrose
	Fructose + Glucose (F+G)
	Fructose/Glucose ratio (F/G)
	Glucose/Water ratio (G/W)

Table II. Number of samples and analytical data collected for each of the 15 honey types chosen.

HONEY TYPES	No. of samples	No. of analytical data
Brassica napus L. and "turnip rape"	715	5939
Calluna vulgaris (L.) Hull	219	1468
Castanea sativa Miller	495	4834
Citrus spp.	299	2555
Eucalyptus spp.	208	1692
Helianthus annuus L.	358	3312
Lavandula spp.	261	2041
Rhododendron spp.	139	1495
Robinia pseudacacia L.	715	5833
Rosmarinus officinalis L.	515	4017
Taraxacum officinale Weber	114	1131
Thymus spp.	308	2313
Tilia spp.	261	2411
Honeydew honey	721	5530
Honeydew honey from *Metcalfa pruinosa* (Say)	153	1610
Total	5 481	46 181

the most representative and most often used were chosen for describing the European unifloral honeys (Tab. I). Possible extra parameters characteristic for some honey types are quoted in the single descriptive sheets. In Table II the selected honey types with the respective number of samples and analytical data are reported.

Data were transferred in a normalised database (MS Access 97). In several cases (about 3%) data needed to be converted in terms of units of measurement. More than 54% of samples reported the year of production and/or analysis: the total range of years is between 1970 and 2002, but more than 90% of data were produced in the period 1990–2002.

Before the inclusion in the data bank, the data were verified and compared with the international standards, in order to avoid the inclusion of irregular honeys. Figure 1 shows the behaviour of water and HMF content respectively.

After this first check, mean, standard deviation, minimum and maximum values were calculated for each honey type and for each parameter. Then, a comparison between results of the different laboratories was carried out (F-test of data). In Figure 2 an example is presented related to the distribution of electrical conductivity of *Robinia* honey: data of the total sampling are compared with those from different laboratories. Generally, a very good agreement was found among laboratories. When results of a single laboratory were not in agreement with the others, they were discussed in the working group, to identify the possible source of the difference (analytical method or error): if the differences could not be explained, they are reported or commented on in the respective descriptive sheets.

Finally, in order to show up possible errors, other general controls were performed, like the general behaviour of the parameters, the sum of main components (no more than 100%), etc.

After the above-mentioned selections the total number of used data was 46 181 related to 5481 honey samples (respectively 76% and 81% of original data received).

For each single parameter the average values, standard deviation and confidence intervals at 95% were calculated for each honey type.

2.2. Analytical methods

The physico chemical methods, used for the honey characterisation are those of the IHC (Bogdanov et al., 1997). The values of the electrical conductivity

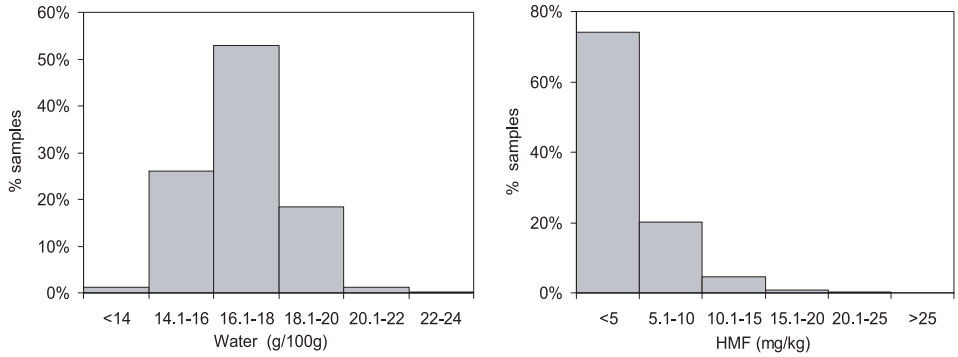


Figure 1. Water and HMF content in the IHC honey samples.

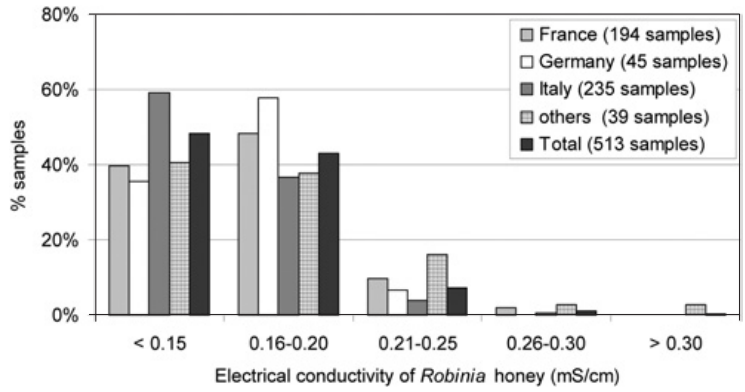


Figure 2. Distribution of electrical conductivity of *Robinia* honey. The total sampling is compared with the data from different laboratories.

and specific rotation are expressed on honey dry matter, the other ones on honey itself.

The pollen analysis was carried out according to the IHC protocol (von der Ohe et al., 2004). The sensory descriptions were based on the harmonized sensory terminology (Piana et al., 2004).

3. RESULTS

For each of 15 unifloral types studied, a descriptive sheet was compiled, where the following items are reported:

– a text with general information on the honey type and notes on its relevant characteristics;
– pollen photograph (courtesy of Katharina von der Ohe);
– a table with sensory characteristics (according to Piana et al., 2004);
– a table with melissopalynological characteristics;
– a table with physicochemical characteristics. For each parameter the number of samples, the average values, standard deviation and confidence intervals at 95% are given; if the confidence limit was greater than the real minimum or maximum value, the real value was given. On the right size of the table, the number of laboratories that provided the data and the total number of data per country are also reported ($^{lab}Country_{data}$), as an indication of the weight of each country on the final average values.

Sometimes, the botanical species that give rise to the unifloral honeys described in this work are not the same in all the countries where the honeys are produced: in other words, the same generic name can be used in different countries (or even in the same country), for honeys coming from one or more different species, hybrids, varieties or cultivars belonging to

the same botanical group. These cases are discussed in the respective sheets.

4. DISCUSSION

4.1. Diagnosis of unifloral honeys

In the routine work, when the analyst has to verify the botanical denomination of a single honey sample, all three complementary approaches have to be taken into account, melissopalynological, sensory and physicochemical. Melissopalynological analysis does not classify unequivocally unifloral honeys, and sensory evaluation may suffer from a certain subjectivity. On the other hand, the discriminating power of physicochemical parameters is to a certain extent affected by the honey variability. Therefore, the whole analytical picture of the sample has to be considered and interpreted in order to establish if it corresponds to the '*reference model'* for that botanical origin (Persano Oddo and Bogdanov, 2004). First, the sensory correspondence has to be evaluated; that must comply with the consumer expectation; then the melissopalynological characteristics have to be consistent with the declared botanical origin, and finally, the physicochemical values have to fall into the ranges specific for that honey type, with particular attention to the more characterising parameters.

According to previous researches on statistical analysis of unifloral analytical data (Mateo and Bosch-Reig, 1998; Piro et al., 2002), the following parameters were found to have the greatest discriminatory power: colour, electrical conductivity, specific rotation, diastase, acidity, fructose and glucose content. Their values (average and standard deviation) for the European unifloral honeys are reported in Table III. To provide more information, in the table also other honey types are included, for which some data were present in the data base, but that were not consistent enough for including them in the descriptive sheets. In the table the highlighted cells indicate, for each parameter, the honey types presenting the highest and the lowest values: indeed, it was demonstrated that, for each honey type, parameters showing very high or very low values have a greater classification power than the ones with medium values (Persano et al., 2000). The variability of the different parameters in the 15 unifloral honey types is shown in Figure 3.

4.2. A practical tool for the control of unifloral honeys

On the basis of the physicochemical data, a practical tool was elaborated for the routine control of the botanical denominations. The aim was to devise a type of graphic able to represent, for each unifloral type, a characteristic physicochemical *profile*, containing all the most discriminating parameters: colour, electrical conductivity, specific rotation, acidity, diastase and sugars (fructose, glucose, fructose+glucose, fructose/glucose ratio and glucose/water ratio).

All these parameters have different measurement units and numeric values. In order to report them on the same graphic (one for each honey type), the values of each parameter (average values, standard deviation and confidence intervals) are transformed, so that they represent percentages of the total range found for that parameter on the whole data set (max value – min value), as follows:

$$val_a\% = \frac{val_a - val_{\min}}{total\ \ range} \cdot 100$$

where:

$val_a\%$ is the transformed value

val_a is the original experimental value

val_{min} is the experimental minimum value found for that parameter on the whole data set

total range is the experimental range found for that parameter on the whole data set (maximum value – minimum value).

Example. The average value of electrical conductivity in *Robinia* honey is 0.16 mS/cm. For electrical conductivity the minimum value found on the whole data set is 0.08 mS/cm and the maximum is 2.17 (total range = 2.09). The transformed value of *Robinia* average conductivity, will be:

$$\frac{0.16 - 0.08}{2.09} \cdot 100 = 3.8\%.$$

In this way it was possible to put on the same graphic all the discriminating parameters related to each honey type, obtaining physicochemical profiles giving a synoptic view of the honey physicochemical behaviour (Fig. 4).

Table III – Characterising parameters of the European unifloral honeys (the whole data set is considered, including honeys not described in the sheets). The highlighted cells indicate, for each honey type, the more characterising parameters (light grey = low values; dark grey = high values).

HONEY TYPE	**Colour** (mm Pfund)	**Electr. cond.** (mS/cm)	**Spec. rotat.** $[\alpha]_D^{20}$	**Free Acidity** (meq/kg)	**Diastase** (DN)	**Fructose** (g/100 g)	**Glucose** (g/100 g)	**Fruct.+Gluc.** (g/100 g)	**Fruct./Gluc.** ratio	**Gluc./Water** ratio
*Arbutus***	70.1± 10.0	0.74± 0.10	–13.1± 1.9	35.1± 8.1	4.6± 2.8	37.6± 1.5	32.7± 1.2	70.3± 2.3	1.15± 0.05	1.76± 0.18
Brassica	26.2± 4.1	0.19± 0.05	–	10.3± 2.1	26.9± 5.8	38.3± 1.7	40.5± 2.6	78.7± 3.5	0.95± 0.07	2.37± 0.21
Calluna	76.9± 18.5	0.73± 0.12	–	32.1± 5.6	23.4± 6.3	40.8± 2.0	32.5± 1.6	73.4± 3.1	1.26± 0.07	1.76± 0.16
Castanea	87.9± 16.0	1.38± 0.27	–16.7± 3.4	13.0± 3.5	24.3± 5.7	40.8± 2.6	27.9± 2.5	68.7± 2.5	1.48± 0.19	1.62± 0.13
Citrus	15.0± 6.6	0.19± 0.06	–13.4± 2.4	14.3± 3.2	9.6± 2.9	38.7± 2.6	31.4± 2.1	70.1± 3.5	1.24± 0.12	1.92± 0.15
*Erica arborea***	99.1± 12.9	0.70± 0.09	–13.9± 1.6	34.7± 5.0	8.7± 3.5	38.4± 1.3	34.7± 1.2	73.1± 1.6	1.11± 0.06	1.89± 0.18
Eucalyptus	54.2± 9.4	0.48± 0.06	–13.3± 2.3	19.4± 5.3	25.5± 4.8	39.1± 2.2	33.0± 1.9	72.0± 3.3	1.19± 0.09	2.14± 0.15
*Hedysarum***	18.4± 8.3	0.20± 0.05	–10.8± 2.7	27.2± 8.0	21.3± 5.2	39.0± 1.4	32.1± 1.3	71.1± 1.9	1.22± 0.07	1.90± 0.12
Helianthus	52.4*± 9.0	0.34± 0.08	–17.5± 1.9	23.1± 6.3	20.8± 5.6	39.2± 1.6	37.4± 1.5	76.7± 2.7	1.05± 0.04	2.10± 0.13
Lavandula	33.3± 6.5	0.21± 0.05	–8.3± 3.8	17.3± 4.0	14.1± 2.4	36.0± 1.9	30.6± 1.7	66.6± 2.9	1.18± 0.07	1.88± 0.09
*Phacelia***	–	0.23± 0.09	–	19.8± 7.5	–	37.3± 2.5	34.0± 1.9	71.3± 3.8	1.10± 0.08	2.09± 0.15
Rhododendron	12.4± 4.0	0.23± 0.06	–5.8± 2.4	13.3± 3.3	12.1± 2.3	39.1± 2.1	30.4± 2.2	69.6± 3.4	1.29± 0.10	1.79± 0.17
Robinia	12.9± 5.6	0.16± 0.04	–16.6± 3.1	11.2± 3.4	10.5± 5.0	42.7± 2.3	26.5± 1.7	69.2± 3.3	1.61± 0.11	1.57± 0.13
Rosmarinus	15.0± 5.8	0.15± 0.04	–6.1± 2.8	11.5± 4.7	9.7± 3.2	38.4± 1.6	33.1± 2.2	71.5± 3.0	1.16± 0.08	2.06± 0.15
Taraxacum	56.6*± 10.4	0.51± 0.07	–10.0± 2.1	10.9± 2.0	11.3± 2.3	37.4± 1.8	38.0± 2.8	75.2± 3.9	0.99± 0.07	2.33± 0.15
Thymus	53.1± 10.8	0.40± 0.07	–20.1± 2.1	37.2± 6.3	29.2± 7.6	42.4± 2.4	30.3± 1.8	72.7± 2.9	1.41± 0.12	1.90± 0.13
Tilia	33.3± 13.1	0.62± 0.12	–12.5± 2.8	20.8± 7.7	16.8± 3.4	37.5± 2.9	31.9± 2.5	69.5± 4.0	1.18± 0.12	1.93± 0.19
Honeydew	86.0± 16.4	1.20± 0.22	13.9± 5.7	26.0± 5.6	22.6± 5.6	32.5± 1.9	26.2± 2.5	58.7± 3.8	1.25± 0.12	1.61± 0.17
Metcalfa h.dew	100.8± 7.5	1.69± 0.24	17.5± 6.5	37.2± 6.6	39.3± 7.9	31.6± 3.2	23.9± 2.7	55.5± 4.5	1.34± 0.18	1.51± 0.18

* Colour of *Helianthus* and *Taraxacum* honeys presents a typical yellow hue.
** Honey types not described in the sheets.

