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Optimizing Good Apiculture Practices for Premium Honey Production:

An Overview

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Abstract

Apiculture, commonly referred to as beekeeping, stands as the pragmatic guardianship of social bee species, yielding sustenance and agricultural treasures. Honey embraces a kaleidoscope of essential elements, including amino acids, vitamins, minerals, and enzymes. Beyond its identity as a natural sweetener, honey unveils a significant repertoire, embodying roles as an anti-inflammatory, antioxidant, and versatile medicinal asset. Honey products extend their benevolence through oral administration, mitigating disorders such as cough, and through topical application, expediting wound healing.

This review aimed to elucidate a roadmap for consumers in selecting premier honey products, provide beekeepers with insights to nurture robust honeybee colonies and highlight the antimicrobial activity of different honey variants. The available data cover the influence of technological advancements on honey quality, the ramifications of diverse harvesting and processing techniques on its caliber, the interplay between intensified agricultural practices and honey quality, and the intricate relationship linking diseases and honey quality.

As apiculture ascends to its pivotal role in harmonizing sustenance and ecological equilibrium, stakeholders are implored to resonate with the ongoing research. A profound grasp of ecologically sound farming techniques, coupled with effective bee management, forms the bedrock for promoting exemplary apiculture practices and nurturing the production of high-quality honey. Proper care and maintenance of beehives by beekeepers enhance the quality of honey, elevating its value as a medicinal product.

Keywords: Honey, Beekeeping practices, medical uses, Honeybees, Good Apiculture practices.



1. Introduction

Honey is a naturally occurring substance with a wide range of therapeutic effects. It is made up of approximately 200 different substances, including fructose and glucose, fructo-oligosaccharides, amino acids, vitamins, minerals, and enzymes (Eteraf-Oskouei and Najafi, 2013).

Honey is a viscous, sweet substance made by bees from the nectar of flowers. Its high viscosity acts as a protective barrier against infection and contamination, making it a wholesome natural food with medicinal properties. Honey has been shown to have effective antimicrobial activity against a wide range of bacteria, including both grampositive and gram-negative strains (Mohapatra et al., 2011) and it is also reported to have wound healing capabilities (Hadagali and Chua, 2014). The aspects of honey's healing properties have been identified, including antioxidant, anti-inflammatory and anti-tumor properties (Gorjanović et al., 2014). These health properties are of great interest since oxidative stress and inflammation are mechanisms involved in the development of major chronic diseases like cancer (Reuter et al., 2010).

Honey has a wide range of sensory, physical and chemical characteristics that are influenced by the climate, environment, and the specific plants from which it is collected. These characteristics, including the concentration of phenolic compounds and antioxidant activity, can vary significantly between different types of honey (Gheldof, 2002). Additionally, the processing, handling, and storage of honey can alter its composition. Given its potential medicinal benefits, honey is often recommended for children, athletes, and the elderly or infirm as a way to support overall well-being (Blasa et al., 2006). Therefore, it is important to determine the antioxidant potential of honey in order to authenticate and differentiate between various types of honey (Moniruzzaman et al., 2012).

Human beings have been aware of the medicinal properties of honey for centuries and have traditionally used it to treat wounds, bacterial infections, and other health issues in alternative medicine. Recently, honey has seen a resurgence in modern medicine as well.



In the quest to reduce the impact of infectious diseases, the development of antimicrobial agents has been a priority. However, the overuse of antibiotics has led to the emergence of drug-resistant pathogens that no longer respond to traditional treatments (Mandal and Mandal, 2011). Honey has a number of unique qualities that make it an effective treatment for wounds. Its low water content creates a moist healing environment, while its slightly acidic pH of 3.6-3.7 inhibits the growth of most bacteria. Honey also stimulates the production of lymphocytes, which are involved in the immune response, and contains hydrogen peroxide, a key antibacterial component. Some types of honey are able to inhibit bacteria effectively even when they have low levels of hydrogen peroxide (Raitzel, 2013).

This review aimed to create a guide for consumers when choosing high-quality honey products, offer beekeepers valuable information for fostering healthy honeybee colonies, and emphasize the antimicrobial properties found in various types of honey. The provided data encompass the impact of technological advancements on honey's overall quality, the consequences of various harvesting and processing methods on its excellence, the relationship between intensified agricultural practices and honey quality, as well as the complex connection between diseases and the quality of honey.

2. Honey types

The table provided below presents the characteristics of the most commonly found unifloral honey species worldwide.



