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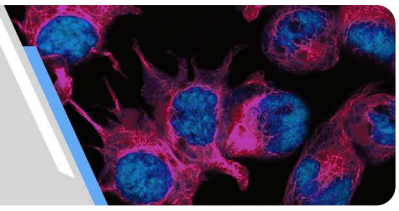

# Honey: Chemical Composition and Moisturizing Potential for The Skin – A Review

**Pedro Henrique Fonseca Veloso*, Lilianny Mendes Soares Araújo Vanessa de Andrade Royo**

## Abstract

Human skin is the largest organ of the body and plays essential roles such as thermoregulation, immune response, and serving as a protective barrier against external agents. The outermost layer, the epidermis, includes the stratum corneum, which is primarily responsible for the skin's barrier function, retaining moisture and protecting it against microorganisms and pollutants. The composition of this skin layer includes proteins, lipids, and hygroscopic substances known as the Natural Moisturizing Factor (NMF), which help regulate hydration and skin permeability. In this context, honey stands out as a cosmetic ingredient due to its complex composition, rich in sugars, amino acids, proteins, organic acids, vitamins, minerals, and phytoconstituents. This set of substances gives honey humectant, moisturizing, antioxidant, and immunomodulatory properties, enhancing water retention by the stratum corneum and supporting the integrity of the skin barrier. In addition, it contains unique elements such as polyhydroxy acids and phenolic compounds that improve the skin's appearance. These features make honey a high-performance cosmetic ingredient, justifying its use in various formulations aimed at skin hydration and dermal health.

**Keywords:** Honey, Cosmetic ingredient, Skin barrier, Hydration, Humectant

## Structure and Function of The Skin

The human skin is the largest organ of the body, performing functions such as protection, thermoregulation, immune defense, endocrine and metabolic regulation, among others (Klingman, 2002). The homeostatic barrier formed by the skin is essential in preventing excessive water loss to the external environment, thus maintaining the body's hydration (Supe & Takudage, 2020). It serves as the first line of defense against external agents such as pollution (Damevska et al., 2019), microorganisms (Gallo & Nakatsuji, 2011), and ultraviolet radiation (Mohania et al., 2017). The epidermis is the outermost layer of the skin, being stratified, squamous, and predominantly composed of two cell types: keratinocytes and dendritic cells. It also contains melanocytes, Langerhans cells, and Merkel cells in smaller quantities (Lefévre-Utile et al., 2021). It is divided into five layers based on keratinocyte morphology and degree of differentiation, from innermost to outermost: the basal layer, spinous layer, granular layer, clear layer, and the stratum corneum (Jiao et al., 2024; Myer & Maibach, 2013). This layer is responsible for the skin's waterproof characteristic. It features continuous renewal and gives rise to skin appendages such as nails, sweat glands, and pilosebaceous units (Kolarsick et al., 2011; Zwirner et al., 2024). Its main functions include protecting the skin against environmental threats through physical, chemical, and immunological barriers (Baroni et al., 2012).

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## Stratum Corneum and Natural Moisturizing Factor

The stratum corneum (SC) is the superficial layer of the epidermis, composed of proteins, lipids, and water, and functions as a shield against external aggressors (Tobin, 2005). The proteins in the SC are highly cross-linked and located within corneocytes and corneodesmosomes, which are epidermal cells (Boireau-Adamezyk et al., 2021). Corneocytes, in particular, are embedded in a lipid matrix composed of fatty acids, cholesterol, and ceramides, forming a protective envelope that makes this cellular structure an effective barrier for the human body (Vietri Rudan et al., 2022). In addition to these components, the SC contains hygroscopic substances known as Natural Moisturizing Factor (NMF), which plays a key role in water retention by the skin (Bonté, 2011). NMF is derived from a histidine-rich protein called filaggrin, which aggregates keratin during the final stages of epidermal differentiation (Kroll et al., 2012).

It is composed of small, polar molecules such as free amino acids and their derivatives, inorganic salts, sugars, lactic acid, trans-urocanic acid, urea, and lactate. These contribute to the composition of sweat and the renewal of triglycerides in sebaceous glands (Gunnarsson et al., 2021). These substances account for approximately 10% of the corneocyte mass and 20–30% of the dry weight of the SC (Voegeli et al., 2022). Therefore, the NMF is essential in regulating the permeability of the stratum corneum (Kroll et al., 2012). In addition, many active ingredients aim to stabilize the SC while mimicking the NMF by providing nutrients and promoting humectation - such is the case of honey (Falcão, 2024).