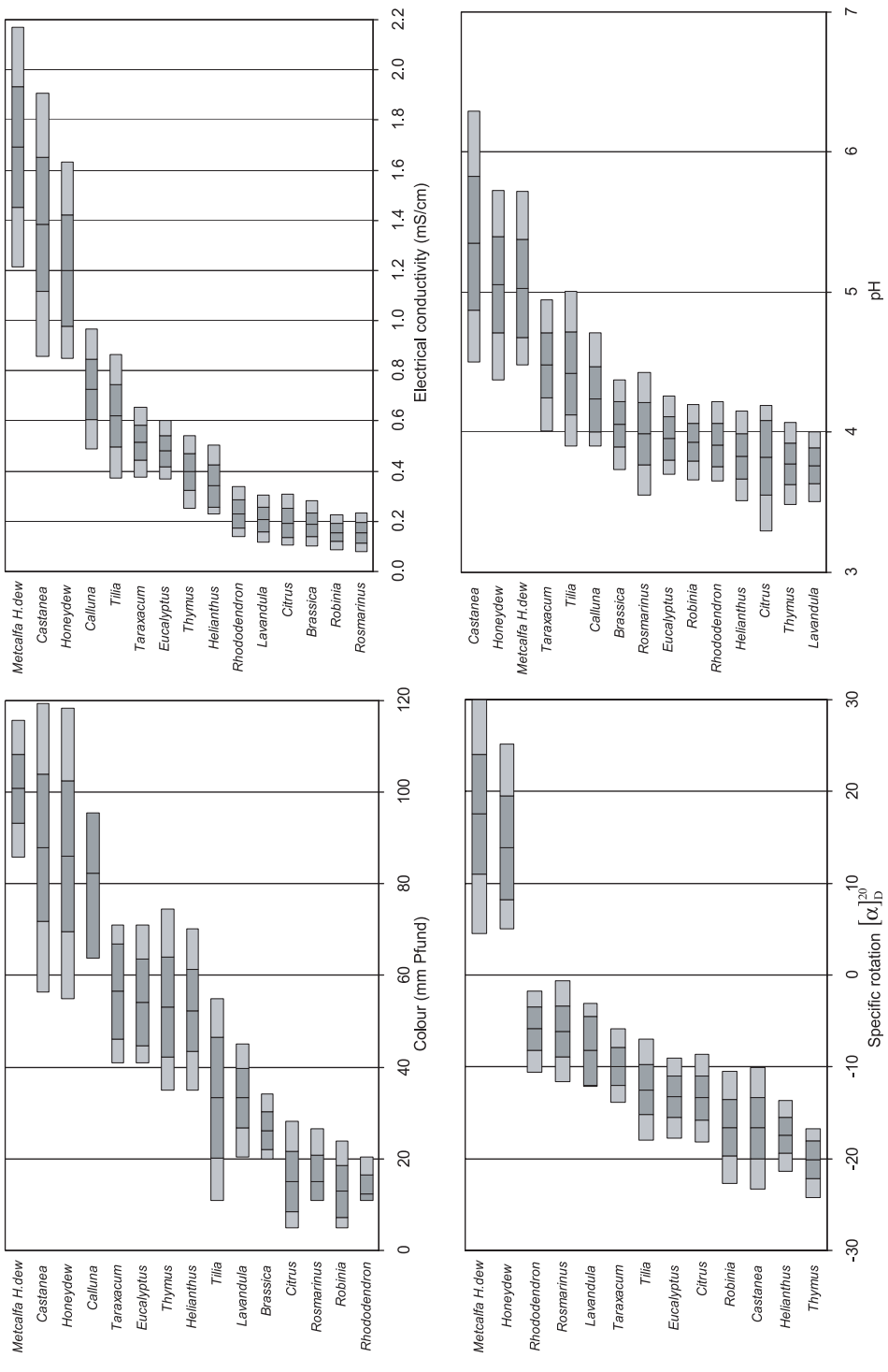
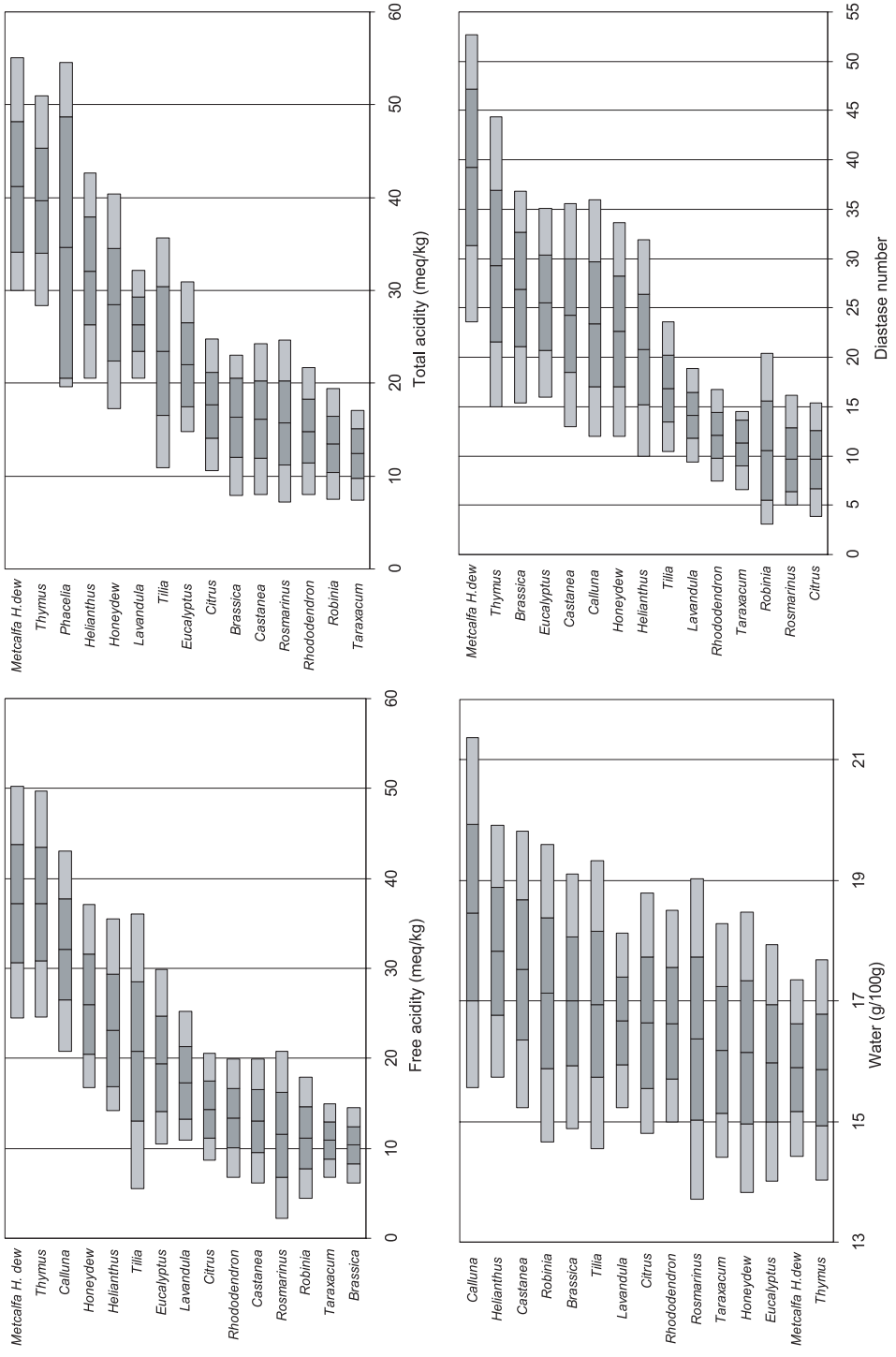


Figure 3. Variability of the various parameters in the unifloral honey types studied (dark grey area = mean ± st. dev; light grey area = min-max values).



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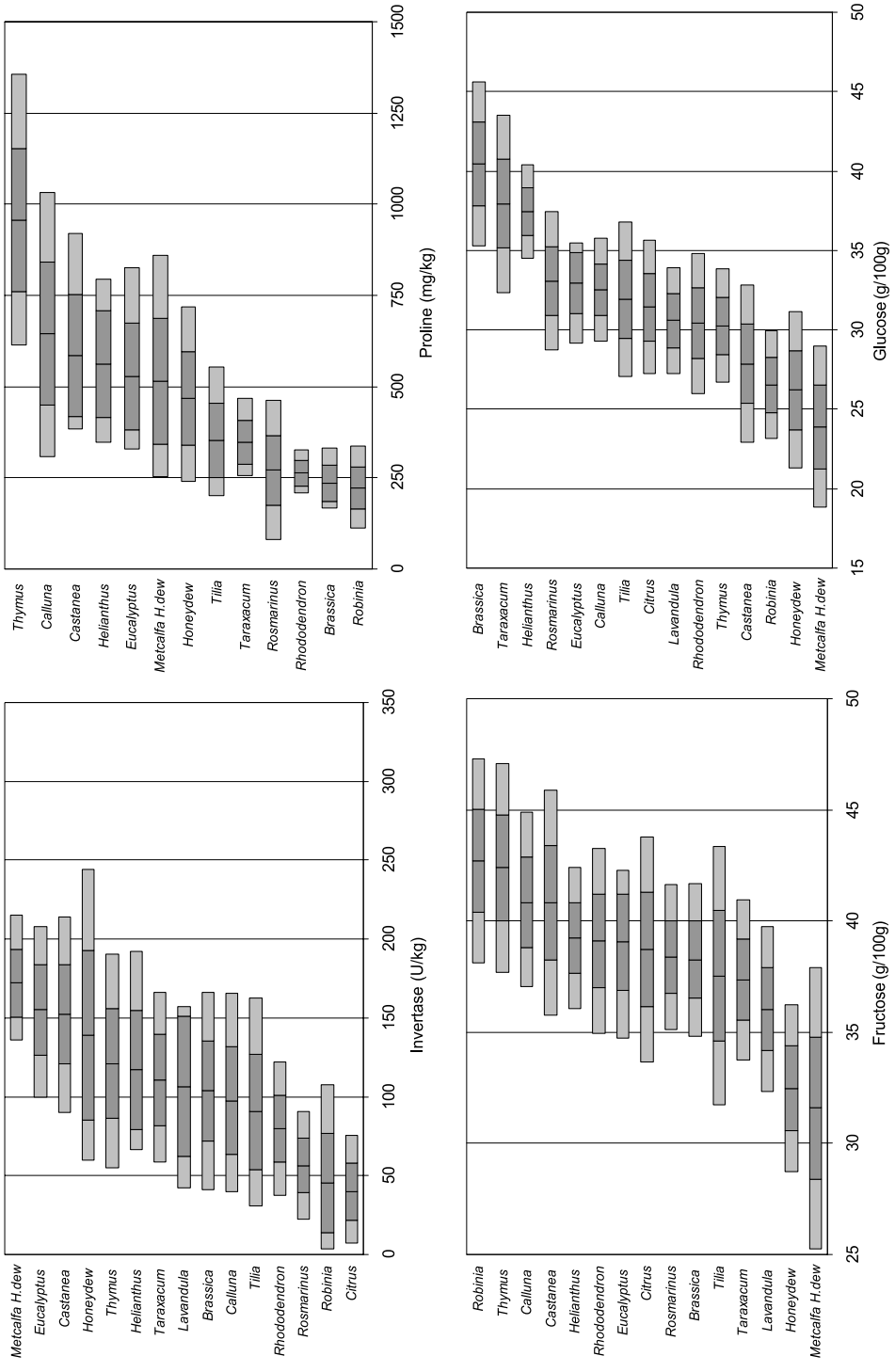

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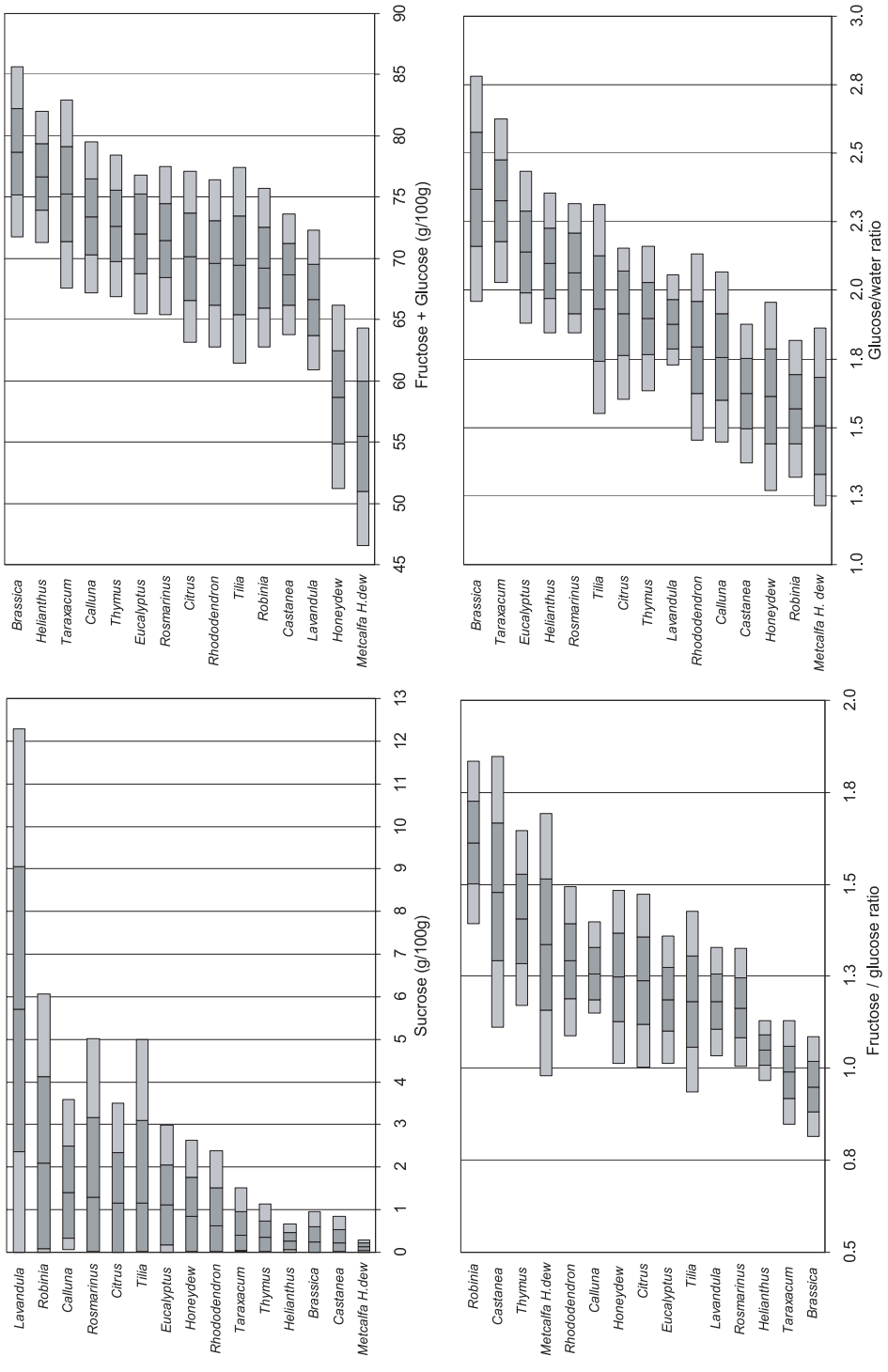