المجلة العربية للعلوم الإنسانية والاجتماعية Arab Journal for Humanities and Social Sciences Table 1: Harvest and properties of the main world unifloral honeys (Bogdanov,

2016).

COMMON NAME	BOTANICAL NAME OF PLANT	PLACE OF HARVEST	COLOR, PFUND SCALE	GRANULATI ON: SPEED, CRYSTALS FORM	FLAVOR
ACACIA	Robinia pseudoacacia	temperate Europe, Asia, America, Oceania	light water- white to extra-white	Slow Coarse	Weak floral, fresh
EUCALYPT US	Eucalyptus spp.	South Europe, Oceania, Africa, South America	yellow to brown white to amber	rapid to medium fine to medium	medium-strong caramel
FIR SPRUCE	Abies alba Picea abies	Central and Southern Europe	dark brown amber to dark amber	very slow coarse	medium-strong, woody-resinous
HEATHER	Calluna vulgaris	Europe	brown- reddish amber to dark amber	medium gel consistency coarse crystals	Strong caramelised, floral-fruity
LAVENDE R	Lavandula intermedia	temperate Europe, Asia and North America	light white to extra light amber	Rapid fine	medium warm, refreshing
LIME, LINDEN	Tilia spp.	temperate Europe and Asia, temperate and subtropical North America	white to yellow, white to amber	rapid to medium fine to medium	strong, fresh, pharmaceutical
ORANGE BLOSSOM	Citrus spp.	Europe, temperate and subtropical, North America, south America	very light white	rapid, fine	medium floral, fruity
PINE	Pinus spp.	temperate Europe, Asia, Oceania	brownish amber-dark amber	Slow coarse	medium-strong malty, resinous
RAPE	Brassica napus	Europe, North America,	white to yellowish white	rapid, fine	Medium Vegetable
ROSEMAR Y	Rosmarinus Officinalis	temperate Europe, Asia, Africa	Light white to extra light Amber	Fast fine	floral, fruity
SUNFLOW ER	Helianthus Annuus	temperate Europe, South and North America, Asia; subtr. Asia.	yellow to golden light amber	Rapid fine	Weak vegetable, warm



		Africa, Oceania; trop. Africa North. America.			
SWEET CHESTNUT	Castanea sativa	Europe	redish- brownamber to dark amber	slow coarse	Strong mouldy, caramelised, bitter
ТНҮМЕ	Thymus capitatus	Mediterranean and temperate Europe, N. America, Oceania	yellow-light brown amber to amber	fast to medium fine to medium	Strong woody-aromatic, resinous
WHITE	Trifolium	Europe, N.	light white	rapid, fine	Weak
CLOVER	repens	America	to light amber	granulation	Vegetal

3. Composition of honey

Depending on the source(s) of nectar, honey can have a variable composition. Natural bee honey is a complex product containing several hundred compounds belonging to various chemical groups.

a- Carbohydrates:

The types and proportions of sugars in honey can be affected by factors such as the plant species it comes from, where it was produced, how it was processed and stored, as well as the prevailing climate (Escuredo et al., 2014). Sugars play a significant role in determining the energy content and viscosity of honey. The presence of sucrose in honey not only indicates its maturity but can also be a sign of adulteration (Da Silva et al., 2016).

Honey contains 25 different types of sugars, including erlose, maltose, sucrose, and turanose in nectar honeys, and melezitose and ranose in honeydew honey. The sugar in honey is not a single type, but rather consists of three types of sugar: fruit sugar (fructose) at 41%, grape sugar (glucose) at 34%, and ordinary sugar (sucrose) at 1-2% (Tafere, 2013).

Fructose and glucose concentrations, along with the F/G ratio, are utilized to classify honey based on its botanical origin. It's noteworthy that fructose is the carbohydrate with the highest concentration in honey (Da Saliva et al., 2016).

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المجلة العربية للعلوم الإنسانية والاجتماعية Arab Journal for Humanities and Social Sciences b- Amino acids and proteins:

Honey contains proteins, which are found in the nectar and pollen of plants. These proteins can be present in the honey in either complex or simple forms, such as amino acids (Alvarez-Suarez et al., 2013).

The proteins and amino acids found in honey can be traced back to both animal and plant origins, with pollen being the primary source. Among these amino acids, they make up about 1% by weight, and proline stands out as the most significant contributor, accounting for 50–85% of the total amino acids present (Hermosin et al., 2003). In addition to proline, honey contains 26 other amino acids, and their respective ratios can vary depending on whether the honey is derived from nectar or honeydew. Given that pollen serves as the primary source of amino acids in honey, the amino acid composition of honey may serve as a distinctive marker of its botanical origin (Hermosin et al., 2003).

