Coletânea Nacional sobre Entomologia 2

Alexandre Igor Azevedo Pereira
(Organizador)

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APRESENTAÇÃO

Entomologia! A Ciência que estuda os insetos, que são os organismos vivos mais abundantes no Planeta Terra. Possuem importância médica, agrícola e veterinária, por isso pode-se dizer que os insetos de maneira direta ou indireta detém de alguma relevância para os seres humanos. Se considerarmos aqueles insetos que são utilizados para gerarem produtos valorosos para a sociedade, como mel, própolis, geleia real, tecidos e até alimentos através de seu consumo direto, percebe-se a extensa e complexa relação existente entre nós, seres humanos, e os insetos.

A obra "*Coletânea Nacional sobre Entomologia 2*" é a mais recente iniciativa da Atena Editora no sentido de difusão de conhecimento, demonstração de aprimoramentos e divulgação de tecnologias, em forma de e-book, no que tange ao estudo de insetos de importância médica, ambiental e agronômica, compreendendo 11 capítulos oferecendo o mais variado conteúdo sobre os insetos contidos na entomofauna Brasileira, sejam eles nativos ou exóticos.

Abordagens de interesse à comunidade científica, acadêmica e civil-organizada envolvidas de forma direta e indireta com insetos de importância agrícola, médica, alimentícia ou ecológica determinam a grandeza dos conhecimentos aqui disponibilizados, através de temáticas atuais e relevantes, tais como: (i) a dinâmica populacional de *Helicoverpa armigera*, (ii) Coleptera encontrados em plantios de eucalipto, da Região Sudoeste da Bahia, (iii) bem como a comunidade de Coleoptera de solo da floresta de restinga da Área de Proteção Ambiental (APA) Guanandy, no estado do Espírito Santo; (iv) a avaliação do ataque, bem como danos, da lagarta-elasmo na cultura da soja após a aplicação de diferentes inseticidas em tratamento de sementes, (v) o acesso à entomofauna de *Chrysopidae* em área de restinga, (vi) a abundância da família de *Chrysopidae* na Floresta Nacional de Pacotuba em distintas fases lunares, por meio de armadilhas atrativas, (vii) a disponibilização de informações relevantes a respeito dos requisitos de qualidade do mel e oriundas da internet, (viii) a toxicidade de produtos químicos à indivíduos da família Chrysopidae, espécie Chrysoperla externa, (ix) a avaliação da situação atual da mosca negra em diferentes localidades e municípios com plantas hospedeiras no estado de Alagoas e, por fim, (x) o uso de armadilhas ovitrampas demonstrando eficiência para a retirada de ovos de *Aedes aegypti* em diferentes períodos do ano são as principais abordagens técnicas aqui contidas e esmiuçadas por intermédio de trabalhos com qualidade técnico-científica comprovada.

Por fim, desejamos que o presente e-book, de publicação da Atena Editora, possa representar como legado, a oferta de saberes para capacitação de mão-de-obra através da aquisição de conhecimentos técnico-científicos de vanguarda praticados por diversas instituições em âmbito nacional; instigando professores, pesquisadores, estudantes, profissionais (envolvidos direta e indiretamente) com o estudo dos insetos e a sociedade (como um todo) frente ao acúmulo constante de conhecimento: a

melhor ferramenta para conviver, lidar, controlar, usufruir e conhecer sobre esses fascinantes seres vivos, de maior abundância no planeta, e que há milhões de anos vem se adaptando constantemente aos mais diversos habitats, sejam eles agrícolas, urbanos ou naturais.

Alexandre Igor de Azevedo Pereira

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HONEY: THE MAIN PRODUCT OF BRAZILIAN BEEKEEPING ACTIVITY AND ITS QUALITY REQUIREMENTS

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ABSTRACT: Honey stands out among beekeeping products as the best-known product, and it is consumed on a global scale. The present study aimed to gather relevant information regarding the quality requirements of this beehive product. A literature search was performed, and the content presented highlights the importance of this product, as well as the legal requirements in the production process that leads to a quality product to the end consumer.
KEYWORDS: Beehive products, beekeeping, physicochemical analysis

MEL: PRINCIPAL PRODUTO DA ATIVIDADE APÍCOLA BRASILEIRA E SEUS REQUISITOS DE QUALIDADE

RESUMO: Dentre os produtos da apicultura destaca-se o mel, sendo o mais conhecido e consumido em escala global. Dessa forma, o presente estudo teve como objetivo reunir informações relevantes a respeito dos requisitos de qualidade deste produto da colmeia. Para tanto, realizou-se a busca em literaturas diversas, sendo o conteúdo apresentado em tópicos que melhor evidencie a importância deste produto, assim como as exigências legais no processo de produção a fim de oferecer um produto de qualidade para o consumidor final.
PALAVRAS-CHAVE: Produtos da colmeia, apicultura, análise físico-química