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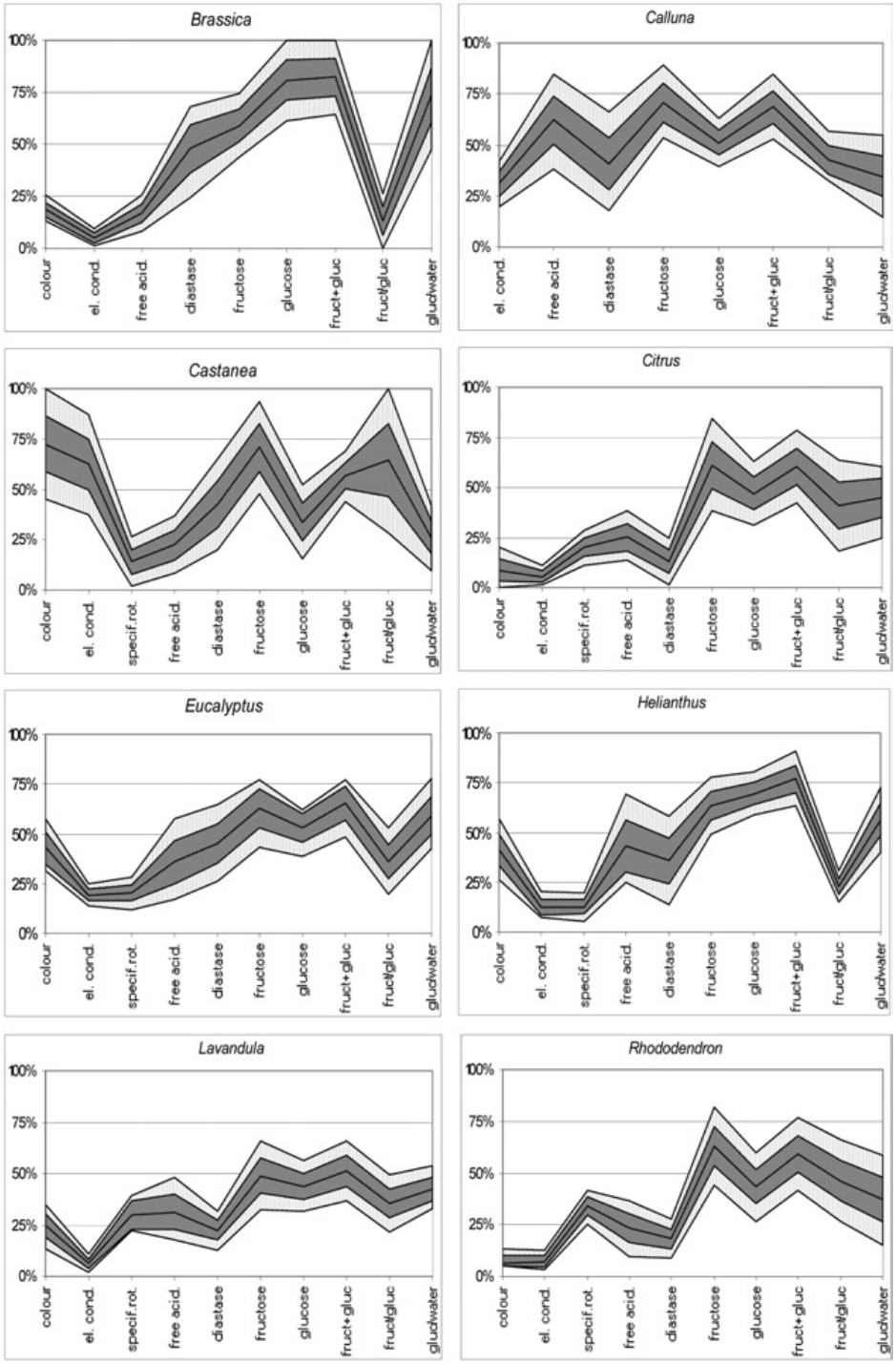

Figure 4. Physicochemical profiles of the main European unifloral honeys. (Values of each parameter are transformed as percentage of the experimental range found for that parameter on the whole data set.)

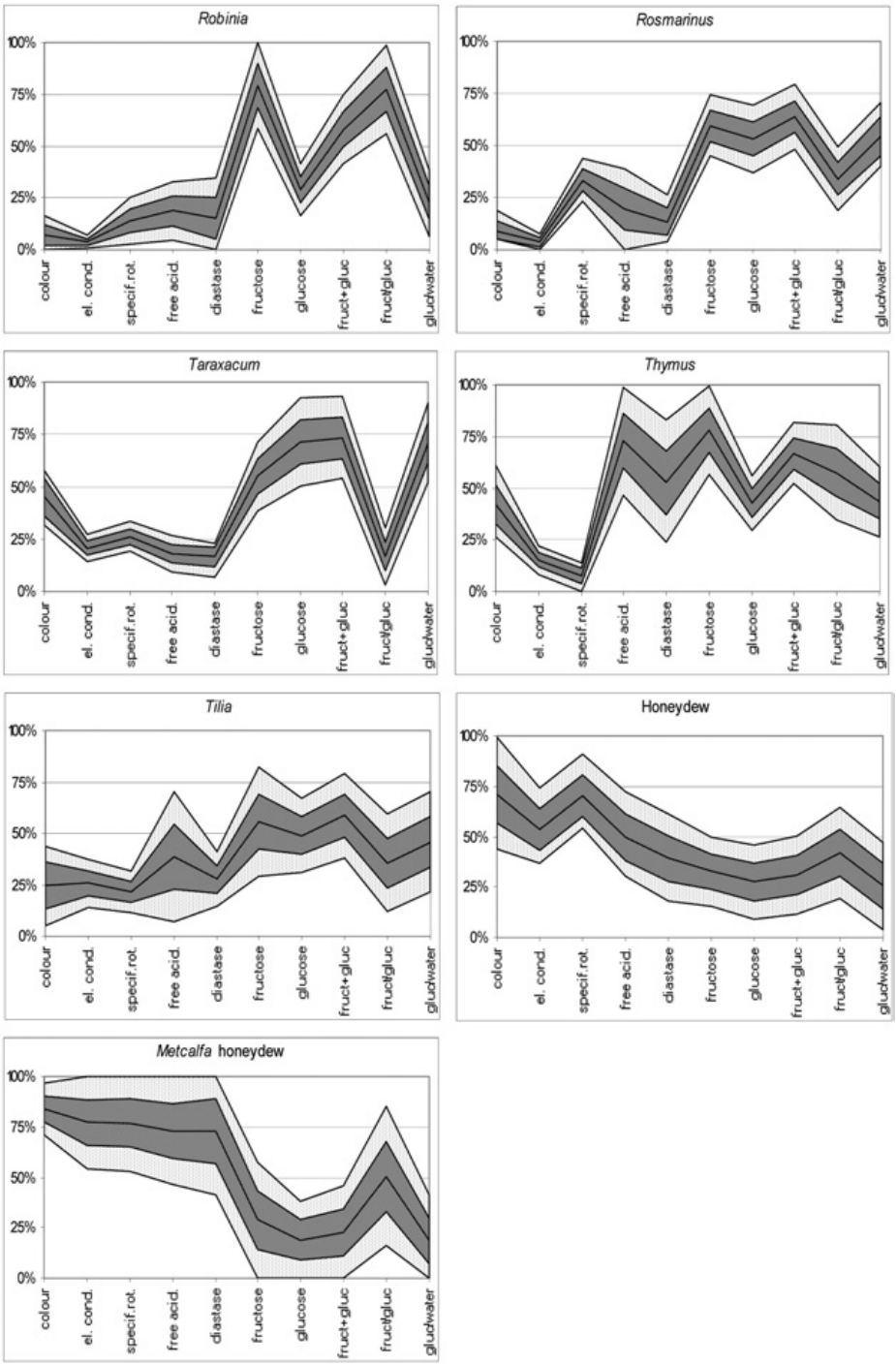

Figure 4. Continued.

Table IV. Minimum values (Val_{min}) and ranges (Val_{max}–Val_{min}) of the main physicochemical parameters.

Parameter	Minimum value	Total range (Val_{max}–Val_{min})
colour (mm Pfund)	5.0	114.4
electrical conductivity (mS/cm)	0.08	2.09
specific rotation $[\alpha]_D^{20}$	–24.2	54.2
free acidity (meq/kg)	2.3	49.1
diastase (DN)	0	52.7
fructose (g/100 g)	25.3	22.0
glucose (g/100 g)	18.8	26.8
F+G (g/100 g)	46.6	39.1
F/G ratio	0.81	1.03
G/W ratio	1.22	1.56

To verify the botanical denomination of unknown samples, the global correspondence to the characteristic profile can be evaluated: after analysing the main parameters, the respective "transformed values" are calculated, according to the above formula (for each parameter val_{min} and *total range* values are reported in Tab. IV). The resulting profile is compared to the characteristic profile of that honey type. If the profile mostly falls into the standard deviation range (dark area) the sample is perfectly corresponding to the type; if it falls into the light area it can be considered acceptable; if it is out of the light area, it does not correspond to the type.

The excel file for applying this method is available in the online version (Appendix6.xls).

4.3. Compliance to norms

With respect to the composition and quality standards, the values of almost all the 6,719 honey samples analysed by the 20 participants laboratories perfectly comply with the limits established by the new European Directive concerning honey (European Commission, 2002). In Table V the values found for the Directive parameters in all the 6,719 IHC honey samples are reported and compared with the prescribed limits. For some honey types, particular values were found that should be included among the Directive exceptions. They are highlighted in the table.

5. CONCLUSIONS

From the coordinated work carried out by the IHC, an extensive databank was obtained, from which it was possible to outline a fairly complete picture of the main unifloral honey types produced in European countries. In most cases, data from different laboratories were in very good agreement. They are also fairly consistent with those available in the literature (Piazza and Persano Oddo, 2004), some differences mostly depending on the use of different analytical methods.

The descriptive sheets of the main European unifloral honeys give, for the various parameters, ranges of values that include 95% of the analysed samples. Therefore they reasonably represent a basic criterion of acceptability for the market and a useful reference for the evaluation of botanical denominations. They may assist the control authorities in the different European countries, and stimulate the production and trade of these valuable honey varieties.

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Table V. Quality parameters fixed by the new European Directive concerning honey (2001/110/CE). The limits prescribed by the directive are compared with the corresponding experimental values of the samples analysed in the IHC work (the whole data set is considered, including honeys not described in the sheets). Honey types not complying with Directive limits are highlighted, and the extreme values are reported.

Parameter	EU Directive limits		Experimental values from IHC databank		Total No of data
H_2O (g/100 g)	<20		<20		3411
Exceptions	*Calluna*:	<23	*Calluna*	max = 21.4	200
Other honey types that can exceed 20 g/100 g limit			***Arbutus***	max = 21.0	73
Fructose+Glucose (g/100 g)	>60		>60		2342
Exceptions	Honeydew	>45	Honeydews	>45	474
Sucrose (g/100 g)	<5		<5		1305
Exceptions	*Robinia*	<10	*Robinia*	max = 10.4	458
	Hedysarum	<10	*Hedysarum*	max = 8.3	35
	Eucalyptus	<10	*Eucalyptus*	max = 4.2	81
	Citrus	<10	*Citrus*	max = 6.4	110
	Medicago, *Banksia*, *Eucryphia*	<10	–		–
	Lavandula	<15	*Lavandula*	max = 15.2	218
	Borago	<15	–		–
Other honey types that can exceed 5 g/100 g limit			***Tilia***	max = 10.0	131
			Rosmarinus	max = 6.6	74
			Phacelia	max = 8.8	26
Electrical conductivity ($mS \cdot cm^{-1}$)	< 0.8		< 0.8		3123
	Castanea, Honeydew > 0.8		> 0.8		1158
Exceptions	*Arbutus*		*Arbutus*	0.5–0.9	63
	Erica		*Erica*	0.6–0.9	34
	Eucalyptus		*Eucalyptus*	0.4–0.6	163
	Tilia		*Tilia*	0.3–0.9	202
	Calluna		*Calluna*	0.4–1.0	189
	Leptospermum, *Melaleuca*		–		–
Free acidity (meq/kg)	<50		<50		2517
Honey types that can exceed 50 meq/kg limit			***Metcalfa* Hd**	max = 58.1	116
HMF (mg/kg)	<40		0.1–22.8		1769
Exceptions	tropical honeys	<80	–		–
Diastase (Schade units)	>8		>8		1634
Exceptions	honeys with low enzyme content: >3		*Citrus*	min = 3.9	191
			Robinia	min = 3.1	283
			Rosmarinus	min = 5.0	59
			Taraxacum	min = 5.2	26
			Erica	min = 3.7	25
Honey types that can go under the limit of 3 Schade units			***Arbutus***	0–9.7	50

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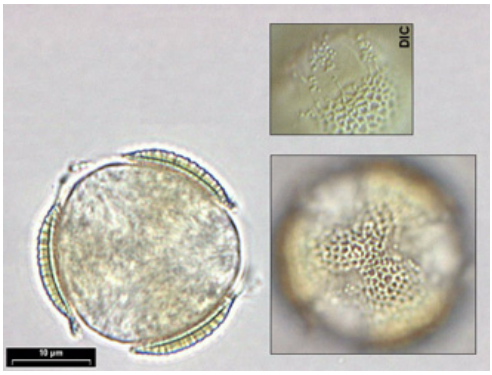
RAPE HONEY
(*BRASSICA* SPP. - BRASSICACEAE)

Rape (*Brassica napus* L. and other species, hybrids and varieties) is largely cultivated in Europe for the seed, used for oil production. It is very attractive to bees both for nectar and pollen and in Central and Eastern European countries represents one of the most important spring sources, giving rise to large amounts of very pure unifloral honey. The extension of cultivation and consequently the production of unifloral honey varies from year to year, according to European agricultural policy. In Northern Europe, e.g. Finland, the main *Brassica* honey is produced by turnip rape (*Brassica rapa* L. var. *oleifera* subvar. *annua*) (Ruoff, 2003). Outside Europe rape honey is produced in all the countries of the temperate area (mainly North America and China).

