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## Exploring the Physico-Chemical and Antimicrobial Characteristics of Honey: An Analytical Review

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**Abstract:** *This analytical review explores the physico-chemical and antimicrobial characteristics of honey, offering a thorough investigation of its properties. Honey, a natural sweet substance of plant origin, has been very important for its medicinal and nutritional properties for centuries. The color of honey is an important indicator of its botanical origin, and differences in honey color are due to botanical sources, processing and storage. Its color varies from pale yellow to dark brown. The moisture content of machine-extracted varies between 17.07 and 17.20%. A. mellifera (modern beehives) honey from private and public apiaries, pH and acidity range from 3.88 to 4.58, honey which are important quality parameters that vary according to climate, flower sources and harvest season. The antimicrobial properties of honey are mainly due to its floral origin and the presence of bioactive compounds such as hydrogen peroxide, phenolic acids and flavonoids. The study also sheds light on possible differences in the therapeutic effectiveness of honey from different regions. Modern scientific literature suggests that honey may be useful and has protective effects for the treatment of various disease conditions, such as diabetes mellitus, respiratory, gastrointestinal, cardiovascular, and nervous systems. Honey is even useful in cancer treatment because many types of antioxidant present in honey. Insights from this comparative analysis provide valuable information for consumers seeking medicinal properties of honey and bee industry stakeholders to optimize honey production, marketing and quality practices. The review provides a nuanced picture of the physicochemical and antimicrobial properties of honey from these regions, contributing to the unique properties of honey that can impact both consumers and the bee industry.*

**Keywords:** Honey, Nutritional, Antimicrobial, Medicinal, Antioxidant

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## 1. Introduction

Honey is a natural sweet herbal substance, produced by honeybees from the flowering plant and holds great economic value. It has been of great importance due to its therapeutic and nutritional properties for centuries. The past 12 years have seen a 200% growth in honey output in India, which can be credited to significant efforts and committed programmes like the nation's Honey Mission (HM). In 2018, the globe produced 1.85 million tons of honey, with China accounting for 29% of the overall production. Other big producers included Turkey, Iran, the United States, Russia, and India [1]. It contains a high-energy carbohydrate diet (80–85%) containing readily digested honey sugars and energy-supplying nutrients such as amino acids, vitamins, minerals, enzymes, organic acids, phenols, and water [2]. Honey has strong antioxidant and demulcent qualities. It also boosted the release of cytokines, which may have antibacterial benefits. Numerous ailments, such as skin ulcers, wounds, respiratory, and digestive issues are treated with it [3]. Honey also works better than pharmaceutical cough syrups to relieve coughs [4, 5]. Furthermore, the geographic location of honey affects its chemical makeup since soil properties and climate circumstances, such as sunlight and moisture, can affect the

concentration of phytochemicals in plants, even those belonging to the same species. Its granulation, flavour, texture, electrical conductivity (EC), sucrose content, reducing sugars, free acids, hydroxy methyl furfur aldehyde (HMF), and other factors affect its nutritional quality [6]. Color influences the price of honey on the global market since it is a key factor in culinary goods and one of the most significant features in consumer decisions [7]. Thus, colour, flavour, and scent are three other crucial aspects of honey's quality. Potassium, which makes up around one-third of the total mineral content in honey, is the most prevalent element in this mineral reservoir [8]. Honey's chemical makeup has been shown to have a major effect on human nutrition and health [9]. The distinctive flora and climate of different geographical areas have an impact on the type and composition of honey that is produced. Considering the interest in the value of honey in conventional treatment procedures, this is crucial to know honey's physicochemical characteristics: the moisture content, pH, sugar composition, etc. as they are important variables that affect its quality and authenticity. Variations in these attributes can be linked to variations in floral sources and environmental factors by region. Based on available data, honey has been shown to have several health benefits, such as

antioxidant, anti-inflammatory, antimicrobial, anti-diabetic, respiratory, gastrointestinal, cardiovascular, and nervous system protective effects. This study emphasizes the physicochemical and antimicrobial properties of and provides a thorough evaluation of the available information.

## 2. Physicochemical Properties

### 2.1 Colour and Appearance

The colour of honey is an important indicator of its botanical origin. Himachal Pradesh has a diverse flora and often produces honey of

different color spectrums. Jammu and Punjab, characterized by certain types of flowers, differ in the color of the honey, providing an insight into the botanical sources. The variations in honey colors could be due to effects of plant sources [10], processing, storage, severity of methods, rapidity of nectar secretion [11, 12] and Millard reaction [13]. The optical density of honey was recorded which vary from 0.27 - 0.62 OD from different agro climatic zones of Himachal Pradesh [14]



**Fig. 1.:** Honey samples Collected from Jammu, Punjab & Himachal Pradesh

Different honey colors viz., light amber yellowish color of natural honeys produced in different areas of Al-Qassim region, Saudi Arabia [15], light-dark brown (market honey), golden yellow (raw honey) and light-dark brown (industrial honey) from Kerala, India

[16]. Earlier researchers have documented the optical density (colour) of fresh *A. mellifera* honey as 0.33–0.66[17], 0.32 to 1.0 for apiary honey and 0.05 to 0.28 for wild honey from Mahabaleshwar [18]. The effect of plant sources [19], processing, storage, soil habitat,

rapidity of nectar secretion and Millard reaction [20] on honey quality has been observed.