## Honey as A Moisturizing Ingredient

Honey is a natural product synthesized by *Apis mellifera* bees from the nectar of flowers. Its composition is quite complex and includes mainly sugars (especially fructose and glucose), water, amino acids, proteins, organic acids, vitamins, minerals, and phytoconstituents such as polyphenols and flavonoids (Al-Mamary et al., 2002; da Silva et al., 2016). These components give honey antioxidant, antimicrobial, immunomodulatory, anti-inflammatory, and moisturizing properties (Carvalho et al., 2006; Erejuwa et al., 2012; Samarghandian et al., 2017). The high sugar content in honey allows for water absorption from the environment and its retention in the superficial layers of the skin, acting as a humectant agent (Eteraf-Oskouei & Najafi, 2013). Additionally, its viscosity and low water activity contribute to creating a moist environment on the skin, favoring the hydration of the stratum corneum and the regeneration of the epidermal barrier (Jenkins et al., 2011). Another noteworthy feature is the presence of organic acids and polyhydroxy acids (PHAs), such as gluconic acid, which promote gentle exfoliation and cell renewal, improving the texture and appearance of the skin without causing irritation (Vázquez-Tato et al., 2019).

These acids also contribute to maintaining the acid pH of the skin, which is important for barrier function and microbiota balance (Jahns et al., 2022). Phenolic compounds and flavonoids found in honey act as antioxidants, protecting the skin from damage caused by free radicals and oxidative stress — factors associated with skin aging and inflammation (Eteraf-Oskouei & Najafi, 2013; Nguyen et al., 2020). These properties, combined with the presence of vitamins and trace elements, enhance the skin's defense mechanisms and contribute to its healthy appearance. Given all these attributes, honey is frequently incorporated into moisturizers, facial masks, and other dermocosmetic formulations with the aim of providing hydration, soothing effects, and skin revitalization. Its versatility and compatibility with other ingredients make it a valuable component in natural and functional cosmetics.

## Honey Biochemistry and Cutaneous Action

O honey is a natural compound produced by bees from floral nectar or secretions of living parts of plants (Hossain et al., 2022). It has a complex composition consisting of amino acids, organic acids, vitamins, minerals, proteins, phytochemicals, and, in greater quantity, sugars (Manickavasagam et al., 2024; Tanuğur et al., 2024). In the International Nomenclature of Cosmetic Ingredients (INCI), honey is listed as "mel" or "honey" (CAS No. 8028-66-8) and is characterized as a moisturizer/humectant/emollient (Nilforoushzadech et al., 2018). Its derivatives include "Honey Extract" (CAS No. 91052-92-5/8026-66-8), used as a moisturizer, and "Hydrogenated Honey" (CAS No. 223705-79-1), used as a humectant/skin conditioning agent (Burlando & Cornara, 2013).

The physicochemical characteristics of honey make it a product capable of promoting skin hydration (Belcher, 2012). In medical-grade applications, it is used as an alternative medicine for the treatment of infections and wounds, aiding in healing, reepithelialization, angiogenesis, and stimulating skin and immune cells (McLoone et al., 2020; Hadi, 2016). Additionally, it can stimulate lymphocytes and phagocytes (Molan, 2001), induce epithelial repair through molecular markers (Al-Waili et al., 2011), and trigger epithelial-mesenchymal transition in keratinocytes, promoting the formation of a protective barrier on the skin (Barui et al., 2011). As presented by Burlando and Cornara (2013), the constituents of honey have bioactive properties, as shown in Table 1.

From the standpoint of honey composition, sugars make up about 80%, with variations in glucose and fructose content that may be linked to botanical origin (Angioi et al., 2021). An analysis of six monofloral honeys and one polyfloral honey produced in Minas Gerais, Brazil, indicated levels of reducing sugars ranging from 66.66% to 74.07% (Royo et al., 2022). Specifically, these sugars possess important characteristics for skin hydration. The presence of free hydroxyl groups,

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**Table 1:** Biochemical composition of honey and its biological properties

| Compounds | Properties |
|---|---|
| Sugars | Moisturizing, antimicrobial |
| Amino acids | Humectant |
| Proteins | Antimicrobial, immunomodulating |
| Organic acids | Humectant, moisturizing |
| Vitamins | Nourishing, antioxidant |
| Minerals | Nourishing |
| Phytocompounds | Antioxidants |

**Source:** Adapted from Burlando and Cornara (2013)

commonly found in reducing sugars, allows for water attraction through hydrogen bonding, increasing moisture in the stratum corneum and promoting skin hydration (Suwinski & Nowak, 2024) (Figure 1).