The determination of a honey's botanical source is more likely to be influenced by its free amino acid composition rather than its protein composition. It has been suggested that a more comprehensive and informative understanding can be achieved by analyzing a larger number of honey samples, combining various analytical data sets, and applying statistical analysis to the results (Anklam, 1998).

c- Minerals:

Honey is composed of a variety of minerals, with potassium being a significant constituent, making up about 33% of all minerals present in honey. Other minerals found in honey include chlorine, sulfur, calcium, sodium, phosphorus, magnesium, silicon, iron, manganese, and copper (Aili et al., 2014).

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المجلة العربية للعلوم الإنسانية والاجتماعية Arab Journal for Humanities and Social Sciences Table 2: minerals in honey (Pu'scion-Jakubik et al., 2020).

Minerals

Average amount (mg) in 100g honey

Calcium	4-30
	2.20
Chlorine	2-20
Copper	0.01-0.1
Iron	1-3.4
Magnesium	0.7-13
Phosphorus	2-60
Potassium	10-470
Sodium	0.6-40
Zinc	0.2-0.5
Barium	0.01-0.08
Boron	0.05-0.3
Cobalt	0.1-0.35
Fluoride	0.4-1.34
Iodine	10-100
Lithium	0.225-1.56
Molybdenum	>0.004
Nickel	>0.005
Rubidium	0.04-3.5
Silicium	0.05-24
Strontium	0.04-0.35
Sulfur	0.7-26
Vanadium	0.04-0.35
Zirconium	0.05-0.08

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المجلة العربية للعلوم الإنسانية والاجتماعية Arab Journal for Humanities and Social Sciences d- Conductivity and acidity of honey:

The electrical conductivity of honey is a useful indicator of its botanical origin and is frequently used to determine the quality and purity of honey (Kroft et al., 2008). Honey contains organic acids and mineral salts, which are known as "ionizable" compounds and have the ability to conduct electricity when dissolved in a solution (Acquarone et al., 2006). The electrical conductivity of honey is typically measured as a 20% (w/v) weight solution at 200 C \pm 0.5, with the 20% referring to anhydrous honey, the unit of measurement used is mill Siemens per centimeter (mS.cm-1) (Yadata, 2014).

Acids are also components of honey. In the past, it was believed that bees used bee venom to preserve honey by inserting it into the honeycomb cells. Since formic acid is a major component of bee venom, it was thought that honey contains formic acid (De-Melo et al., 2018).

e- Hydroxyl-Methyl-Furfur-aldehyde (HMF):

HMF is a six-carbon heterocyclic organic compound containing both aldehyde and alcohol (hydroxyl-methyl) functional groups (Lichtenthaler, 2002).

The hydroxyl-methyl-furfural content is the most recognized indicator of honey quality and freshness (Pauliuc et al. 2022). HMF is a breakdown product of fructose (one of the main sugars in honey) that is formed slowly and naturally during the storage of honey, and much more quickly when honey is heated. The amount of HMF present in honey is the reference used as a guide to the amount of heating that has taken place: the higher the HMF value, the lower the quality of the honey is considered to be (Da Silva et al., 2016).

f- Enzymes:

Enzymes present in honey include diastase, invertase, glucose oxidase, catalase, glucosylceramidase, α -amylase, α -glucosidase, β -glucosidase, and proteases (Alaerjani et al., 2022). What is particularly important in regard to enzymes, their content in bee honey is influenced by, among others, storage conditions (including high temperatures), and decrystallization process (Pu'scion-Jakubik et al., 2020).

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"In honey, enzymatic processes involve the transformation of oligosaccharides and disaccharides (like sucrose and maltose) into glucose and fructose through the action of diastase and invertase enzymes. Glucose is further converted into gluconic acid and hydrogen peroxide by the enzyme glucose oxidase. Additionally, catalase enzymes break down hydrogen peroxide into water and oxygen. Honey samples with elevated catalase activity have reduced levels of hydrogen peroxide (Nolan et al., 2019).