In many countries the unifloral denomination does not increase the market value and the honey is sold without mention of the botanical origin or it is blended with other honeys.

This honey is characterised by quick granulation, due to the high glucose content. For this property it is frequently used as a "crystallisation starter", added to other honeys to obtain a finer granulation.



Rapeseed pollen is normally represented. The unifloral honey presents low values of electrical conductivity, proline and F/G ratio, and high values of glucose, F+G and G/W ratio. For an authentic rapeseed honey some European laboratories requires a F/G ratio lower than 1 (Russmann, personal communication).

Sensory description		
Visual assessment	*Colour intensity*: light	
	Colour tone: normal honey colour	
Olfactory assessment	*Intensity of odour*: medium	
	Description: spoiled and vegetal	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: medium
	Description of aroma: floral – fresh fruit (fruity), warm, spoiled and vegetal	
	Persistence/aftertaste: short; aftertaste sometimes present (blackcurrant)	
	Other mouth perceptions: when crystallised in very small crystals, refreshing (like "fondant")	
Physical characteristics	*Crystallisation rate*: quick *Other*: this honey is often in crystallised form with very small crystals; in this case the colour appears whitish or dull ivory	

Brassica honey (715 samples; 5939 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	704				Min.	Max.									
Specific pollen		%	82.8	11.2	60.7	99.2	652	1 CH 47	1 D 451	1 F 92	1 FIN 51	1 NL 11			
Pollen absolute number		PG/10 g·10^3	75.7	37.3	4.2	150.7	52	1 CH 22	1 D 18	1 NL 12					

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	5235				Min.	Max.									
Color		mm Pfund	26.2	4.1	20.0	34.3	93	1 F 93							
Electrical Conductivity		mS/cm	0.19	0.05	0.10	0.28	687	1 B 22	1 CH 47	2 D 461	2 F 94	1 FIN 51	1 NL 12		
pH			4.1	0.2	3.7	4.4	177	1 B 25	1 CH 47	1 F 93	1 NL 12				
Free Acidity		meq/kg	10.3	2.1	6.2	14.5	137	1 B 19	1 CH 25	1 F 93					
Lactones		meq/kg	6.3	2.6	1.2	11.4	112	1 B 19	1 F 93						
Total Acidity		meq/kg	16.3	4.3	7.9	23.0	112	1 B 19	1 F 93						
Water		g/100 g	17.0	1.1	14.9	19.1	702	1 B 25	1 CH 47	2 D 477	2 F 94	1 FIN 51	1 NL 8		
Diastase (*)		DN	26.9	5.8	15.3	36.8	95	1 B 1	1 D 1	1 FIN 93					
Invertase (*)		U/kg	103.7	31.7	41.4	166.0	541	1 B 25	2 D 465	1 FIN 51					
Proline		mg/ kg	235	49	168	333	380	1 CH 25	1 D 355						
Fructose		g/100 g	38.3	1.7	34.8	41.7	419	1 B 23	1 CH 47	2 D 252	2 F 94	1 NL 3			
Glucose		g/100 g	40.5	2.6	35.3	45.6	419	1 B 23	1 CH 47	2 D 252	2 F 94	1 NL 3			
Sucrose		g/100 g	0.3	0.4	0.0	1.0	106	1 B 23	1 CH 47	1 D 34	2 F 2				
Fructose + Glucose		g/100 g	78.7	3.5	71.8	85.6	419	1 B 23	1 CH 47	2 D 252	2 F 94	1 NL 3			
Fructose / Glucose			0.95	0.07	0.81	1.09	419	1 B 23	1 CH 47	2 D 252	2 F 94	1 NL 3			
Glucose / Water			2.37	0.21	1.96	2.78	417	1 B 23	1 CH 47	2 D 250	2 F 94	1 NL 3			

(*) only for fresh honeys.
Legend: B = Belgium; Bu = Bulgaria; CH = Switzerland; CZ = Czech Republic; D = Germany; F = France; FIN = Finland; GR = Greece; I = Italy; NL = Netherlands; P = Portugal; S = Spain; PG = pollen grains; PE = plant elements; HDE = honeydew elements.

HEATHER HONEY
(*CALLUNA VULGARIS* (L.) HULL - ERICACEAE)

Calluna vulgaris (heather) is widely distributed in the Northern and Western countries of Europe, where it represents one of the most important resources for honey production in the late summer.

Heather honey is characterised by a particular physical phenomenon, called *thixotropy*: due to the presence of colloidal proteins, it becomes of a jelly consistence. This property makes the extraction from the combs only possible with the help of special tools (provided with needles that, mixing the honey in each comb cell, turn it into a *sol* state). A high water content, due to the season of production and the quick increase of HMF, due to a high acidity level, make the shelf-life of this honey shorter than other honey types.

The melissopalynological characteristics of *Calluna* honey are very variable: from the PG/10 g value (mostly between 20 000 and 100 000, II class of representativity) it seems to be normally represented, but the pollen percent is often under the 45% limit. This behaviour may be accounted for by the particular extraction technique (Louveaux, 1970).

The unifloral honey shows high values of colour, water and acidity; also electrical conductivity is one of the highest among nectar honeys, apart from chestnut honey. The European Directive allows a water content of up to 23 g/100 g and includes this honey in a group whose electrical conductivity may go beyond the 0.8 mS/cm limit.

A chemical marker for this honey type could be represented by the high content of total protein (Serra Bonvehí and Granados Tarrés, 1993). One European laboratory accept as unifloral only honeys whose protein content is above 1.15 g/100 g (Russmann, personal communication). Another element of characterisation can be the typical thixotropy, measurable through a viscosimeter (Serra Bonvehí and Granados Tarrés, 1993) or a thixotropic test (Louveaux, 1967).

Sensory description		
Visual assessment	*Colour intensity*: dark to very dark	
	Colour tone: normal honey colour with reddish/orange tone	
Olfactory assessment	*Intensity of odour*: medium to strong	
	Description: woody, floral – fresh fruit, warm	
Tasting assessment	*Sweetness*: weak	*Acidity*: medium
	Bitterness: medium	*Intensity of aroma*: strong
	Description of aroma: floral – fresh fruit, warm	
	Persistence/aftertaste: long	
	Other mouth perceptions: -	
Physical characteristics	*Crystallisation rate*: moderate *Other*: it often forms big rounded crystals; when liquid, the typical gel consistency is one of the diagnostic characteristics	

Calluna honey (219 samples; 1468 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	93				Min.	Max.										
Specific pollen		%	37.0	19.8	10.3	76.5	79	[1] D 60	[1] F 1	[1] NL 18						
Pollen absolute number		PG/10 g·10^3	50.0	42.3	4.2	141.5	14	[1] NL 14								

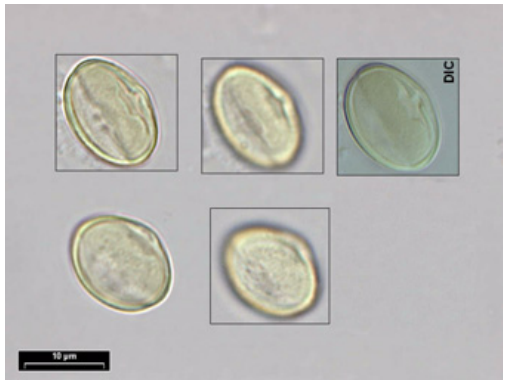
Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	1375				Min.	Max.										
Color		mm Pfund	76.9	18.5	63.8	90.0	2	[2] F 2								
Electrical Conductivity		mS/cm	0.73	0.12	0.49	0.97	189	[1] D 154	[2] F 2	[1] NL 18	[1] P 15					
pH			4.2	0.2	3.9	4.7	35	[2] F 2	[1] NL 18	[1] P 15						
Free Acidity		meq/kg	32.1	5.6	20.8	43.0	40	[1] P 40								
Water		g/100 g	18.5	1.5	15.6	21.4	200	[1] D 149	[2] F 2	[1] NL 9	[1] P 40					
Diastase (*)		DN	23.4	6.3	12.0	36.0	40	[1] P 40								
Invertase (*)		U/kg	97.6	34.4	40.0	165.7	132	[1] D 131	[1] F 1							
Proline		mg/ kg	646	196	309	1033	144	[1] D 144								
Fructose		g/100 g	40.8	2.0	37.1	44.9	109	[1] D 107	[2] F 2							
Glucose		g/100 g	32.5	1.6	29.3	35.7	109	[1] D 107	[2] F 2							
Sucrose		g/100 g	1.4	1.1	0.1	3.6	52	[1] D 16	[2] F 2	[1] P 34						
Fructose + Glucose		g/100 g	73.4	3.1	67.2	79.5	109	[1] D 107	[2] F 2							
Fructose / Glucose			1.26	0.07	1.15	1.40	109	[1] D 107	[2] F 2							
Glucose / Water			1.76	0.16	1.45	2.07	105	[1] D 103	[2] F 2							

(*) only for fresh honeys

CHESTNUT HONEY
(*CASTANEA SATIVA* MILLER - FAGACEAE)

Castanea sativa is found in many European countries, mostly Central and Southern ones and between 500 and 1000 m above sea level, spontaneous or cultivated for nuts and wood production. It represents for honey bees one of the best sources of nectar and pollen, but it can also provide honeydew, following the attack by some insects belonging to Rhynchota Homoptera: *Lachnus roboris* L. (Lachnidae), *Myzocallis castanicola* (Baker) (Callaphididae), *Parthenolecanium rufulum* (Cockrell) (Coccidae).

Pure chestnut honeys remain for a long time in a liquid state, due to the high fructose and low glucose content. *Castanea* pollen is strongly over-represented, and many laboratories require a percentage of at least 90%, with more than 100 000 PG/10 g honey, before accepting the honey as unifloral. This honey shows quite a typical physicochemical pattern, with low values of G/W ratio and high values of colour, electric conductivity, enzymes, pH and F/G ratio. For this honey the European Directive requires a value of electrical conductivity higher than 0.8 mS/cm.



In the IHC data collection, data from one French laboratory show different fructose and glucose values, resulting in a lower average fructose/glucose ratio (1.19 ± 0.07); excluding these values, the F/G mean value resulting from the remaining data would increase from 1.48 ± 0.19 to 1.56 ± 0.11.

Sensory description		
Visual assessment	*Colour intensity*: dark to very dark	
	Colour tone: normal honey colour with reddish tone	
Olfactory assessment	*Intensity of odour*: strong	
	Description: woody, chemical, warm	
Tasting assessment	*Sweetness*: weak	*Acidity*: weak
	Bitterness: strong	*Intensity of aroma*: strong
	Description of aroma: woody, chemical, warm and spoiled	
	Persistence/aftertaste: long	
	Other mouth perceptions: astringent	
Physical characteristics	*Crystallisation rate*: slow *Other*: it is quite common a fluid consistency, due to a high water content	

Castanea honey (495 samples; 4834 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	632				Min.	Max.									
Specific pollen		%	94.5	4.5	85.6	100.0	375	1 CH 55	1 D 15	1 F 62	1 GR 10	2 I 233			
Pollen absolute number		PG/10 g·10^3	288.2	180.1	100.0	642.8	257	1 CH 42	1 GR 10	2 I 205					

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	4202				Min.	Max.									
Color		mm Pfund	87.9	16.0	56.3	119.4	279	1 F 63	1 GR 10	2 I 206					
Electrical Conductivity		mS/cm	1.38	0.27	0.86	1.91	406	1 B 3	1 CH 52	1 D 29	2 F 72	1 GR 10	2 I 235	1 P 5	
Specific Rotation		$[\alpha]_D^{20}$	−16.7	3.4	−23.3	−10.0	240	1 Bu 10	2 I 230						
pH			5.3	0.5	4.5	6.3	365	1 B 4	1 CH 55	1 F 62	2 I 239	1 P 5			
Free Acidity		meq/kg	13.0	3.5	6.2	20.0	263	1 B 3	1 Bu 10	1 CH 13	1 F 63	2 I 167	1 P 7		
Lactones		meq/kg	3.1	2.4	0.0	7.8	233	1 B 3	1 F 63	2 I 167					
Total Acidity		meq/kg	16.1	4.1	8.0	24.2	233	2 B 3	1 F 63	2 I 167					
Water		g/100 g	17.5	1.2	15.2	19.8	210	1 B 4	1 Bu 10	1 CH 55	1 D 28	1 F 57	1 GR 10	2 I 40	1 P 6
Diastase (*)		DN	24.3	5.7	12.9	35.6	298	1 Bu 10	1 F 63	2 I 219	1 P 6				
Invertase (*)		U/kg	152.3	31.2	90.3	214.2	110	1 B 4	1 D 27	1 I 79					
Proline		mg/ kg	585	167	383	919	69	1 CH 13	1 D 28	1 I 28					
Fructose		g/100 g	40.8	2.6	35.8	45.9	276	1 B 4	1 CH 55	1 D 18	2 F 72	2 I 127			
Glucose		g/100 g	27.9	2.5	22.9	32.8	273	1 B 4	1 CH 55	1 D 18	2 F 71	2 I 125			
Sucrose		g/100 g	0.2	0.3	0.0	0.8	228	1 B 4	1 CH 53	2 F 54	2 I 115	1 P 2			
Fructose + Glucose		g/100 g	68.7	2.5	63.8	73.6	273	1 B 4	1 CH 55	1 D 18	2 F 71	2 I 125			
Fructose / Glucose			1.48	0.19	1.11	1.85	273	1 B 4	1 CH 55	1 D 18	2 F 71	2 I 125			
Glucose / Water			1.62	0.13	1.37	1.88	173	1 B 4	1 CH 55	1 D 18	2 F 56	2 I 40			

(*) only for fresh honeys

CITRUS HONEY
(*CITRUS* SPP. - RUTACEAE)

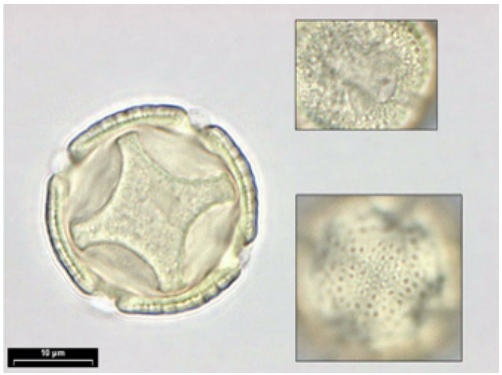
Different species, hybrids, varieties and cultivars of *Citrus* are cultivated in Mediterranean countries for the production of fruits and aromatic essences. All of them are very attractive to bees and give rise to large amounts of unifloral honey, mainly in Spain and Italy. The honey has a high commercial value and is the object of an import-export market.