1 I INTRODUCTION

Bee cultivation has been a man-made activity for many centuries. Technological advances, as well as management practices, have contributed to the success of beekeeping (TSUTSUMI; OISHI, 2010; HILMI et al., 2011). The cultivation of these social insects promotes both environmental and socioeconomic benefits. These characteristics are related

to the pollination service of flowering plants by bees and the exploitation of beehive products (PITA-CALVO; VÁZQUEZ, 2017; VEER; JITENDER, 2017; NASCIMENTO et al., 2018).

Beehive products (honey, pollen, propolis, wax, and royal jelly) are gaining more and more market share, and consumers are largely attracted to their nutritional and medicinal benefits (WARRÉ, 2010; BASA et al., 2016; CONAP, 2016; NASCIMENTO et al., 2018). The physicochemical properties and composition of bee products are related to the flora visited by the bees, as well as the intrinsic characteristics of the producing bee species. The climatic conditions, manipulation, processing, and storage of this product also influences its quality (TRUZZI et al., 2014; NASCIMENTO et al., 2015; PITA-CALVO; VÁZQUEZ, 2017).

In this sense, the evaluation of the quality of beekeeping products is of fundamental importance and is a premise for food safety. Determination of physicochemical and microbiological parameters and pollen analysis assists in the evaluation of the quality requirements of beehive products (BRASIL, 2000; 2001; MERCOSUR, 2011).

Honey is the main marketable product of Brazilian beekeeping, and therefore, the purpose of this study was to gather information related to honey quality analysis with an emphasis on the determination of physicochemical parameters.

2 I METHODOLOGY

The information presented in this manuscript arising from a search in several kinds of literature such as backlist ebooks, books, book chapters, and original or review scientific papers. The most recent studies on the subject were selected, as well as documents of Brazilian and international legislation for beehive product quality, specifically for honey. The search was performed in a database of Web of Science, ScienceDirect, SciELO - Scientific Electronic Library Online, Google Scholar, and PubMed, as well as research-driven social networking like ResearchGate.

3 I BEEKEEPING

Beekeeping is the science or art, of cultivating stinging bees (*Apis mellifera* L.) for leisure or commercial purposes and taking advantage of the direct and indirect benefits of its cultivation, such as marketing the hive, swarm, and poison (apitoxin) products. As well as to pollination service which is an ecosystem service performed by bees (WIESE, 2005; VEER; JITENDER, 2017).

Bees and their products are known on a global scale with a broad spectrum of consumers for beehive products, and it is an important livelihood for small farmers. When compared to any other agricultural company, beekeeping has great business potential with minimal investment (TSUTSUMI; OISHI, 2010; HILMI et al., 2011). Additionally, as an agribusiness company, it not only offers diverse products such as honey, pollen, propolis, royal jelly, and wax which can be sold in local markets

and become an important source of regular income for small farmers, it also provides complimentary services such as pollination of crops (HILMI et al., 2011).

In Brazil, beekeeping was developed from the Africanization of European bees, and between 2011 and 2013, it ranked sixth among the world's largest honey producers and ninth among the main honey exporting countries according to data released by ABEMEL, the Brazilian Honey Exporters Association (SEBRAE, 2013; ABEMEL, 2018). Brazilian beekeeping has as a favorable factor a large beekeeping potential (flora and climate) with the possibility of maximizing production and increasing apiculture agribusiness (BACAXIXI et al., 2011; TASSINARI et al., 2013).

4 I HONEY

Honey is a food made by honey bees from floral nectar, secretions from living plant parts, or from plant-sucking insect excretions (Aphididae) that bees collect, transform, combine with their specific substances, store and let it mature in the honeycomb (BRASIL, 2000).

Some components of honey come from plants, others are added by bees, and others come from the biochemical reactions that occur during honey maturation. Honey is a complex mixture composed mainly of carbohydrates (70 - 80%), water (10 - 20%), and other minor proportion components such as enzymes, amino acids, organic acids, minerals, aromatic substances, pollen pigments, and grains and may also contain beeswax from the extraction process. The main carbohydrates are glucose (~ 31%) and fructose (~ 38%) monosaccharaides (IGLESIAS et al., 2004; PITA-CALVO; VÁZQUEZ, 2017; DE-MELO et al., 2017).

Honey is classified as floral honey (plant nectar) or melate honey (secretions of live parts of plants or excretions of plant-sucking insects), also called melate (honeydew). It is important to determine the type of honey (floral or melate) to prevent adulteration. The antioxidant and antibacterial properties of melate honey are higher compared to floral honey (PITA-CALVO; VÁZQUEZ, 2017).

