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Review

Differences between honeydew and blossom honeys: A review

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ABSTRACT

Background: Honey is classified in blossom honey (nectar of plants) or honeydew honey (secretions of living parts of plants or excretions of plant-sucking insects on plants). The antioxidant and antibacterial properties of honeydew honey are higher than those of most blossom honeys.
Scope and approach: Therefore it is important to determine the kind of honey to avoid adulterations. In this work, studies carried out to differentiate honeys according their botanical origin (blossom or honeydew) have been reviewed.
Key findings and conclusions: Honeydew honey is generally characterized by higher values of electric conductivity, pH, acidity and ash content, darker colour, higher oligosaccharides content and lower content of monosaccharides than blossom honey. FT-NIR and FT-MIR spectroscopy have been proposed for the honey authentication. These techniques also allowed the simultaneous determination of sugars and physicochemical parameters used in routine quality control of honey. The trisaccharide melezitose was regarded as a characteristic feature of honeydew honey. A diacylglycerilether was identified as a biochemical marker for honeydew honey. As conclusion, nowadays frauds can be avoid because honeydew and blossom honeys can be classified correctly.

1. Introduction

Honey is produced by bees (*Apis mellifera*) from carbohydrate-containing exudates produced by plants. Thus, some components of honey come from the plants, others are added by honeybees, and yet others are due to biochemical reactions during honey maturation (Iglesias, De Lorenzo, Polo, Martin-Alverez, & Pueyo, 2004). Therefore, honey is a complex mixture mainly composed of carbohydrates (70–80% w/w), water (10–20% w/w) and a great number of minor components (Ouchemoukh, Louaileche, & Schweitzer, 2007). The major carbohydrates are the monosaccharides glucose (~31% w/w) and fructose (~38% w/w).

Using gas chromatography (GC), 16 oligosaccharides in honey have been found, including 11 disaccharides (maltose, turanose, kojibiose, sucrose, palatinose, laminaribiose, gentiobiose, cellobiose, isomaltose, neotrehalose, nigerose) and 5 trisaccharides (erlose, isopanose, panose, theanderose, maltotriose) (Low & Sporns, 1988). Other trisaccharides include melezitose, isomaltotriose, raffinose, kestoses, and isomelezitose, which have been identified by chromatographic methods. Tetrasaccharides in honey include isomaltotetraose, maltotetraose, stachyose, nystose, fructosyl-isomelezitose, α-4′-glucosyl-erlose, and α-6′-glucosyl-erlose (Ruiz-Matute, Brokl, Soria, Sanz, & Martínez-Castro, 2010).

The minor components in honey include, among others, amino and organic acids, proteins, enzymes, hormones, lipids, phenolic compounds, vitamins, essential oils, pigments, sterols, phospholipids and mineral salts.

Honey is appreciated not only for its taste and flavour but also for its high nutritive value and its contribution in human health. A wide range of therapeutic activities such as antibacterial and anti-inflammatory properties, useful in stimulating the healing of wounds and burns and treatment of gastric ulcers and gastritis, have been attributed to the use of honey (Gheldof & Engeseth, 2002).

Additionally, honey has also significant antioxidant activity. Polyphenols, such as flavonoids and phenolic acids, are considered an important group of compounds with antioxidant activity (Gašic et al., 2014). The total flavonoids content (TFC) in honey represented 2–10% (w/w) of the total phenolic content (TPC) (Can et al., 2015). A 5% (w/w) of TFC was found by other researchers (Jasicka-Misiak, Poliwoda, Dereń, & Kafarski, 2012).

Other group of antioxidant compounds is formed by amino acids such as proline, histidine, glycine and alanine. The amount of amino acids in honey is about 1% (w/w). Proline is the major amino acid

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and constitutes 50–80% (w/w) of the total amino acid content (Hermosín, Chicón, & Cabezudo, 2003).

Another constituents, such as enzymes (glucose oxidase and catalase), ascorbic acid, some proteins and carotenoids have also antioxidant properties (Alvarez-Suarez, Tulipani, Romandini, Bertoli, & Battino, 2010; León-Ruiz, Vera, González-Porto, & Andrés, 2011; Molan & Betts, 2004).

Antibacterial properties of honey are related to its acidity, high osmolarity and hydrogen peroxide. Non-peroxide factors such as lysozyme, phenolic acids and flavonoids also contribute for antibacterial properties (Snowdon & Cliver, 1996).

With regard to the original raw plant, honey can have two different botanical origins being classified as blossom honey or honeydew honey. Blossom or floral honey is produced by bees from nectar contained in specialized botanical structures (flowers of blossoming plants). Honeydew honey is obtained from secretions produced by certain trees and other plants (genera *Pinus*, *Abies*, *Castanea* and *Quercus*, among others) or excretions of plant-sucking insects, mainly from the family *Aphididae*, on the living parts of plants. Therefore, honey composition is tightly associated to its botanical origin. It also depends on geographical region, because soil and climate characteristics determine melliferous flora (Iglesias et al., 2004).

Aroma and taste are two very sought-after properties in honey. The flavour of honeydew honey is stronger than that of blossom honeys. On the other hand, the honeydew honey is not so sweet as blossom honey (Castro-Vázquez, Díaz-Maroto, & Pérez-Coello, 2006).