Out of Europe the main producers of *Citrus* honey are Israel, USA (California), Brazil and Mexico, from where it is also imported into Europe.

Physicochemical characteristics of honeys from the various species are similar and one overall class is considered here, referred to *Citrus* spp.

Citrus pollen is under-represented, at a lesser or greater extent depending on the different species and cultivars. The unifloral honey shows low values of colour, electrical conductivity, enzymes, and a slightly high content of sucrose. In the European Directive, a diastase number as low as 3 and a sucrose content up to 10 g/100 g are allowed for this honey. However, in the IHC data collection only 2 samples had a sucrose content higher than the limit of 5 g/100 g.

Methylanthranilate is a chemical "marker" for *Citrus* unifloral honey (Talpay, 1985; Serra Bonvehí, 1988; Serra Bonvehí and Ventura Coll, 1995; White and Bryant, 1996); German



laboratories consider a content of at least 2 mg/kg as typical for an authentic unifloral honey (Talpay, 1985; Russmann, personal communication). The flavonoid "hesperitin" is also reported as a marker for *Citrus* unifloral honey by Ferreres et al. (1993) and Tomas-Barberan et al. (2001).

In the IHC data collection a considerable difference was recorded in proline values between Greece (769 mg/kg ± 157) and Italy (232 mg/kg ± 95). Since no other countries provided data for proline this parameter was omitted from the physico-chemical table.

Sensory description		
Visual assessment	*Colour intensity*: very light	
	Colour tone: normal honey colour	
Olfactory assessment	*Intensity of odour*: medium	
	Description: floral – fresh fruit (floral)	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: medium
	Description of aroma: fresh (anise), floral – fresh fruit (floral)	
	Persistence/aftertaste: short to medium	
	Other mouth perceptions: -	
Physical characteristics	*Crystallisation rate:* moderate	

Citrus honey (299 samples; 2555 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	334				Min.	Max.										
Specific pollen		%	18.6	12.0	2.3	42.2	192	3 GR 45	2 I 147							
Pollen absolute number		PG/10 g·10^3	10.5	5.5	2.5	21.3	142	1 GR 10	2 I 132							

2555

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	2221				Min.	Max.										
Color		mm Pfund	15.0	6.6	5.0	28.1	172	1 F 1	1 GR 14	2 I 157						
Electrical Conductivity		mS/cm	0.19	0.06	0.11	0.31	250	2 F 25	3 GR 50	2 I 175						
Specific Rotation		$[\alpha]_D^{20}$	−13.4	2.4	−18.2	−8.6	168	2 I 168								
pH			3.8	0.3	3.3	4.2	213	1 F 1	2 GR 47	2 I 165						
Free Acidity		meq/kg	14.3	3.2	8.7	20.6	141	1 F 1	2 I 140							
Lactones		meq/kg	3.3	2.5	0.0	8.2	141	1 F 1	2 I 140							
Total Acidity		meq/kg	17.6	3.6	10.6	24.7	141	1 F 1	2 I 140							
Water		g/100 g	16.6	1.1	14.8	18.8	94	1 F 1	3 GR 51	2 I 42						
Diastase (*)		DN	9.6	2.9	3.9	15.4	191	1 F 1	2 GR 34	2 I 156						
Invertase (*)		U/kg	40.0	18.0	7.1	75.7	101	1 GR 6	2 I 95							
Fructose		g/100 g	38.7	2.6	33.7	43.8	114	2 F 30	1 GR 3	2 I 81						
Glucose		g/100 g	31.4	2.1	27.2	35.6	113	2 F 30	1 GR 3	2 I 80						
Sucrose		g/100 g	1.2	1.2	0.0	3.5	110	2 F 30	1 GR 2	2 I 78						
Fructose + Glucose		g/100 g	70.1	3.5	63.1	77.1	113	2 F 30	1 GR 3	2 I 80						
Fructose / Glucose			1.24	0.12	1.00	1.47	113	2 F 30	1 GR 3	2 I 80						
Glucose / Water			1.92	0.15	1.60	2.16	46	1 F 1	1 GR 3	2 I 42						

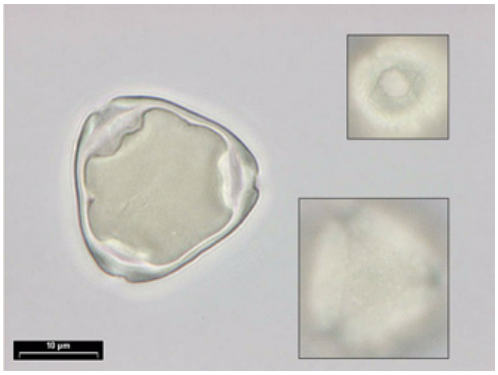
(*) only for fresh honeys

EUCALYPTUS HONEY
(*EUCALYPTUS* SPP. - MYRTACEAE)

Various *Eucalyptus* species, introduced from Australia at the beginning of the twentieth century, are found in the Mediterranean countries of Europe, cultivated mainly along the coasts (the tree has a good resistance to the coastal climate), for the paper industry, for the essential oil and as ornamental species. *E. camaldulensis* Dehn is one of the most important, but all species are very attractive to bees that gather from them both nectar and pollen.

The unifloral honey production is important in Italy, Spain and Portugal. Outside Europe, large amounts of *Eucalyptus* honey are produced in the countries where these species come from (Australia and New Zealand) or are introduced (North and South Africa, Israel, Central and Southern America).

E. camaldulensis pollen is over-represented (usually, Italian laboratories consider that for authentic honeys, at least 90% of specific pollen is typical). Unifloral honey has slightly high values of diastase, invertase and G/W ratio (due to a low water content rather than high glucose content). The European Directive includes *Eucalyptus* honey in a group whose electrical conductivity may go beyond the 0.8 mS/cm limit, and allows for this honey a sucrose content up to 10 g/100 g. However, in samples collected by IHC, the highest value of electrical conductivity was about 0.6 mS/cm, and no sucrose values were recorded above the 5 g/100 g limit. Indeed, the Directive takes into account *Eucalyptus* honeys from non-European countries, that may have different values (Bogdanov et al., 1999).



Sensory description		
Visual assessment	*Colour intensity*: medium to dark	
	Colour tone: normal honey colour with dull tone (greyish)	
Olfactory assessment	*Intensity of odour*: medium to strong	
	Description: warm and spoiled	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: medium
	Description of aroma: woody, warm and spoiled	
	Persistence/aftertaste: medium	
	Other mouth perceptions: -	
Physical characteristics	*Crystallisation rate:* moderate	

Eucalyptus honey (208 samples; 1692 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	228				Min.	Max.									
Specific pollen		%	94.8	5.9	83.1	100.0	118	[1] GR 9	[2] I 109						
Pollen absolute number		PG/10 g·10^3	269.6	136.7	90.0	540.6	110	[1] GR 9	[2] I 101						

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	1464				Min.	Max.									
Color		mm Pfund	54.2	9.4	41.0	71.0	113	[1] GR 9	[2] I 104						
Electrical Conductivity		mS/cm	0.48	0.06	0.37	0.60	163	[1] F 10	[1] GR 9	[2] I 136	[1] P 8				
Specific Rotation		$[\alpha]_D^{20}$	−13.3	2.3	−17.8	–9.0	121	[2] I 121							
pH			4.0	0.2	3.7	4.3	144	[2] I 136	[1] P 8						
Free Acidity		meq/kg	19.4	5.3	10.5	29.9	91	[2] I 82	[1] P 9						
Lactones		meq/kg	3.3	2.4	0.0	8.0	82	[2] I 82							
Total Acidity		meq/kg	22.0	4.5	14.8	31.0	82	[2] I 82							
Water		g/100 g	16.0	1.0	14.0	17.9	52	[1] GR 9	[2] I 29	[1] P 14					
Diastase (*)		DN	25.5	4.8	16.0	35.1	117	[2] I 106	[1] P 11						
Invertase (*)		U/kg	155.3	28.7	99.5	208.2	75	[2] I 75							
Proline		mg/ kg	528	147	330	827	33	[2] I 33							
Fructose		g/100 g	39.1	2.2	34.7	42.3	71	[1] F 12	[2] I 59						
Glucose		g/100 g	33.0	1.9	29.1	35.5	70	[1] F 12	[2] I 58						
Sucrose		g/100 g	1.1	0.9	0.0	3.0	81	[1] F 12	[2] I 57	[1] P 12					
Fructose + Glucose		g/100 g	72.0	3.3	65.4	76.8	70	[1] F 12	[2] I 58						
Fructose / Glucose			1.19	0.09	1.01	1.36	70	[1] F 12	[2] I 58						
Glucose / Water			2.14	0.15	1.88	2.43	29	[2] I 29							

(*) only for fresh honeys

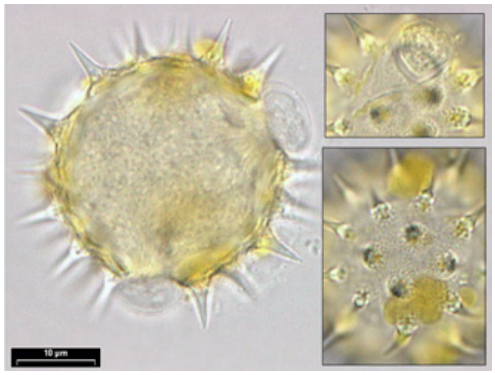
SUNFLOWER HONEY
(*HELIANTHUS ANNUUS* L. - ASTERACEAE)

Sunflower is largely cultivated for the oily seeds in many European countries, above all in Eastern and Southern ones, where it represents to bees an important source of nectar and pollen. The extension of cultivation and consequently the production of unifloral honey varies from year to year according to the European agricultural policy.

At present the unifloral denomination does not add market value to this honey, and in some countries it is not labelled as unifloral or it is blended with multifloral honeys.

The unifloral honey has a quick and often hard crystallisation, due to the high glucose content.

A big variability was recorded in the *Helianthus* pollen content, from less than 20% to more than 90%, with a PG/10 g value mostly below 30 000. The morphology of flower and pollen grains do not justify any under-represented behaviour, but different varieties or cultivars may have a variable pollen production.



Apart from its bright yellow colour, *Helianthus* unifloral honey is characterised by slightly high proline and acidity values and by a typical sugar spectrum, with a high glucose content, leading to a high F+G and a low F/G ratio. G/W ratio is quite elevated, but not at the highest levels, because of an often high water content. Low values were also recorded for sucrose and other oligosaccharides (Persano Oddo et al., 2000).

Sensory description		
Visual assessment	*Colour intensity*: medium	
	Colour tone: bright yellow	
Olfactory assessment	*Intensity of odour*: weak	
	Description: floral – fresh fruit (fruity), warm and vegetal	
Tasting assessment	*Sweetness*: medium	*Acidity*: strong
	Bitterness: absent	*Intensity of aroma*: weak to medium
	Description of aroma: floral – fresh fruit (fruity), warm and vegetal	
	Persistence/aftertaste: short	
	Other mouth perceptions: when crystallised with very small crystals, refreshing (like "fondant")	
Physical characteristics	*Crystallisation rate:* quick *Other*: crystallisation with hard crystals (hardly soluble) is frequent	

Helianthus honey (358 samples; 3312 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	321				Min.	Max.										
Specific pollen		%	56.7	24.2	12.0	92.0	229	[1] D 11	[1] F 121	[3] GR 39	[2] I 58					
Pollen absolute number		PG/10 g·10^3	18.8	12.1	2.3	42.7	92	[1] D 5	[1] GR 8	[2] I 79						

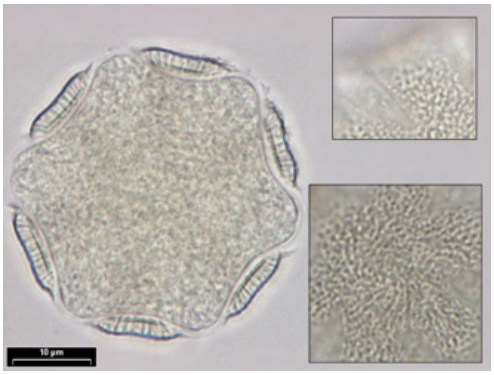
Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	2991				Min.	Max.										
Color		mm Pfund	52.4	9.0	35.0	70.1	189	[1] F 119	[1] GR 6	[2] I 64						
Electrical Conductivity		mS/cm	0.34	0.08	0.23	0.51	272	[1] Bu 9	[1] D 17	[3] F 126	[3] GR 40	[2] I 80				
Specific Rotation		$[\alpha]_D^{20}$	−17.5	1.9	−21.3	−13.6	105	[1] Bu 26	[2] I 79							
pH			3.8	0.2	3.5	4.2	243	[1] Bu 6	[1] F 122	[2] GR 34	[2] I 81					
Free Acidity		meq/kg	23.1	6.3	14.2	35.5	221	[1] Bu 28	[1] F 122	[2] I 71						
Lactones		meq/kg	10.1	5.8	0.9	20.1	193	[1] F 122	[2] I 71							
Total Acidity		meq/kg	32.1	5.8	20.6	42.7	193	[1] F 122	[2] I 71							
Water		g/100 g	17.8	1.1	15.7	19.9	233	[1] Bu 31	[2] D 20	[2] F 123	[3] GR 41	[2] I 18				
Diastase (*)		DN	20.8	5.6	10.0	31.9	231	[1] Bu 17	[1] D 5	[1] F 114	[2] GR 32	[2] I 63				
Invertase (*)		U/kg	117.0	37.6	66.2	192.1	66	[1] Bu 6	[1] D 14	[1] F 1	[1] GR 7	[2] I 38				
Proline		mg/ kg	562	146	348	794	28	[1] D 6	[1] GR 10	[2] I 12						
Fructose		g/100 g	39.2	1.6	36.1	42.4	178	[2] D 10	[3] F 127	[1] GR 2	[2] I 39					
Glucose		g/100 g	37.4	1.5	34.5	40.4	177	[2] D 10	[3] F 127	[1] GR 2	[2] I 38					
Sucrose		g/100 g	0.3	0.2	0.0	0.7	157	[1] D 3	[3] F 114	[1] GR 2	[2] I 38					
Fructose + Glucose		g/100 g	76.7	2.7	71.3	82.0	176	[2] D 10	[3] F 127	[1] GR 2	[2] I 37					
Fructose / Glucose			1.05	0.04	0.97	1.13	176	[2] D 10	[3] F 127	[1] GR 2	[2] I 37					
Glucose / Water			2.10	0.13	1.84	2.35	153	[2] D 10	[2] F 123	[1] GR 2	[2] I 18					

(*) only for fresh honeys+A1

LAVANDER HONEY
(*LAVANDULA* SPP. - LAMIACEAE)

Lavandula unifloral honey is mainly produced from the hybrid *L. x intermedia* Emeric ex Loiselieur, cultivated for the essential oil in France, Spain and, to a lesser extent, in other Southern and Mediterranean countries. It is extremely attractive to bees and represents a very valuable resource for honey production; Lavander honey also has a high commercial value and is marketed internationally.

