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ORIGINAL ARTICLE

Physicochemical properties of some honeys produced from different plants in Morocco

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Abstract Seventy-three Moroccan honey samples were collected between 2005 and 2008. In this study, water content, pH, acidity (free, lactone and total acidity), electrical conductivity (EC), colour, diastase, hydroxymethylfurfural (HMF) and sugar content were all determined in different types of bee honey which include multifloral, honeydew and nine types of unifloral honeys (*Euphorbia resinifera*, *Euphorbia echinus*, *Citrus*, eucalyptus, carob, thyme, lavender, *Ziziphus* and rosemary). The moisture shows values of 14.3% and 20.2%, pH between 3.52 and 5.13, the total acidity ranges between 11.94 and 58.03 meq kg^{-1}, hydroxymethylfurfural (HMF) content shows values between 0.09 and 53.38 mg kg^{-1}; diastase values were between 4.3° and 24.6° Gothe; electrical conductivity between 119.9 and 1741 μs cm^{-1} and fructose, glucose and sucrose values range between 35.07–46.26%, 23.7–39.3% and 0.42–2.98%.

A statistical analysis was carried out to classify 10 types of honeys, and identified the most significant parameters, using analysis of variance, principal component analysis (PCA) and stepwise discriminant analysis (SDA). PCA showed that the cumulative variance was 74.97% and about 88.9% of samples was correctly classified.

The principal aim of this study was to contribute more to the knowledge of the Moroccan honeys by means of the analysis of chemical composition and of physical parameters. Seventy-three

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Moroccan unifloral, multifloral and honeydew honey samples, including types that have never been studied before, produced in different regions in Morocco (Tables 1 and 2), were analysed to define its main features.

As a consequence, we present data on water content, electrical conductivity, pH, free acidity, lactone acidity, total acidity, diastase, 5-(hydroxymethyl)-2-furaldehyde (HMF) amounts, fructose, glucose and sucrose.

1. Introduction

Morocco is a valid territory for honey production, due to its melliferous variety sources. Beekeeping is an old activity and 80% of the productivity is due to traditional beekeeping.

In 2006, honey production has reached 3500 ton of which 2500 ton is from the industrial sector and 1000 ton is from traditional methods, an increase of about 17% over 2005. The number of beekeepers is about 35,000 including 26,000 traditional and 9000 modern beekeepers. The number of hives is 385,000 of which 300,000 were traditional and 85,000 modern hives (Ministère de l'Agriculture et de la Pêche Maritime, Morocco, 2006).

Honey composition depends highly on the type of flowers utilised by the bee as well as the climatic conditions (Abu-Tarboush et al., 1993). The Moroccan honey productions regard many types of floral origin (Díez et al., 2004; Terrab et al., 2003a,b,c); many researchers have published studies about their parameters especially in Northwest of Morocco (Belouali et al., 2008; Naman et al., 2005, Noaman et al., 2004; Terrab et al., 2001, 2002, 2003a,b,c,d).

In Morocco, honey is widely used in traditional medicine, unfortunately, there are not enough investigations regarding its quality and characterisation, and *Euphorbia echinus*, *Ziziphus lotus* and lavender honeys were never studied.

Three races of bees that live in Morocco (Hepburn and Radloff, 1998) are *Apis mellifera intermissa* (Buttel-Reepen, 1906) present in most regions, *Apis mellifera major* (Ruttner, 1987) in the Rif mountains in the North, and it is considered as an ecotype not differing from *Apis mellifera intermissa* in behaviour and its taxonomic status, and *Apis mellifera sahariensis* (Baldensperger, 1932) in the South.

2. Materials and methods

2.1. Honey samples

Seventy-three unifloral, multifloral and honeydew honey samples were collected from beekeepers in different regions of Morocco between 2005 and 2008, during different seasons of the year depending on floral sources (*Euphorbia*, *Citrus*, eucalyptus, carob, thyme, lavender, *Ziziphus* and rosemary). The informations about samples are presented in Tables 1 and 2.

2.2. Analytical procedures

Water content (moisture) was determined by an Abbe-type refractometer reading at 20 °C, according to the relationship between honey water content and refractive index (Bogdanov, 2002; Chataway, 1932).

Table 1 Unifloral honey samples.

No. samples	Honey type	Production region	Production year
1	*Euphorbia echinus*	Souss Massa	2005
1	*Euphorbia echinus*	Souss Massa	2006
2	*Euphorbia echinus*	Souss Massa	2007
3	*Euphorbia resinifera*	Tadla Azilal	2006
9	*Euphorbia resinifera*	Tadla Azilal	2007
3	*Citrus*	Souss Massa	2007
3	*Citrus*	Tadla Azilal	2007
2	*Citrus*	Tadla Azilal	2008
2	*Citrus*	Tensift Al Haouz	2006
6	*Citrus*	Tensift Al Haouz	2007
1	*Citrus*	Tensift Al Haouz	2008
1	Eucalyptus	Chaouia	2005
1	Eucalyptus	Gharb	2007
1	Eucalyptus	Oriental	2007
1	Eucalyptus	Tadla Azilal	2007
3	Eucalyptus	Tensift Al Haouz	2007
2	Carob	Gharb	2007
1	Carob	Tadla Azilal	2006
2	Thyme	Gharb	2007
1	Thyme	Tadla Azilal	2007
1	Lavender	Gharb	2007
1	Lavender	Tafilalet	2007
1	*Ziziphus*	Gharb	2007
1	*Ziziphus*	Oriental	2007
1	*Ziziphus*	Souss Massa	2007
1	*Ziziphus*	Tensift Al Haouz	2007
1	Rosemary	Oriental	2007
1	Rosemary	Gharb	2007

Table 2 Multifloral and honeydew honey samples.

No. samples	Honey type	Production region	Production year
2	Multifloral	Chaouia	2006
1	Multifloral	Chaouia	2007
2	Multifloral	Gharb	2007
1	Multifloral	Oriental	2007
2	Multifloral	Tadla Azilal	2007
1	Multifloral	Tadla Azilal	2008
3	Multifloral	Tafilalet	2006
1	Multifloral	Tafilalet	2007
3	Multifloral	Tensift Al Haouz	2006
1	Multifloral	Zaer	2007
1	Honeydew	Tensift Al Haouz	2007
1	Honeydew	Oriental	2007

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