The antioxidant and antibacterial properties of honeydew honey are higher than those of most blossom honey (Prodolliet & Hischenhuber, 1998). In addition, honeydew honey is appreciably higher in oligosaccharides than blossom honey (Doner, 1977; Prodolliet & Hischenhuber, 1998). Honey oligosaccharides present potential prebiotic activity increasing the populations of *bifidobacteria* and *lactobacilli* in human gut (Sanz et al., 2005).

Honeydew honey and blossom honey have different acceptances by consumers. In many European countries, there is a growing market for honeydew honey. Therefore, differentiation between both types of honey is demanded to avoid adulterations and frauds. The wide variability in composition and organoleptic properties among samples from the same source and the frequent occurrence of honeys resulting from a blend of blossom and honeydew honey do difficult the differentiation (Soria, González, De Lorenzo, Martínez-Castro, & Sanz, 2005).

In this work, studies carried out to differentiate honeys according their botanical origin (blossom or honeydew) have been reviewed. A comparative study of the main chemical and physicochemical parameters that shown differences for the two kinds of honey was performed. The antioxidant properties of both kinds of honeys and their relation to the content of phenolic compounds have been discussed. Analytical methodology used to classify honeys as honeydew or blossom has been reviewed. Specific chemical markers for honeydew honey were also reported.

2. Differentiation by chemical and physicochemical parameters

Many chemical and physicochemical parameters have been used to characterize honeydew honey and blossom honey. The main parameters used to differentiate both types of honey are electric conductivity (EC), specific rotation, ash content and pH (Ouchemoukh et al., 2007).

2.1. Electric conductivity

EC is a good criterion for the botanical origin of honey. It is used in routine honey quality control for discrimination between honeydew and blossom honeys. The European legislation (EU Directive 110/2001, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:010:0047:0052:EN:PDF) states that blossom honey and blends of these honeys must have EC values $\leq$ 0.8 mS/cm. However, there are exceptions to this rule, which include strawberry tree *(Arbutus unedo)*, bell heather *(Erica)*, eucalyptus, lime (*Tilia* spp.), ling heather *(Calluna vulgaris)*, manuka or jelly bush *(leptospermum) and* tea tree *(Melaleuca* spp.). Honeydew and chestnut honeys and blends of these with blossom honey (except those mentioned) must have values $\geq$ 0.8 mS/cm.

A mathematic equation based on the EC, 10 g 75 ml^{-1} (EC1075), and on the percentage of fructose plus glucose was developed for the estimation of the percentage of honeydew in honey samples (Soria, González, De Lorenzo, Martınez-Castro, & Sanz, 2004, 2005).

2.2. Specific rotation

Honey has the property of rotating the polarization plane of polarized light. Specific rotation depends largely on types and relative proportions of the sugars in honey. Blossom honeys are levorotatory and honeydew or adulterated honeys are usually dextrorotatory. This is a consequence of the normal preponderance in blossom honey of fructose, which has a negative specific rotation ($[\alpha]_D^{20} = -92.4°$), over that of glucose ($[\alpha]_D^{20} = +52.7°$). Honeydew honeys are usually somewhat lower in fructose content and contain melezitose ($[\alpha]_D^{20} = +88.2°$) or erlose ($[\alpha]_D^{25} = +121.8°$) which, together with glucose, usually give a positive net optical rotation (Garciá-Alvarez, Ceresuela, Huidobro, Hermida, & Rodríguez-Otero, 2002).

2.3. Colour

Another important parameter is colour, which is often related to the consumption patterns and consequently used to make judgments on its quality (Wilczynska, 2014).

Generally, honeydew honeys are darker than the blossom honeys. Some floral honeys such as chestnut and heather have also dark colour. A significant difference in the mean colour value (mm Pfund) was found between both types of honey by several researchers (Bentabol-Manzanares, Hernandez-Garcia, Rodriguez-Galdon, Rodriguez-Rodriguez, & Diaz-Romero, 2011; González-Miret, Terrab, Hernanz, Fernández-Recamales, & Heredia, 2005; Marini, Magrì, Balestrieri, Fabretti, & Marini, 2004; Terrab, González, Díez, & Heredia, 2003a).

The colour of honey is mainly determined by its botanical origin. It also depends on its ash content, temperature and time of storage (Baltrusaityte, Venskutonis, & Ceksteryte, 2007). A correlation between the colour of honeys and their mineral content has been found by applying multivariate statistical techniques such as multiple linear regression (MLR) and linear discriminant analysis (LDA). The colour parameter L^* of the dark honeys (avocado, chestnut, honeydew and heather) was greatly correlated with the concentration of minerals such as As, Cd, Fe, S, Pb and Ca (González-Miret et al., 2005).

Many researchers found that honeys with darker colour have a higher total phenolic content (TPC). On the other hand, the darkest coloured honeys presented the highest antioxidant capacity (McKibben & Engeseth, 2002). Therefore, phenolic compounds must be partly responsible for the antioxidant effects of honeys, but other factors must obviously be involved (Vela, de Lorenzo, & Perez, 2007).