Unifloral honey can be produced also from other *Lavandula* species: *L. angustifolia* Miller (France and Spain), *L. latifolia* Medicus (Spain and France) and *L. stoechas* L. (Spain, Portugal and Italy). In the IHC data collection, the first one showed a physicochemical pattern quite similar to *L. x intermedia*, therefore one overall class was considered, referred to *Lavandula* spp. Different characteristics were recorded for *L. latifolia* and *L. stoechas* honeys, that are not described here, since their production is mostly of local interest.



L. x intermedia pollen is strongly under-represented and even absent. The physicochemical pattern of Lavander unifloral honey is characterised by low values of electrical conductivity, slightly low F+G and high values of sucrose. For this honey the European Directive allows a sucrose content up to 15 g/100 g.

Sensory description		
Visual assessment	*Colour intensity*: light	
	Colour tone: normal honey colour, with bright tone (yellow)	
Olfactory assessment	*Intensity of odour*: medium	
	Description: woody, floral – fresh fruit (floral) and vegetal	
Tasting assessment	*Sweetness*: medium	*Acidity*: medium
	Bitterness: absent	*Intensity of aroma*: medium
	Description of aroma: woody, fresh, floral - fresh fruit and warm	
	Persistence/aftertaste: medium	
	Other mouth perceptions: aftertaste sometimes present (blackcurrant)	
Physical characteristics	*Crystallisation rate*: moderate	

Lavandula honey (261 samples; 2041 data)

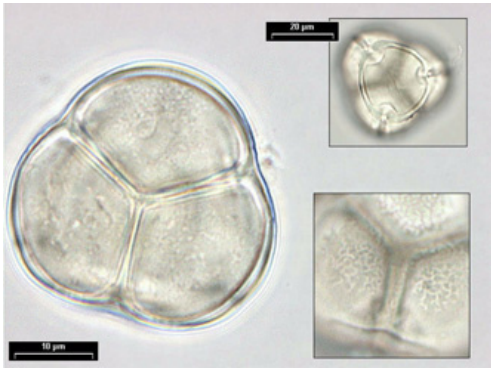
Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	84				Min.	Max.										
Specific pollen		%	8.2	5.9	1.0	19.9	84	[1] F 58	[1] S 26							

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	1957				Min.	Max.										
Color		mm Pfund	33.3	6.5	20.3	45.0	59	[2] F 59								
Electrical Conductivity		mS/cm	0.21	0.05	0.12	0.31	231	[1] Bu 3	[3] F 202	[1] S 26						
Specific Rotation		$[\alpha]_D^{20}$	−8.3	3.8	−12.1	−3.1	4	[1] Bu 4								
pH			3.8	0.1	3.5	4.0	89	[1] Bu 3	[2] F 60	[1] S 26						
Free Acidity		meq/kg	17.3	4.0	10.9	25.2	90	[1] Bu 5	[1] F 59	[1] S 26						
Lactones		meq/kg	9.7	2.5	4.7	14.2	84	[1] F 58	[1] S 26							
Total Acidity		meq/kg	26.3	2.9	20.6	32.1	84	[1] F 58	[1] S 26							
Water		g/100 g	16.7	0.7	15.2	18.1	96	[1] Bu 10	[2] F 60	[1] S 26						
Diastase (*)		DN	14.1	2.4	9.4	18.8	64	[1] Bu 5	[1] F 59							
Invertase (*)		U/kg	106.5	44.4	42.6	157.2	6	[1] Bu 5	[1] F 1							
Fructose		g/100 g	36.0	1.9	32.3	39.8	219	[3] F 219								
Glucose		g/100 g	30.6	1.7	27.3	33.9	218	[3] F 218								
Sucrose		g/100 g	5.7	3.3	0.0	12.3	218	[3] F 218								
Fructose + Glucose		g/100 g	66.6	2.9	60.9	72.3	218	[3] F 218								
Fructose / Glucose			1.18	0.07	1.03	1.33	218	[3] F 218								
Glucose / Water			1.88	0.09	1.73	2.06	59	[2] F 59								

(*) only for fresh honeys

RHODODENDRON HONEY (*RHODODENDRON* SPP - ERICACEAE)

Rhododendron honey originates from the species and natural hybrids spread in the Alps and Pyrenees: *R. ferrugineum* L., *R. hirsutum* L. and their hybrid *R. x intermedium*. One overall class is considered here, referred to as *Rhododendron* spp.



The unifloral honey is produced exclusively at an altitude where bees can stay only during some months, therefore the seasonal migration of hives is always required. The harvest is not abundant (or even certain), because of the variable meteorological conditions, and does not meet the demand. It is mostly sold in the production areas. Its market value is elevated and this may encourage an incorrect use of the denomination.

Rhododendron pollen is under-represented (PG/10 g < 20 000), but relatively high percentages of the specific pollen are not rare. The unifloral honey shows low values of colour, electrical conductivity and proline, and moderately negative values of specific rotation.

Sensory description		
Visual assessment	*Colour intensity*: very light	
	Colour tone: normal honey colour	
Olfactory assessment	*Intensity of odour*: weak	
	Description: woody and floral – fresh fruit	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: weak
	Description of aroma: woody, fresh, floral – fresh fruit (fruity) and warm	
	Persistence/aftertaste: short	
	Other mouth perceptions: -	
Physical characteristics	*Crystallisation rate*: moderate	

Rhododendron honey (139 samples; 1495 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	150				Min.	Max.										
Specific pollen		%	38.6	19.5	15.0	77.3	85	[1] CH 11	[2] I 74							
Pollen absolute number		PG/10 g·10^3	12.6	6.4	3.5	25.0	65	[2] I 65								

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	1345				Min.	Max.										
Color		mm Pfund	12.4	4.0	11.0	20.4	74	[2] I 74								
Electrical Conductivity		mS/cm	0.23	0.06	0.14	0.34	125	[1] CH 11	[1] F 37	[2] I 77						
Specific Rotation		$[\alpha]_D^{20}$	−5.8	2.4	−10.6	−1.7	76	[2] I 76								
pH			3.9	0.2	3.7	4.2	91	[1] CH 11	[1] F 1	[2] I 79						
Free Acidity		meq/kg	13.3	3.3	6.8	19.9	84	[1] CH 5	[1] F 1	[2] I 78						
Lactones		meq/kg	1.2	1.2	0.0	3.6	77	[2] I 77								
Total Acidity		meq/kg	14.8	3.4	8.0	21.7	77	[2] I 77								
Water		g/100 g	16.6	0.9	15.0	18.5	38	[1] CH 11	[1] F 1	[2] I 26						
Diastase (*)		DN	12.1	2.3	7.4	16.7	75	[1] F 1	[2] I 74							
Invertase (*)		U/kg	79.6	21.1	37.2	121.9	52	[2] I 52								
Proline		mg/ kg	264	35	208	327	16	[1] CH 5	[2] I 11							
Fructose		g/100 g	39.1	2.1	35.0	43.3	107	[1] CH 11	[1] F 38	[2] I 58						
Glucose		g/100 g	30.4	2.2	26.0	34.8	106	[1] CH 11	[1] F 38	[2] I 57						
Sucrose		g/100 g	0.6	0.9	0.0	2.4	99	[1] CH 11	[2] F 38	[2] I 50						
Fructose + Glucose		g/100 g	69.6	3.4	62.8	76.4	105	[1] CH 11	[1] F 38	[2] I 56						
Fructose / Glucose			1.29	0.10	1.09	1.50	105	[1] CH 11	[1] F 38	[2] I 56						
Glucose / Water			1.79	0.17	1.45	2.13	38	[1] CH 11	[1] F 1	[2] I 26						

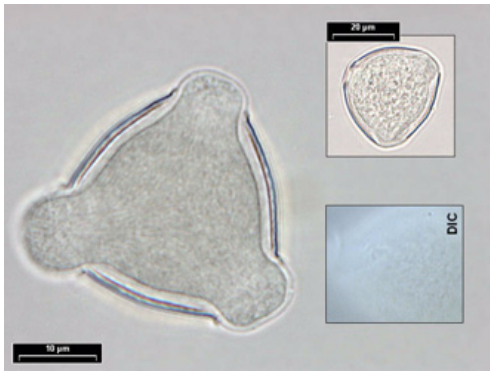
(*) only for fresh honeys

BLACK LOCUST HONEY
(*ROBINIA PSEUDOACACIA* L. - FABACEAE)

Robinia pseudoacacia, native to the North-east United States, is widely naturalised and cultivated in Europe. Important amounts of *Robinia* unifloral honey (often incorrectly called *Acacia* honey) are produced in many European countries, mainly in the Eastern ones, where the major quantities come from. Outside Europe, the *Robinia* honey is produced mostly in China.

Robinia honey is one of the most valuables honey types on the European market, because its characteristics are very much appreciated by the consumer: liquid (due to the high fructose content) and very light coloured and flavoured. These characteristics may easily be spoiled by the presence of foreign nectars or honeydew components, even in small quantities.

Robinia pollen is under-represented. The unifloral honey has quite a typical pattern, with low values of electrical conductivity, colour, acidity, enzymes, proline, glucose and G/W ratio and high values of fructose, sucrose and F/G ratio. For accepting a *Robinia* honey as unifloral, one European laboratory requires a F/G ratio of at least 1.55 (Russmann, personal communication). According to the European Directive a content of sucrose up to 10 g/100 g is permitted for this honey; moreover, it can be included in the category of honeys with a low enzyme content, for which a minimum diastase number of 3 is allowed.



In the IHC data collection, data from one French laboratory show slightly different fructose and glucose values, resulting in a lower average fructose/glucose ratio (1.49 ± 0.06); excluding these values, the F/G mean value resulting from the remaining data would increase from 1.61 ± 0.11 to 1.65 ± 0.10.

Sensory description		
Visual assessment	*Colour intensity*: very light	
	Colour tone: normal honey colour	
Olfactory assessment	*Intensity of odour*: weak	
	Description: floral – fresh fruit and warm	
Tasting assessment	*Sweetness*: medium to strong	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: weak
	Description of aroma: floral – fresh fruit and warm	
	Persistence/aftertaste: short	
	Other mouth perceptions: -	
Physical characteristics	*Crystallisation rate*: slow	

Robinia honey (715 samples; 5833 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	514				Min.	Max.										
Specific pollen		%	28.1	15.9	7.0	59.5	288	[1] CH 19	[1] D 33	[1] F 35	[2] I 201					
Pollen absolute number		PG/10 g·10^3	9.2	5.0	1.0	19.0	226	[1] D 19	[2] I 207							

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	5319				Min.	Max.										
Color		mm Pfund	12.9	5.6	5.0	23.9	240	[2] F 53	[2] I 187							
Electrical Conductivity		mS/cm	0.16	0.04	0.09	0.23	513	[1] B 11	[1] Bu 9	[1] CH 19	[1] D 45	[1] F 194	[2] I 235			
Specific Rotation		$[\alpha]_D^{20}$	–16.6	3.1	–22.7	–10.5	256	[1] Bu 50	[2] I 206							
pH			3.9	0.1	3.7	4.2	293	[1] B 11	[1] CH 19	[2] F 54	[2] I 209					
Free Acidity		meq/kg	11.2	3.4	4.5	17.9	297	[1] B 10	[1] Bu 50	[1] CH 12	[1] F 36	[2] I 189				
Lactones		meq/kg	2.8	2.2	0.0	7.1	234	[1] B 9	[1] F 36	[2] I 189						
Total Acidity		meq/kg	13.4	3.0	7.5	19.4	234	[1] B 9	[1] F 36	[2] I 189						
Water		g/100 g	17.1	1.3	14.7	19.6	263	[1] B 11	[1] Bu 50	[1] CH 19	[1] CZ 21	[2] D 66	[2] F 54	[2] I 42		
Diastase (*)		DN	10.5	5.0	3.1	20.4	283	[1] B 1	[1] Bu 50	[1] D 13	[1] F 36	[2] I 183				
Invertase (*)		U/kg	45.5	31.4	3.4	107.5	159	[1] B 9	[2] D 52	[1] F 18	[2] I 80					
Proline		mg/ kg	222	58	112	337	77	[1] CH 12	[1] D 27	[2] I 38						
Fructose		g/100 g	42.7	2.3	38.1	47.3	455	[1] B 5	[1] Bu 3	[1] CH 19	[1] CZ 21	[2] D 62	[3] F 206	[2] I 139		
Glucose		g/100 g	26.5	1.7	23.1	29.9	456	[1] B 5	[1] Bu 3	[1] CH 19	[1] CZ 21	[2] D 62	[3] F 206	[2] I 140		
Sucrose		g/100 g	2.1	2.0	0.0	6.1	458	[1] B 11	[1] Bu 3	[1] CH 19	[1] CZ 21	[2] D 55	[3] F 208	[2] I 141		
Fructose + Glucose		g/100 g	69.2	3.3	62.7	75.7	454	[1] B 5	[1] Bu 3	[1] CH 19	[1] CZ 21	[2] D 62	[3] F 206	[2] I 138		
Fructose / Glucose			1.61	0.11	1.39	1.83	454	[1] B 5	[1] Bu 3	[1] CH 19	[1] CZ 21	[2] D 62	[3] F 206	[2] I 138		
Glucose / Water			1.57	0.13	1.32	1.82	193	[1] B 5	[1] CH 19	[1] CZ 21	[2] D 53	[2] F 54	[2] I 41			

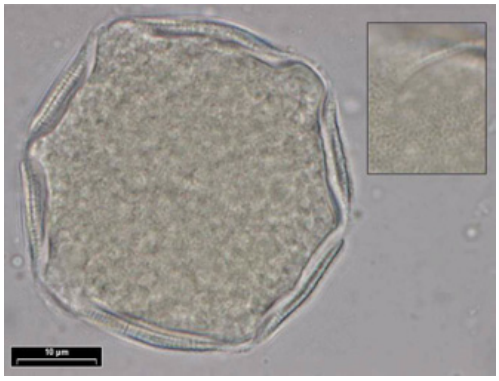
(*) only for fresh honeys

ROSEMARY HONEY
(*ROSMARINUS OFFICINALIS* L. - LAMIACEAE)

Rosmarinus officinalis is a typical plant of the Mediterranean vegetation. Spontaneous along the coasts, it is also cultivated as an aromatic plant in a wider area. It is very attractive to bees, but as the main flow is in early spring, a good exploitation of this very valuable nectar source is not always possible.