4. Quality of honey

Beekeeping involves maintaining colonies of bees, using various types of beehives, which are classified as modern or traditional. These beehives are designed to be easy to use and replace combs without disrupting the colony, allowing the bees to continue collecting honey. However, pesticides and herbicides pose significant challenges for beekeepers, as they can harm worker bees of all ages (Evans and Schwarz., 2011). In certain countries, such as Canada, the United States, and Italy, bees are used to monitor environmental pollution by measuring the accumulation of pollutants in hives, which reflects the presence of these materials in the environment. This is because bees collect pollen from nature, and by analyzing the hives, it is possible to gauge the extent of environmental pollution and its impact on honey quality (Bett, 2017).

Moisture is one of the most important parameter of honey quality. The amount of water present in honey determines its stability against fermentation and granulation (Dyce, 1979). Honey having high water content ferments easily with time. So, it is necessary to process the honey by subjecting it to thermal treatment to prevent fermentation by sugar tolerant yeasts (Fallico, et al. 2004). The quality of honey is greatly impacted by the duration of storage and exposure to heat, which can lead to a decrease in quality. The study of various quality parameters has revealed that the activity of diastase, HMF levels, and color are particularly sensitive to heat treatment, and this sensitivity is influenced by both the duration and temperature of the treatment (Singh and Singh, 2018).

The quality of honey can be influenced by a variety of factors, including climate, soil, flora, bee species, and production methods (Terrab et al., (2003). The physicochemical



composition, flavor, and color of honey can all vary as a result. The composition of honey is particularly affected by the plant species on which bees forage (Gulfra et al. 2010). Additionally, storage conditions can impact the final composition, with disaccharide levels increasing over time (White and Subers, 1964). Poor handling of honey can also reduce its quality, with factors such as high temperature, extended storage time, and moisture content leading to fermentation, high levels of HMF, and a loss of enzymatic microbial growth (Areda, 2015).

5. Good Beekeeping practices

Farmers use a variety of techniques and make efforts to improve production and produce high-quality products. This also applies to beekeeping, where the quality of honey produced by bee colonies is largely influenced by environmental conditions and the types of plants that provide nectar (Tucak et al., 2004).

It is crucial for the government and related development partners to collaborate in creating and promoting platforms for training bee farmers on managing hives, identifying hive products, and adding value to those products (Bett, 2017). There are various types of bee hives used by beekeepers worldwide, which can be divided into two categories: modern and traditional (Bett, 2017).

The foundation for a sustainable and robust beekeeping industry is established through the implementation of good beekeeping practices (GBPs) in daily apiary management. These practices yield a range of benefits including economic advantages, such as reduced costs, increased production per unit, and higher profits for beekeepers. GBPs also promote safety by ensuring the safe handling of veterinary medicines and result in better quality honeybee products for consumers (Olatz and Valeriano, 2022). Additionally, GBPs have a positive impact on public health by reducing the presence of veterinary products in honeybee products, and lead to improved honeybee health and productivity, and more effective treatment (FAO, 2021).



The beekeepers play a critical role in producing high-quality honey. The health and productivity of a honeybee colony depend on the beekeeper's knowledge, experience, and management practices (Olate-Olave et al., 2021). Some of the factors that beekeepers can control to ensure the production of good honey include: hive management, pesticide use and harvesting practice (Bett, 2017). In addition to these factors, beekeepers also play a role in selecting the appropriate honeybee species or strains for their region and managing the bees' exposure to environmental factors such as temperature, moisture, and air quality (Vercelli, et al., 2021). All of these factors can contribute to the production of high-quality honey.

6. Honey in medicine

Stone age paintings indicate that humans began using honey approximately 8000 years ago (Eteraf-Oskouei and Najafi, 2013). While natural honey has traditionally been used in medicine, recent laboratory and clinical studies have shown that it also has potential in modern medicine (Emsen, 2007). Honey is employed for its ability to exhibit antibacterial effects against both Gram-positive (Gram+) and Gram-negative (Gram-) bacteria, its capacity to act as an antifungal agent against molds and yeasts, and its potential to display protozoal and antiviral properties (Feknous and Boumendjel, 2022). Honey has been used to treat various conditions, including those affecting the gastrointestinal, cardiovascular, inflammatory, and neoplastic systems (Eteraf-Oskouei and Najafi, 2013).

In modern medicine, the effective utilization of honey for therapeutic purposes necessitates its demonstration of uniform and standardized antimicrobial effects. Researchers in pharmaceutical and biological fields must pinpoint the specific floral varieties responsible for conferring antimicrobial properties. Honeys possess a low pH and high osmolarity, which, when combined via enzymatic processes involving hydrogen peroxide, lead to antimicrobial outcomes (Bang et al., 2003).