Recently, the benefits provided by honey to human physiology have received much attention, especially regarding the nutritional and health effects (TRUZZI et al., 2014). Considering that this product can be used as a natural sweetener, knowledge of its properties is important.

Nutritionally, honey has a high energetic (caloric) value, 330 kcal / 100g, and its carbohydrates are quickly absorbed when consumed. It is a carbohydrate-rich food with antibacterial and anti-inflammatory properties and has been used in the treatment of skin wounds and various gastrointestinal diseases. Honey activates the immune system, and its ingestion may be beneficial in relation to cancer and metastasis prevention (BOGDANOV et al., 2008; ALVAREZ-SUAREZ et al., 2010; CONTI et al., 2014; OROIAN et al., 2017).

The antimicrobial effects of honey against disease or infection have been reported

and the biological activity of honey has been attributed to, not only the high sugar concentration, but also to different compounds found within the honey such as acids, phenolics, proteins, vitamins, minerals, and carbohydrates (RODRIGUEZ et al., 2012; AL-FARSI et al., 2018).

The best known and most used bee product is honey (TSUTSUMI; OISHI, 2010) and its quality depends in part on its chemical properties, which is related to its floral origin (CORVUCCI et al., 2015; PITA-CALVO; VÁZQUEZ, 2017). Therefore, information regarding its physicochemical characterization and metal determination is of fundamental importance in the evaluation of this product.

5 I HONEY QUALITY: BRAZILIAN LEGISLATION

In order to guarantee the honey quality standard and to ensure equal conditions and full transparency in the elaboration and commercialization of this beehive product, the Brazilian legislation (BRASIL, 2000) established the minimum quality requirements that must be met for honey intended for direct human consumption. Also, according to this technical regulation, it has prohibited the addition of any substance that changes the composition of this product.

The requirements observed by Brasil (2000) refer to sensory characteristics (color, taste, aroma, and consistency), physicochemical characteristics of maturity (reducing sugars, apparent sucrose, and moisture), purity (ashes, water-insoluble solids and pollen) and deterioration (acidity, diastase and hydroxymethylfurfural activity) (Table 1). Additionally organic and inorganic contaminants must not be present in quantities exceeding the limits established by the corresponding MERCOSUR Technical Regulation and by Brasil (1965; 1998; 2009).

Sensory Characteristics	**Requirements**
Color	water white to dark amber
Taste and aroma	characteristic according to its origin
Consistency	variable according to the physical state of the honey
Physicochemical Characteristics (Maturation)	**Requirements**
Reducing sugars	minimum 65 g/100 g or (65%)
Moisture	maximum 20 g/100 g or (20%)
Apparent sucrose	maximum 6 g/100 g or (6%)
Physicochemical Characteristics (Purity)	**Requirements**
Ashes	maximum 0.6 g/100 g or (0.6%)
Water insoluble solids	maximum 0.1 g/100 g or (0.1%)
Pollen	must have pollen grains
Physicochemical Characteristics (Deterioration)	**Requirements**

Acidity	maximum 50 mEq Kg^{-1}
Diastase	minimum 8 Göthe scale
Hydroxymethylfurfural (HMF)	maximum de 60 mg Kg^{-1}

Table 1. Quality requirements for floral honey established by Brasil (2000).

Honey adulteration is an illegal practice that incorporates sugar syrups such as sucrose, corn syrup, and molasses in genuine honey. It can also be caused by the incorporation of sugars into the honey through bee feeding. This adulteration can have serious impacts on local and international honey market opportunities, as well as having negative nutritional impacts that are not beneficial to consumers' health (AYANSOLA; BANJO, 2011; OROIAN et al., 2017; AL-FARSI et al., 2018).

Analyses that ensure the quality of honey are of paramount importance considering that honey adulteration can cause public health problems because it may involve ingredients that are not allowed due to their toxic or allergenic potential. Additionally, it has implications on legal aspects (legislation) because, according to the European Union, the addition of any compound to honey is prohibited. Another negative effect is related to the economic sector, due to the unfair competition involving industry, distributors and the support of beekeepers, leading to a destabilization of markets (EUROPA, 2010; EVERSTINE et al., 2013; SOBRINO-GREGORIO et al., 2017; OROIAN et al., 2018).

The detection of honey adulteration is not simple, and several techniques to determine the physicochemical parameters (analytical methods, chromatography, spectrometry, and nuclear magnetic resonance, among others) that indicate the quality of this product have been studied for decades (SIMSEK et al., 2012; TOSUN, 2013; AMIRY et al., 2017).