The unifloral honey is produced in the Mediterranean countries of Europe (mainly in Spain), North Africa and Turkey. It is appreciated by the consumer for its fine flavour and has a good commercial value.

The pollen of *Rosmarinus* is under-represented. The unifloral honey shows low values for colour, electrical conductivity, proline and diastase, and moderately negative values of specific rotation. Some samples from Spain and France showed a sucrose content higher than 5 g/100 g, but this seems to be more a sporadic exception than a typical feature of the honey. This honey type can be included in the category of honeys with low enzyme content, for which the European Directive allows a minimum diastase number of 3.



Sensory description		
Visual assessment	*Colour intensity*: very light	
	Colour tone: normal honey colour	
Olfactory assessment	*Intensity of odour*: weak to medium	
	Description: fresh, floral – fresh fruit and vegetal	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: weak to medium
	Description of aroma: fresh, floral – fresh fruit and vegetal	
	Persistence/aftertaste: short	
	Other mouth perceptions: -	
Physical characteristics	*Crystallisation rate:* moderate	

Rosmarinus honey (515 samples; 4017 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	509				Min.	Max.										
Specific pollen		%	28.7	14.7	10.0	57.5	465	[2] I 41	[1] S 424							
Pollen absolute number		PG/10 g·10^3	9.4	3.9	1.9	17.3	44	[2] I 44								

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	3508				Min.	Max.										
Color		mm Pfund	15.0	5.8	11.0	26.6	42	[1] F 1	[2] I 41							
Electrical Conductivity		mS/cm	0.15	0.04	0.08	0.23	490	[1] F 18	[2] I 51	[1] S 421						
Specific Rotation		$[\alpha]_D^{20}$	−6.1	2.8	−11.6	−0.6	103	[2] I 51	[1] S 52							
pH			4.0	0.2	3.6	4.4	480	[1] F 2	[2] I 56	[1] S 422						
Free Acidity		meq/kg	11.5	4.7	2.3	20.8	470	[1] F 1	[2] I 46	[1] S 423						
Lactones		meq/kg	4.2	3.4	0.0	10.9	467	[1] F 1	[2] I 46	[1] S 420						
Total Acidity		meq/kg	15.7	4.6	7.2	24.7	467	[1] F 1	[2] I 46	[1] S 420						
Water		g/100 g	16.4	1.4	13.7	19.0	441	[1] F 2	[2] I 15	[1] S 424						
Diastase (*)		DN	9.7	3.2	5.0	16.1	59	[1] F 1	[2] I 49	[1] S 9						.
Invertase (*)		U/kg	56.4	17.2	22.1	90.7	70	[2] I 44	[1] S 26							
Proline		mg/ kg	271	95	82	461	63	[2] I 15	[1] S 48							
Fructose		g/100 g	38.4	1.6	35.1	41.6	66	[3] F 20	[2] I 45	[1] S 1						
Glucose		g/100 g	33.1	2.2	28.7	37.4	66	[3] F 20	[2] I 45	[1] S 1						
Sucrose		g/100 g	1.3	1.9	0.0	5.0	74	[3] F 20	[2] I 40	[1] S 14						
Fructose + Glucose		g/100 g	71.5	3.0	65.4	77.5	66	[3] F 20	[2] I 45	[1] S 1						
Fructose / Glucose			1.16	0.08	1.01	1.33	66	[3] F 20	[2] I 45	[1] S 1						
Glucose / Water			2.06	0.15	1.84	2.32	18	[1] F 2	[2] I 15	[1] S 1						

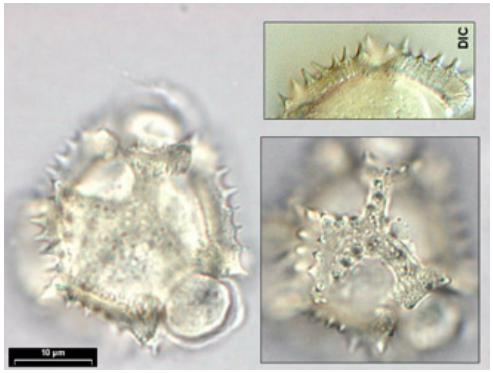
(*) only for fresh honeys

DANDELION HONEY (*TARAXACUM OFFICINALE* GROUP - ASTERACEAE)

Taraxacum officinale is a polymorph botanical group widely spread in Europe, mainly in the Central countries. It represents one of the earlier nectar sources, not always exploited by the bee colonies, which are frequently not developed enough to gather it for honey production.

Dandelion unifloral honey has a typical yellow colour, quite a strong flavour and crystallises rapidly, due to the high glucose content. It is mostly sold in the production areas.

From the PG/10 g values (33 600 ± 15 100) the pollen of *Taraxacum* does not seem to be under-represented, however its percentage in the honey rarely goes beyond 50%, and often it is lower than the associated species, such as *Salix* or Cruciferae. This could indicate that this honey type hardly ever is really pure, nevertheless the sensory and physicochemical patterns are very characteristic and the honey is easily recognisable.



Taraxacum honey shows low values of acidity and F/G ratio, and high values of glucose, F+G and G/W ratio. In some Italian samples the diastase value was under the Directive limit of 8.

Sensory description		
Visual assessment	*Colour intensity*: medium	
	Colour tone: bright yellow	
Olfactory assessment	*Intensity of odour*: strong	
	Description: spoiled	
Tasting assessment	*Sweetness*: medium	*Acidity*: medium
	Bitterness: absent to weak	*Intensity of aroma*: strong
	Description of aroma: woody and spoiled	
	Persistence/aftertaste: long	
	Other mouth perceptions: when crystallised with very small crystals, refreshing (like "fondant")	
Physical characteristics	*Crystallisation rate*: quick *Other*: this honey is often found in a crystallised form with very small crystals; in this case the colour appears faint yellow (like custard)	

Taraxacum honey (114 samples; 1131 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	129				Min.	Max.										
Specific pollen		%	17.2	11.7	5.0	40.5	85	[1] CH 26	[1] D 15	[2] I 44						
Pollen absolute number		PG/10 g·10^3	33.6	15.3	7.8	63.0	44	[2] I 44								

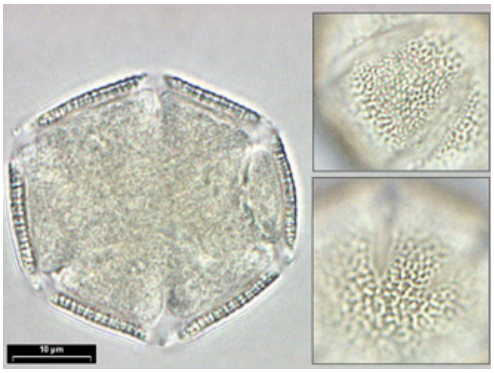
Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	1002				Min.	Max.										
Color		mm Pfund	56.6	10.4	41.0	71.0	45	[2] I 45								
Electrical Conductivity		mS/cm	0.51	0.07	0.37	0.65	105	[1] B 5	[1] CH 26	[1] D 16	[2] I 58					
Specific Rotation		$[\alpha]_D^{20}$	−10.0	2.1	−13.9	−5.9	54	[2] I 54								
pH			4.5	0.2	4.0	4.9	74	[1] B 5	[1] CH 26	[2] I 43						
Free Acidity		meq/kg	10.9	2.0	6.8	14.9	58	[1] B 5	[1] CH 14	[2] I 39						
Lactones		meq/kg	1.5	2.3	0.0	6.1	44	[1] B 5	[2] I 39							
Total Acidity		meq/kg	12.5	2.7	7.4	17.1	44	[1] B 5	[2] I 39							
Water		g/100 g	16.2	1.1	14.4	18.3	60	[1] B 5	[1] CH 26	[1] D 16	[2] I 13					
Diastase (*)		DN	11.3	2.3	6.6	14.5	26	[2] I 26								
Invertase (*)		U/kg	110.7	28.9	58.5	166.0	45	[1] B 3	[1] D 16	[2] I 26						
Proline		mg/ kg	348	60	255	469	36	[1] CH 14	[1] D 16	[2] I 6						
Fructose		g/100 g	37.4	1.8	33.8	41.0	74	[1] B 3	[1] CH 26	[1] D 17	[2] I 28					
Glucose		g/100 g	38.0	2.8	32.4	43.5	74	[1] B 3	[1] CH 26	[1] D 17	[2] I 28					
Sucrose		g/100 g	0.4	0.6	0.0	1.5	59	[1] B 3	[1] CH 26	[1] D 5	[2] I 25					
Fructose + Glucose		g/100 g	75.2	3.9	67.6	82.9	74	[1] B 3	[1] CH 26	[1] D 17	[2] I 28					
Fructose / Glucose			0.99	0.07	0.85	1.13	74	[1] B 3	[1] CH 26	[1] D 17	[2] I 28					
Glucose / Water			2.33	0.15	2.03	2.63	56	[1] B 2	[1] CH 26	[1] D 15	[2] I 13					

(*) only for fresh honeys

THYME HONEY
(*THYMUS* SPP. - LAMIACEAE)

Different species of *Thymus* are found in the Mediterranean countries. Unifloral *Thymus* honey is produced in Italy mainly from *Th. capitatus*, in Greece from a variety of different species of *Thymus* and other Labiatae, and in Spain and France mainly from *Th. vulgaris* L. The data reported in this sheet are in large part from Italy and Greece. Other possible unifloral honeys from other *Thymus* species, with different characteristics, are not described here.

The melissopalynological pattern of Italian samples is more typical of a under-represented honey (PG/10 g: 10 100 ± 6 000; *Thymus* pollen 26.6% ± 10.0), while Greek samples show a very variable pollen content (PG/10 g: 33 800 ± 16 700; *Thymus* pollen 40.2% ± 16.4).



Unifloral thyme honey presents quite high values of diastase, high values of proline, fructose and acidity (causing a quick increase in HMF); the specific rotation has the lowest values.

Sensory description (referred to honey from *Thymus capitatus*)		
Visual assessment	*Colour intensity*: medium to dark	
	Colour tone: normal honey colour	
Olfactory assessment	*Intensity of odour*: medium	
	Description: woody, chemical, fresh and floral – fresh fruit (floral)	
Tasting assessment	*Sweetness*: medium	*Acidity*: medium
	Bitterness: absent	*Intensity of aroma*: medium to strong
	Description of aroma: woody, chemical, fresh and floral – fresh fruit	
	Persistence/aftertaste: medium	
	Other mouth perceptions: -	
Physical characteristics	*Crystallisation rate*: moderate	

Thymus honey (308 samples; 2313 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	463				Min.	Max.									
Specific pollen		%	36.0	16.0	12.5	67.6	253	[1] F 1	[3] GR 175	[2] I 77					
Pollen absolute number		PG/10 g·10^3	25.9	17.9	1.8	61.2	210	[2] GR 130	[2] I 80						

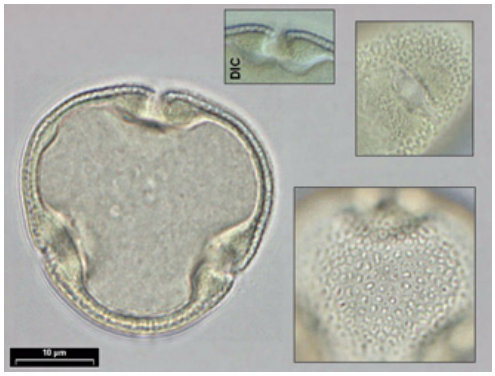
Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data							
Data	1850				Min.	Max.									
Color		mm Pfund	53.1	10.8	35.0	74.5	143	[1] F 1	[1] GR 78	[2] I 64					
Electrical Conductivity		mS/cm	0.40	0.07	0.25	0.54	248	[1] F 4	[4] GR 170	[2] I 74					
Specific Rotation		$[\alpha]_D^{20}$	−20.1	2.1	−24.2	−16.7	70	[2] I 70							
pH			3.8	0.1	3.5	4.1	131	[1] F 1	[2] GR 42	[2] I 88					
Free Acidity		meq/kg	37.2	6.3	24.6	49.7	76	[1] F 1	[2] I 75						
Lactones		meq/kg	2.4	2.2	0.1	6.9	75	[2] I 75							
Total Acidity		meq/kg	39.6	5.7	28.3	50.9	75	[2] I 75							
Water		g/100 g	15.9	0.9	14.0	17.7	200	[1] F 1	[4] GR 178	[2] I 21					
Diastase (*)		DN	29.2	7.6	15.0	44.4	145	[1] F 1	[3] GR 73	[2] I 71					
Invertase (*)		U/kg	121.1	34.7	54.8	190.3	77	[2] GR 30	[2] I 47						
Proline		mg/ kg	956	196	614	1357	34	[2] GR 21	[2] I 13						
Fructose		g/100 g	42.4	2.4	37.7	47.1	105	[2] F 3	[2] GR 49	[2] I 53					
Glucose		g/100 g	30.3	1.8	26.7	33.8	105	[2] F 3	[2] GR 49	[2] I 53					
Sucrose		g/100 g	0.3	0.4	0.0	1.1	91	[2] F 3	[2] GR 49	[2] I 39					
Fructose + Glucose		g/100 g	72.7	2.9	66.9	78.4	105	[2] F 3	[2] GR 49	[2] I 53					
Fructose / Glucose			1.41	0.12	1.17	1.65	105	[2] F 3	[2] GR 49	[2] I 53					
Glucose / Water			1.90	0.13	1.63	2.16	65	[1] F 1	[2] GR 43	[2] I 21					

(*) only for fresh honeys

LIME HONEY
(*TILIA* SPP - TILIACEAE)

Some species of *Tilia* (mainly *T. platyphyllos* and *T. cordata*) grow naturally in many European countries, and a number of different species, hybrids and varieties are cultivated as ornamental trees. All of them are very good sources of nectar, but can also provide honeydew, following the attack of some insects belonging to Rhynchota Homoptera, such as *Eucallipterus tiliae* L. (Callaphididae).