Research into the antimicrobial properties of honey has been ongoing for many decades, revealing in numerous studies that it possesses both bacteriostatic (inhibiting bacterial



growth) and bactericidal (killing bacteria) qualities. It is currently understood that the level of antimicrobial activity varies among different honey types due to the myriad factors that can influence the composition of bioactive components within honey. These factors encompass enzymes, sugar content, peptides like bee-derived defensin-1, and various metabolic compounds (Poulsen-Silva et al., 2023).

The utilization of honey for wound dressing is becoming increasingly popular in modern medical practice due to its ability to combat microbial activity (Bani Ismail, 2015).

Honey possesses significant nutritional value and exhibits potential anti-oxidant, antiinflammatory, anti-bacterial properties, as well as the ability to reduce cough and aid wound healing (Bang et al., 2003). Additionally, honey has been shown to enhance serum testosterone concentration, sperm count and fertility (Fakhrildin and Alsaadi, 2014). However, the primary challenge associated with using honey for medicinal purposes in modern medicine is the inconsistency in its composition and insufficient clinical trials (Meo et al., 2017). In general, honey is recommended as a beneficial dietary supplement, but its use in individuals with metabolic disorders such as diabetes mellitus should be thoroughly explored (Meo et al., 2017).

7. Discussion

Honey, a sugary fluid produced by honeybees from the nectar of blooming plants, comes in around 320 different types that differ in terms of color, odor, and flavor. Comprised primarily of sugar, honey also has a blend of amino acids, vitamins, minerals, iron, zinc, and antioxidants. It not only serves as a natural sweetener but also has anti-inflammatory, antioxidant, and antibacterial properties (Hills et al., 2019). Honey is commonly consumed to alleviate coughing and applied topically to soothe burns and expedite wound healing (Oskouei and Najafi, 2013).

In addition to producing honey and beehive products like royal jelly, bee pollen, and propolis, bees play a crucial role in preserving thriving ecosystems and safeguarding food sources (Pasupuleti et al., 2017). For centuries, these natural bee products have been



utilized in traditional medicine for their biological properties and beneficial health effects (Meo et al., 2017). In recent years, natural bee products have garnered significant attention from the pharmaceutical and dietary supplement industries (Raoa et al., 2016). These organizations have explored their pharmacological possibilities and therapeutic uses in preventing and managing illnesses.

Honey has been found to have a variety of biological, biochemical, and physiological effects in both animals and humans. The effectiveness of these properties is determined by the type of phenolic compounds found in the honey (Patricia et al., 2015). Various types of honey have been studied for their ability to combat microbes, prevent cancer, lower blood sugar levels, reduce cholesterol, reduce inflammation, act as an antioxidant, and promote wound healing (Raoa et al., 2016).

That different agricultural practices have diverse impacts on both bees and the quality of honey. Furthermore, farmers frequently identified ants, mites, and beetles as the predominant pests and rodents. These undesirable creatures have a negative impact on honey quality as they consume honey and pollen. Moreover, some pests introduce soil particles and droppings into the beehives, resulting in a considerable reduction in the overall quality of honey (Bett, 2017).

High-quality honey offers a range of positive nutritional and health benefits, which are influenced by the flowers it is sourced from and its chemical composition. (Tafere, 2021). Honey has always been included in diets not only for its nutritional value but also for its health benefits. The primary components that contribute to its nutritional and health properties are carbohydrates, making it an excellent energy source, particularly for children and athletes (Ajibola el al., 2012). Honey is a unique, nourishing, functional, and healthful food. In addition to its nutritional value, it also has the ability to inhibit certain food spoilage organisms (Kieliszek et al., 2023). Given its high antioxidant activity, honey is preferred not only for direct consumption but also as a supportive or preservative ingredient in foods (Tafere, 2021). To fully benefit from the remarkable properties of honey, one must avoid deceptive practices. It is essential to increase the



production and consumption of high-quality honey. Adulteration of honey not only reduces the income of honest producers but also has detrimental effects on consumers nutrition and health (Tafere, 2021).

8. Conclusions and Prospects

Honey, a natural product with a long history of medicinal use, holds significant importance in both traditional and modern medicine. It has gained recognition among scientists as an effective treatment for various ailments. One of the widely acknowledged properties of honey is its antibacterial activity. Based on that, the researcher believes that the necessary care by beekeepers in beekeeping and maintaining the quality of the hive gives honey a better value of quality for its use as a medical product.

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