## 2.2 Moisture Content

The moisture content of honey is an important quality parameter. Differences in climate and flower sources between regions result in differences in humidity levels, which affect honey and its shelf life, as well as its tendency to crystallize. As per literature, the moisture content of honey depends on various factors such as harvesting season, degree of maturity reached in the hive and climatic factors [21] and therefore varies from year to year [22]. More humid conditions before and after honey removal from the hive are likely to increase the moisture content and vice-versa [23]. These variations observed could be due to different reasons, as supported by [24] who reported moisture content varying from 17.07 to 17.20% in machine extracted *A. mellifera* (modern hives) honey from private and government apiaries.

## 2.3 pH and Acidity

pH of honey which is of great importance during honey extraction and storage, affects the texture, stability, and shelf life of honey [25, 26, 27] and is influenced by floral and geographic origins [28, 29]. The acidic pH of honey is basically due to the presence of some acids, mainly gluconic acid, which is formed

as a result of glucose degradation by glucose oxidase [30]. The pH values of 3.88-4.58 was reported in natural honeys produced in different areas of Al-Qassim region, Saudi Arabia [31], 3.72 - 3.97 for honey of Telangana, India [32].

## 3. Antimicrobial Profiling

### 3.1 Floral Origin and Bioactive Compounds

The antimicrobial properties of honey are mainly due to its floral origin and the presence of bioactive compounds such as hydrogen peroxide, phenolic acids and flavonoids. Due to the properties of honey such as low water acidity, glucose oxidase, and hydrogen peroxide, honey does not help in the growth of yeast and bacteria [33]. The peroxidase is not all origin of antibacterial level of honey, but many products with low antibacterial level were discovered in honey including terpenes, pinocembrin, benzyl alcohol, 3,5-dimethoxy-4-hydroxybenzoic acid (syringic acid), methyl-3,5-dimethoxy-4-hydroxybenzoate (methylsyringate), 2-hydroxy-3-phenylpropionic acid, 2-hydroxybenzoic acid, 3,4,5-trimethoxybenzoic acid, and 1,4-dihydroxybenzene [34]. Investigations indicated that *Escherichia coli* and *Staphylococcus aureus* can be significantly prevented by manuka honey [35]. This section

explores how the unique flora of each region contributes to the antimicrobial properties of the honey produced.

### **3.2 Antibacterial and Antifungal Activity**

Antibacterial and antifungal properties refer to the ability of a substance to inhibit the growth or kill bacteria and fungi respectively. Substances with these properties can help prevent infections and promote healing when applied to wounds or used in products such as soaps, creams, or medicines. Oral administration of honey increases the expression of pro-apoptotic protein Bax and also reduces the anti-apoptotic protein Bcl-2 expression in tumor tissue of Wistar rats [36]. Intravenous injection of manuka honey acts its apoptotic effect on cancer cells lines through the involvement of the caspase 9 which in turn activates the caspase-3, the executor protein. Apoptosis was made by manuka honey which also involves in the activation of PARP, DNA fragmentation and loss of Bcl-2 expression [37]. A comparative analysis of antibacterial and antifungal properties of honey from Himachal Pradesh, Jammu and Punjab sheds light on potential differences in therapeutic efficacy. Understanding these differences is crucial to taking advantage of honey and its medicinal benefits.

### **4. Implications for Consumers and Industry**

Insights from this comparative analysis offer valuable information for consumers seeking specific therapeutic properties in honey. It is an appetizer and also promotes digestion/metabolism. It is very good for the eyes, vision, and heart. It quenches thirst and stops hiccups. It dissolves or mitigates kapha. It is a natural detoxifying agent; the effects of toxin are nullified. It is very useful in urinary tract disorders, worm infestations, bronchial asthma, cough, diarrhea and nausea, vomiting. It cleanses and promotes wound healing by facilitating formation of granulation tissue. Honey that is newly collected from the beehive increases body weight and is a mild laxative. Honey that is stored and is old helps in fat metabolism and is indicated in obesity and scrapes kapha and adipose tissue (medas). It promotes nourishment and stimulates union of tissues. It acts as a sedative or hypnotic and is useful in bed wetting disease. Honey, being a very good antioxidant, restores the damaged skin and gives soft, young looks. Additionally, beekeepers and stakeholders in the apiculture industry can use this knowledge to optimize honey production, marketing, and quality assurance practices.

### **5. Conclusion**

The multifaceted properties of honey, including its therapeutic, nutritional, and antimicrobial characteristics, have garnered significant attention in recent years. The study's focus on investigating the antimicrobial and physicochemical properties of honey from different regions of India is crucial in understanding the diverse ecosystems' contributions to the unique characteristics of honey. The study aims to evaluate the antibacterial properties and physicochemical characteristics of honey samples from various regions, shedding light on the potential differences in therapeutic efficacy. The color, moisture content, pH, and acidity of honey are important quality parameters influenced by climate, flower sources, and harvesting season,

which can affect its shelf life and therapeutic potential. Additionally, the antimicrobial properties of honey, attributed to its floral origin and bioactive compounds, play a significant role in its potential therapeutic benefits. The study's findings offer valuable insights for consumers seeking specific therapeutic properties in honey and provide opportunities for beekeepers and stakeholders in the apiculture industry to optimize honey production, marketing, and quality assurance practices. Overall, the review provides a comprehensive understanding of the physicochemical and antimicrobial properties of honey from these regions, emphasizing the potential impact on both consumers and the bee industry.

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