Other components, such as amino acids present in honey,

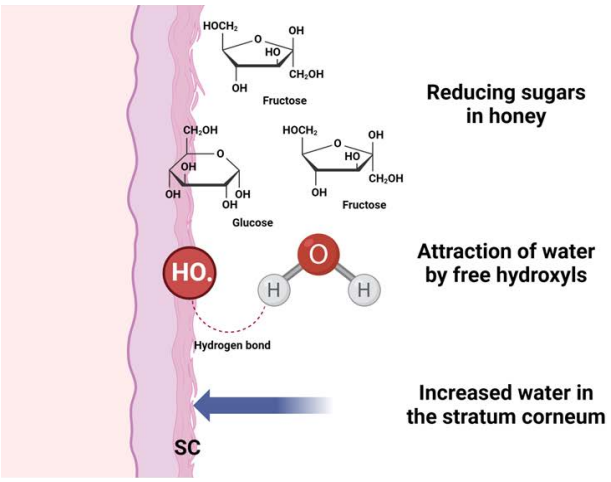


**Figure 1:**

can assist in the skin's moisturization process. Free amino acids make up about 40% of the natural moisturizing factor (Clar, 1981). The presence of these components in honey is confirmed in several studies, which not only indicate but also quantify and describe different levels depending on the botanical origin. Honeys produced in eastern Europe and central Asia show a variation of 127.7 to 1523.2 mg/kg of free amino acids, with the lowest concentration found in dandelion honey and the highest in multifloral honey (Łozowicka et al., 2021). Notable amino acids in honey include: glutamic acid, lysine, methionine, threonine, valine, tryptophan, phenylalanine, and isoleucine - a set of amino acids with direct and indirect effects on skin health, with conditioning, moisturizing, collagen- and elastin-stimulating actions, as well as anti-aging effects (Khadka, 2021; Diaz et al., 2021; Burke et al., 1966). Proteins are minor components in honey, the most relevant being those that belong to the royal jelly protein family (Muresan et al., 2022). Other protein-enzyme complexes found include diastases, invertases, glucose oxidase, acid phosphatase, catalase, transglucosylase, phosphorylase, and proteolytic enzymes (Hossain et al., 2023). The role of proteins in cosmetics is associated with their ability to bind water molecules to the stratum corneum of the epidermis (Secchi, 2008), a mechanism similar to those previously described. When associated with sugars in the form of glycoproteins and glycopeptides, they have immunomodulatory activities (Mesaik et al., 2014).

Organic acids, in addition to their use in determining botanical and geographical origin, are directly related to honey's physicochemical aspects, such as color, flavor, pH, acidity, and electrical conductivity (Silva et al., 2016). Organic acids identified in honey include formic, citric, malic, glycolic, lactic, gluconic, acetic (Silva et al., 2024), succinic, oxalic, tartaric, benzoic, and pyromucic acids (Kurek-Górcka et al., 2020). Among those found in higher concentrations, gluconic acid stands out, with levels of 1431.95 mg/100g in Bracatinga honeydew honey (Seraglio et al., 2021) and 2254 mg/100g in *Eucalyptus globulus* honey (Silva et al., 2024). In cosmetics, gluconolactone - a cyclic form of gluconic acid - is frequently used in product formulations. Specifically, in water-based or skin-contact formulations, gluconolactone is hydrolyzed into gluconic acid (Briden & Green, 2006). This substance is classified as a polyhydroxy acid (PHA), formed via the pentose phosphate pathway by glucose oxidation (Green et al., 2009). PHAs are gentler alternatives compared to alpha hydroxy acids, suitable for the phenotypic diversity of skin, offering gentle exfoliation, antioxidant activity, enhanced dermal hydration, and protection against environmental stressors (Prabakaran et al., 2025). With slow penetration and absorption, PHAs are ideal for people with sensitive or irritated skin, such as in rosacea and atopic dermatitis, promoting moisturization and strengthening of the stratum corneum barrier, contributing to improvements in photoaged skin (Talakoub et al., 2016). Vitamins and minerals, like other substances, are closely related to botanical and geographical origin, but it is possible to identify recurring patterns. Studies focused on determining water-soluble vitamins in honey have detected B-complex vitamins (B1, B2, B3, B5, B6, B9, and traces of B7 and B12) and vitamin C (El-Hawiet, 2022). In recent years, analytical research into honey's vitamin composition has revealed, in addition to the previously described ones, fat-soluble vitamins E and K (Valverde et al., 2022). Some of these have wide applications in cosmetics, such as B3 (niacinamide), which stabilizes the skin barrier, reduces trans-epidermal water loss, and stimulates the production of proteins and ceramides (Dattola et al., 2020). Vitamins C and E are used in various types of cosmetics; when combined with a compatible base, they exhibit antioxidant action, stabilize the protective barrier, and combat photoaging (Thiele et al., 2007; Boo, 2022).