Unifloral honey is produced mainly in Central and Eastern European Countries. Outside Europe large amounts of Lime honey are produced in Russia and China. It has a good commercial value. It is not possible to distinguish between honeys from the different *Tilia* species, so one overall class is described here, referred to as *Tilia* spp.



Tilia pollen is under-represented, sometimes extremely (due to cultivated sterile varieties). Unifloral *Tilia* honey has average values for most of the physicochemical parameters. Electrical conductivity values are quite high, for a nectar honey, and the European Directive includes this honey in a group whose electrical conductivity may go beyond the 0.8 mS/cm limit. Several samples showed a sucrose content higher than 5 g/100 g, however this honey is not included among the ones for which a 10 g/100 g limit is allowed by the European Directive. Some G+F values are lower than 60 g/100 g, but this can be accounted for by the possible presence of honeydew, which can also cause a certain variability in the other characteristics of lime honey (including colour, which is very light in pure nectar honey). This variability could also be caused by the fact that, due to the very strong and typical flavour of this honey, honeys not completely pure may be interpreted as unifloral.

Sensory description		
Visual assessment	*Colour intensity*: light to medium	
	Colour tone: normal honey colour, with bright tone (yellow)	
Olfactory assessment	*Intensity of odour*: strong	
	Description: woody, chemical and fresh	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent to medium	*Intensity of aroma*: strong
	Description of aroma: woody, chemical and fresh	
	Persistence/aftertaste: long	
	Other mouth perceptions: astringent	
Physical characteristics	*Crystallisation rate*: moderate	

Tilia honey (261 samples; 2411 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data									
Data	137				Min.	Max.											
Specific pollen		%	22.9	16.6	1.0	55.9	100	[1] Bu 12	[1] CH 7	[1] F 9	[1] D 53	[2] I 19					
Pollen absolute number		PG/10 g·10^3	15.8	9.6	3.0	35.2	37	[1] D 9	[2] I 28								

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data									
Data	2274				Min.	Max.											
Color		mm Pfund	33.3	13.1	11.0	55.0	81	[1] F 15	[2] I 66								
Electrical Conductivity		mS/cm	0.62	0.12	0.37	0.87	202	[1] B 20	[1] Bu 6	[1] CH 7	[2] D 88	[2] F 13	[2] I 68				
Specific Rotation		$[\alpha]_D^{20}$	−12.5	2.8	−18.0	−7.0	82	[1] Bu 7	[2] I 75								
pH			4.4	0.3	3.9	5.0	120	[1] B 20	[1] Bu 6	[1] CH 7	[2] F 15	[2] I 72					
Free Acidity		meq/kg	20.8	7.7	5.5	36.1	97	[1] B 13	[1] Bu 20	[1] CH 7	[1] F 9	[2] I 48					
Lactones		meq/kg	3.6	3.0	0.0	9.6	69	[1] B 13	[1] F 8	[2] I 48							
Total Acidity		meq/kg	23.5	7.0	10.9	35.6	69	[1] B 13	[1] F 8	[2] I 48							
Water		g/100 g	16.9	1.2	14.6	19.3	189	[1] B 20	[1] Bu 26	[1] CH 7	[2] D 91	[2] F 16	[2] I 29				
Diastase (*)		DN	16.8	3.4	10.4	23.6	99	[1] Bu 19	[1] D 8	[1] F 9	[2] I 63						
Invertase (*)		U/kg	90.6	36.5	30.8	162.7	164	[1] B 14	[1] Bu 6	[2] D 78	[1] F 4	[2] I 62					
Proline		mg/ kg	352	102	202	554	109	[1] Bu 12	[1] CH 7	[1] D 76	[2] I 14						
Fructose		g/100 g	37.5	2.9	31.7	43.3	179	[1] B 20	[1] Bu 1	[1] CH 7	[2] D 76	[2] F 16	[2] I 59				
Glucose		g/100 g	31.9	2.5	27.1	36.8	179	[1] B 20	[1] Bu 1	[1] CH 7	[2] D 76	[2] F 16	[2] I 59				
Sucrose		g/100 g	1.2	1.9	0.0	5.0	131	[1] B 20	[1] Bu 1	[1] CH 7	[2] D 41	[2] F 11	[2] I 51				
Fructose + Glucose		g/100 g	69.5	4.0	61.5	77.4	179	[1] B 20	[1] Bu 1	[1] CH 7	[2] D 76	[2] F 16	[2] I 59				
Fructose / Glucose			1.18	0.12	0.94	1.43	179	[1] B 20	[1] Bu 1	[1] CH 7	[2] D 76	[2] F 16	[2] I 59				
Glucose / Water			1.93	0.19	1.55	2.31	146	[1] B 20	[1] CH 7	[2] D 74	[2] F 16	[2] I 29					

(*) only for fresh honeys

HONEYDEW HONEY

Honeydew can be produced by a wide variety of sucking insects on a number of different Coniferae, as *Abies alba* L. (Central and Northern Europe), *A. cephalonica* Loudon (Greece), *Picea excelsa* (Lam) Link. (Central and Northern Europe), *Pinus halepensis* Miller and *P. brutia* Ten. (Greece), and Latifoliae (produced in most of Europe, mainly from different *Quercus* species). The main physicochemical parameters of the respective honeys show quite homogeneous values, except for honey from honeydew produced by *Metcalfa pruinosa* (Say), that presents some different characteristics. Therefore only this type was kept separate, whereas all the other types are grouped in one global class of "honeydew honeys". However, it must be underlined that organoleptic characteristics and market value of these different types can vary.

Under microscopic examination honeydew honeys are characterised by the presence of numerous honeydew elements (HDE, such as mold hyphae and spores, unicellular algae), and pollen from nectarless plants. In the IHC data set, the HDE/pollen ratio was often found below

the limit of 3 that, according to Louveaux et al. (1978), should be typical of this honey.

The physicochemical pattern of honeydew honey includes high values for colour, electrical conductivity and pH, positive values of specific rotation and low values of fructose, glucose, F+G and G/W. For honeydew honey, the European Directive requires a value of electrical conductivity higher than 0.8 mS/cm and allows a minimum F+G of 45 g/100 g.

Sensory description (referred to honey from *Abies alba* honeydew)		
Visual assessment	*Colour intensity*: dark to very dark	
	Colour tone: normal honey colour with green fluorescence	
Olfactory assessment	*Intensity of odour*: medium	
	Description: woody and warm	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: medium
	Description of aroma: woody and warm	
	Persistence/aftertaste: medium	
	Other mouth perceptions: sometimes astringent	
Physical characteristics	*Crystallisation rate*: slow *Other*: it is very commonly of a very thick consistency, due to a low water content	

Honeydew honey (721 samples; 5530 data)

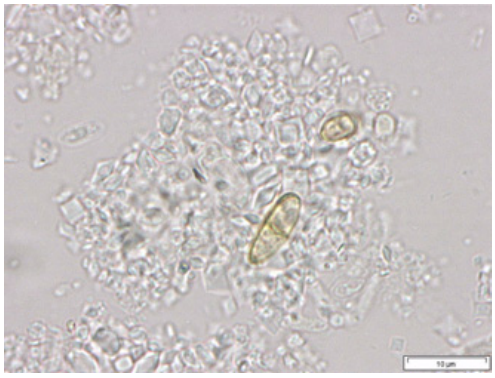
Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	245				Min.	Max.										
DE/PG			1.5	1.2	0.3	4.0	167	[3] GR 167								
Total n. of plant elements		PE/10 g·10^3	151.8	112.0	35.3	373.0	78	[1] GR 78								

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	5285				Min.	Max.										
Color		mm Pfund	86.0	16.4	55.0	118.3	229	[1] F 58	[1] GR 83	[2] I 88						
Electrical Conductivity		mS/cm	1.20	0.22	0.85	1.63	648	[1] Bu 4	[1] CH 30	[1] D 257	[1] F 58	[3] GR 199	[2] I 100			
Specific Rotation		$[\alpha]_D^{20}$	13.9	5.7	5.0	25.2	71	[2] I 71								
pH			5.1	0.3	4.4	5.7	254	[1] Bu 6	[1] CH 30	[1] F 58	[2] GR 67	[2] I 91	[1] P 2			
Free Acidity		meq/kg	26.0	5.6	16.8	37.1	205	[1] Bu 13	[1] CH 30	[1] F 57	[2] I 87	[1] P 18				
Lactones		meq/kg	2.8	2.0	0.0	6.7	143	[1] F 56	[2] I 87							
Total Acidity		meq/kg	28.4	6.1	17.3	40.4	143	[1] F 56	[2] I 87							
Water		g/100 g	16.1	1.2	13.8	18.5	598	[1] Bu 17	[1] CH 30	[1] D 275	[1] F 58	[4] GR 187	[2] I 14	[1] P 17		
Diastase (*)		DN	22.6	5.6	12.0	33.6	264	[1] Bu 3	[1] F 57	[2] GR 106	[2] I 81	[1] P 17				
Invertase (*)		U/kg	139.0	53.6	59.6	244.4	331	[1] Bu 6	[1] D 238	[1] GR 53	[2] I 34					
Proline		mg/ kg	468	127	240	718	305	[1] Bu 1	[1] CH 30	[1] D 253	[1] GR 21					
Fructose		g/100 g	32.5	1.9	28.7	36.2	362	[1] Bu 3	[1] CH 30	[1] D 202	[1] F 58	[2] GR 34	[2] I 35			
Glucose		g/100 g	26.2	2.5	21.3	31.1	362	[1] Bu 3	[1] CH 30	[1] D 202	[1] F 58	[2] GR 34	[2] I 35			
Sucrose		g/100 g	0.8	0.9	0.0	2.6	310	[1] Bu 3	[1] CH 30	[1] D 140	[1] F 58	[2] GR 27	[2] I 35	[1] P 17		
Fructose + Glucose		g/100 g	58.7	3.8	51.2	66.2	362	[1] Bu 3	[1] CH 30	[1] D 202	[1] F 58	[2] GR 34	[2] I 35			
Fructose / Glucose			1.25	0.12	1.01	1.48	362	[1] Bu 3	[1] CH 30	[1] D 202	[1] F 58	[2] GR 34	[2] I 35			
Glucose / Water			1.61	0.17	1.27	1.96	336	[1] CH 30	[1] D 201	[1] F 58	[2] GR 34	[2] I 13				

(*) only for fresh honeys

METCALFA HONEYDEW HONEY (*METCALFA PRUINOSA* (SAY) RINCHOTA HOMOPTERA, FLATIDAE)

Metcalfa pruinosa is an insect introduced in Europe at the end of the 1970s and now spread to Italy, Slovenia and France, where it attacks many indigenous and cultivated species, giving rise, in summer, to significant quantities of unifloral honey. On the market this honey is usually sold with the generic denomination of honeydew honey.



Under microscopic examination *Metcalfa* honeydew honeys are characterised by the presence of numerous honeydew elements (mold hyphae and spores, unicellular algae), and pollen from nectarless plants. The ratio HDE/pollen is mostly higher than 3. *Metcalfa* honeydew honey shows a very characteristic pattern, with high values of colour, electrical conductivity, diastase, invertase, pH and acidity (even beyond the 50 meq/kg limit prescribed by the European Directive), positive values of specific rotation and low values of fructose, glucose, F+G and G/W. For honeydew honeys, the European Directive requires a value of electrical conductivity higher than 0.8 mS/cm and allows a minimum F+G content of 45 g/100 g. The sugar spectrum of this honey type also includes a high dextrin content (Fiori et al., 2000).

Sensory description		
Visual assessment	*Colour intensity*: very dark	
	Colour tone: normal honey colour	
Olfactory assessment	*Intensity of odour*: medium	
	Description: woody, floral – fresh fruit (fruity), warm and vegetal	
Tasting assessment	*Sweetness*: medium	*Acidity*: weak
	Bitterness: absent	*Intensity of aroma*: medium
	Description of aroma: woody, floral – fresh fruit (fruity), warm and vegetal	
	Persistence/aftertaste: medium	
	Other mouth perceptions: sometimes astringent	
Physical characteristics	*Crystallisation rate*: slow *Other*: it is very commonly of a very thick consistency, due to a low water content	

Metcalfa honeydew honey (153 samples; 1610 data)

Melissopalynological parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	74				Min.	Max.										
DE/PG			4.8	6.0	0.2	17.1	37	[2] I 37								
Total n. of plant elements		PE/10 g·10^3	90.3	53.7	10.5	199.4	37	[2] I 37								

Physicochemical parameters		Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data								
Data	1536				Min.	Max.										
Color		mm Pfund	100.8	7.5	85.9	115.7	82	[2] I 82								
Electrical Conductivity		mS/cm	1.69	0.24	1.21	2.17	104	[1] F 10	[2] I 94							
Specific Rotation		$[\alpha]_D^{20}$	17.5	6.5	4.5	30.0	83	[2] I 83								
pH			5.0	0.3	4.5	5.7	97	[2] I 97								
Free Acidity		meq/kg	37.2	6.6	24.5	50.3	116	[2] I 116								
Lactones		meq/kg	4.0	1.2	1.5	6.4	116	[2] I 116								
Total Acidity		meq/kg	41.2	7.0	30.0	55.1	116	[2] I 116								
Water		g/100 g	15.9	0.7	14.4	17.4	41	[2] I 41								
Diastase (*)		DN	39.3	7.9	23.5	52.7	108	[2] I 108								
Invertase (*)		U/kg	172.0	21.4	135.9	215.1	45	[2] I 45								
Proline		mg/ kg	515	173	254	860	27	[2] I 27								
Fructose		g/100 g	31.6	3.2	25.3	37.9	112	[1] F 10	[2] I 102							
Glucose		g/100 g	23.9	2.7	18.8	29.0	112	[1] F 10	[2] I 102							
Sucrose		g/100 g	0.1	0.1	0.0	0.3	112	[1] F 10	[2] I 102							
Fructose + Glucose		g/100 g	55.5	4.5	46.6	64.3	112	[1] F 10	[2] I 102							
Fructose / Glucose			1.34	0.18	0.98	1.69	112	[1] F 10	[2] I 102							
Glucose / Water			1.51	0.18	1.22	1.86	41	[2] I 41								

(*) only for fresh honeys