The physicochemical parameters (acidity, diastase, reducing sugars, ashes, color, hydroxymethylfurfural, apparent sucrose, and moisture) determined in the honey evaluations according to the technical regulation by Brasil (2000) help in the detection of possible extraction and processing failures. They are therefore important to ensure the quality of this product for the consumer.

The color of honey is related to its botanical origin and the presence of minerals in its composition. Color is considered a sensory attribute that influences consumer preference. For example, North Americans prefer light-colored honey ranging from water white to extra white (0-34 mm Pfund) and have a less intense flavor. The European market has a preference for darker, more intense honey, ranging from extra light amber to dark amber (34 to 114 mm Pfund). Additionally, some studies have shown that dark amber honey is rich in vitamins B and C, while light honey is associated with a higher vitamin A content (DELMORO et al., 2010; MARTIN et al., 2014; TAPIA-CAMPOS et al., 2017).

The ash content expresses the mineral richness of honey. It is possible from the determination of this parameter to identify possible processing failures, such as poor hygiene and non-decantation and honey filtration (CONTI et al., 2007; BRAGHINI et al., 2017).

Another example of an important parameter for honey quality assessment is the determination of moisture, as water is the second largest component in honey composition, and its content may influence several characteristics of this product, such as viscosity, specific weight, maturity, taste, and crystallization (SILVA et al., 2010). In general, when the honey is ripe, it has less than 18% moisture. When it has moisture greater than 20%, it is more susceptible to fermentation (PITA-CALVO; VÁZQUEZ, 2017). Honey moisture content is related to environmental and geographical conditions, as well as apiary management and storage. Therefore, the results of this parameter suggest adequate conditions for honey handling and storage by beekeepers (GARCÍA-TENESACA et al., 2018).

The acidity of honey depends on the presence of organic acids, particularly gluconic acid (free acidity), and the balance of its lactones (TRUZZI et al., 2014). This is an important parameter indicative of honey deterioration, pointing to the occurrence of fermentation of sugars by the action of yeasts when high values are observed (DA SILVA et al., 2016).

Hydroxymethylfurfural (HMF), as well as acidity, is a physicochemical parameter used as an indicator of honey deterioration. It is formed by the decomposition of monosaccharaides or by the Maillard reaction when honey is heated or stored for a long time (DAMODARAM; PARKIN; FENNEMA, 2010). Honey with high HMF values may come from prolonged storage at high ambient temperatures and overheating or adulteration by the addition of invert sugar (BRAGHINI et al., 2017; PITA-CALVO; VÁZQUEZ, 2017).

Diastase activity may also indicate honey overheating or tampering when it has indices below eight on the Göthe scale. This warming may cause the degradation of important chemical components from a nutritional and functional point of view. This is one of the most important parameters in honey quality assessment (NASCIMENTO et al., 2015a; PITA-CALVO; VÁZQUEZ, 2017). Thus diastase and HMF indicate the freshness of honey (GARCÍA-TENESACA et al., 2018).

The sugar content (glucose, fructose, and sucrose) indicates the maturity of honey, these components being the main constituents of this product, giving flavor, aroma and viscosity (KAMAL; KLEIN, 2011). According to Brasil (2000), honey is considered ripe when it reaches a minimum reducing sugars content of 65%.

Honey is a complex natural product that can have about 200 substances in its composition. The composition of honey, especially its secondary metabolites, is variable and depends mainly on the floral source. A wide range of minority constituents are also present in honey, many of which are known to possess antioxidant properties. These include phenolic acids and flavonoids. These compounds are important as they

contribute to the color, taste, and aroma of honey, as well as promoting beneficial effects on human health (SALGUEIRO et al., 2014). Interest in the determination of the total phenolic compounds in honey has increased in recent years, as research reports that phenolic compounds correlate with the antioxidant activity of honey (MONIRUZZAMAN et al., 2014; AHMIDA et al., 2017; ALJUHAIMI et al., 2018).

Phenolic compounds are directly involved with the color of honey, mainly through flavonoids. Floral nectar (honey raw material) is a source of phenolic compounds. The type and concentration of phenolic compounds are the main determinants of the bioactive properties of honey. These compounds are valued as they may reduce the risk of oxidative damage to cells (CIAPPINI; STOPPANI, 2014; CABRERA et al., 2017). This information indicates the potential of this beehive product.

6 I FINAL CONSIDERATIONS

Given the above, it is remarkable that honey quality evaluation is necessary, as it is a natural product with a very nutritionally rich composition. Thus, ensuring that this product can be purchased by the consumer without adulteration of its characteristics is not an easy task. However, legislation is a premise of fundamental importance for honey quality control.

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