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The mineral composition of honey is complex, as both biotic and abiotic factors influence the final product. Minerals found in this matrix include calcium, chlorine, copper, iron, magnesium, phosphorus, sodium, zinc, and potassium the latter accounting for about one-third of the total mineral content (Ashagrie Tafere et al., 2021). This composition is similar to that of human skin, playing essential roles and forming a dynamic interface. In particular, calcium and magnesium regulate keratinocyte differentiation, which leads to the formation of the stratum corneum, while zinc and magnesium remodel the extracellular matrix and neutralize free radicals formed by ultraviolet radiation and pollution (Haftek et al., 2022).

Although phytoconstituents are not directly related to the skin hydration process, they indirectly provide a range of bioactivities that can enhance the moisturizing action of other components. Phytochemicals, especially phenolic compounds, are attributed with antioxidant and anti-aging properties (Chakraborty et al., 2018). Polyphenols can interrupt oxidation processes and thereby prevent the formation of free radicals (Khan et al., 2019). Honey contains a variety of polyphenols, including organic acids with hydroxyl groups bound to benzene rings, and more complex phenols such as flavonoids (Yan et al., 2025). Some studies on the quantification of these constituents demonstrate variability in their levels depending on the type of honey. A study with 16 monofloral honeys from northern Minas Gerais, Brazil, reported phenolic content ranging from 42.52 to 101.67 mg/100g, and $EC_{50}$ values from 11.30 to 62.12 mg/mL (Pena Júnior et al., 2022). Another study from the same region reported antioxidant capacity values for monofloral and polyfloral honeys ranging from 51.48 to 150.71 mg/mL, with the highest antioxidant activity observed in velame (*Croton urucurana*) honey (Royo et al., 2022). There are also more specific characteristics of monofloral honeys, such as the occurrence of caffeine (Santos et al., 2024). The phytochemicals in honey exhibit multiple biological activities, making honey a promising ingredient for cosmetics (McLoone et al., 2024).

### Challenges of Using Honey in Cosmetics

One of the main challenges in formulating cosmetics with honey is the sticky texture that the final product may present, which is directly related to the concentration used. Typically, the maximum concentration of honey in cosmetics is around 10% (Kurek-Górecka et al., 2020). Viscosity is a challenge because, in cosmetics with high honey content, water may evaporate, leaving honey residues on the stratum corneum and forming a kind of glassy, viscous, and sticky film (Kurek-Górecka & Nowak, 2024). Another challenge is the difficulty in controlling the physicochemical characteristics of honey. However, adopting an appropriate minimum and maximum variation range for the product to be formulated can ease the process. Nevertheless, despite the challenges, it is possible to develop stable formulations using aqueous bases such as gels and emulsions containing 5 to 10% honey (Suwiński & Nowak, 2024). A study with a hydrogel formulation containing 10% honey reported increased permeability of phenolic acids through the skin (Nowak et al., 2025). The development of a topical emulsion with 4% honey and oils from grape seed, sesame, and pomegranate seed showed efficacy and improvement in moisture, elasticity, and skin softness in a clinical trial (Altunas & Yener, 2015). The formulation with the addition of other active ingredients with synergistic actions can facilitate the use of honey, such as the inclusion of Aloe vera and essential oil (Ahmed et al., 2025). This proves that, despite being a challenge, with appropriate bases, a product formulated with honey can have great potential for use and stability.

## Conclusions

Human skin plays essential roles in protecting against external threats and maintaining hydration, especially through the outermost layer of the epidermis along with the natural moisturizing factor. Honey, as a natural ingredient, rich in sugars and other components such as amino acids, proteins, minerals, phytochemicals, among others, can promote skin hydration and regeneration. The properties attributed to honey, such as its humectant action, contribute to the balance and stability of the skin, making it a promising active ingredient for cosmetics.

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