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HONEY IN DERMATOLOGY AND SKIN CARE: A REVIEW

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ABSTRACT

Bees honey is one of the valued and appreciated natural substances known to mankind since ancient times. There are many types of bees honey mentioned in Ayurveda. Nowadays the natural bees honey product use for skin treatment and skin care. Beeswax is used for production of cosmetics and ointments in pharmacy. Due to wide range of biological activities, bee product could be considered as important ingredient in medicine and cosmetic science. This review mainly focusses on the various applications of honey and its importance in skin care and other applied products.

Keywords: Honey, Dermatology, Skin, Antimicrobial Effects, Traditional Medicine.

I. INTRODUCTION

A supersaturated liquid made by bees, honey is mostly made of fructose and glucose but also contains small amounts of proteins, amino acids, vitamins, enzymes, minerals, and other minor ingredients. One of the most common materials utilised throughout human history is honey, which has a long-standing reputation for being good for the skin. Honey has been utilised widely in early skin cures or toilet preparations since very ancient times. A Sumerian tablet from circa 3000 BC and the Egyptian Ebers Papyrus both mention making honey as a treatment for skin treatment in the past (around 1500 BC). Additionally, it is known that Egyptian women utilised honey and sodium bicarbonate for vaginal irrigations, possibly as a result of the antibacterial qualities of the honey. Additionally, it is known that Egyptian women utilised honey and sodium bicarbonate for vaginal irrigations, possibly because of the antibacterial qualities of the honey [1].

Figure 1: Honey comb

One of the miracles of nature is honey. Honey has been used from the ancient time as a potent remedy and a frequent food sweetener. Since the Sumerians, the earliest civilisation ever known, were familiar with beekeeping and honey, it is safe to conclude that early man was also able to obtain honey and enjoy its sweetness. It can be taken at any time and is the easiest and frequently effective method for relieving a sore throat. The combination of warm water and lemon drink is an age-old cold cure that is still helpful today. According to conventional medicine, honey can treat stomach ulcers and is a mild and safe way to handle this uncomfortable condition. Honey has undoubtedly repeatedly demonstrated its ability to heal even the dirtiest wounds and tenacious sores on the surface of the body. Interest in the utilisation of honey as a wound dressing material, a rediscovered ancient remedy, is rising as more research on its effectiveness are published. In the

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moist healing environment generated, honey's antibacterial qualities hinder microbiological growth. Especially for patients in distant areas where it could take some time for an infection to develop before medical attention is received, honey is a great first-aid dressing material: It is easily accessible and user-friendly. It would be especially helpful for burn first aid because utilising polluted water for emergency dousing or cooling sometimes results in severe infection of the traumatised tissue. The honey would work as an immediate anti-inflammatory treatment as well as the antibacterial agent and a barrier against the wound's subsequent infection [2].

Early records of honey's skin applications reveal that honey have been widely utilised as the binder or carrier as well as for its medicinal virtue. Due to enzymatic H_2O_2 release or the existence of active ingredients, such as methylglyoxal in Manuka, antimicrobial characteristics are essential for dermatological purposes. Medical-grade honey is also attainable. Honey has been used in the treatment of pityriasis, tinea, seborrhea, dandruff, diaper dermatitis, psoriasis, haemorrhoids, and anal fissures and is especially suitable as a dressing for wounds and burns. It is used in cosmetic products as an emollient, humectant, soother, and conditioner for the hair, maintains youthful skin and delays the appearance of wrinkles, regulates pH, and guards against pathogen infections. Lip balms, cleaning milks, moisturising creams, after-sun, tonic lotions, shampoos, and conditioners are among the skin care products with honey as an ingredient. Botanical origins have a profound influence on the mechanisms of action on skin cells, which include antioxidant activity, the activation of cytokines and matrix metalloproteinases, as well as epithelial-mesenchymal transition in injured epidermis [1].

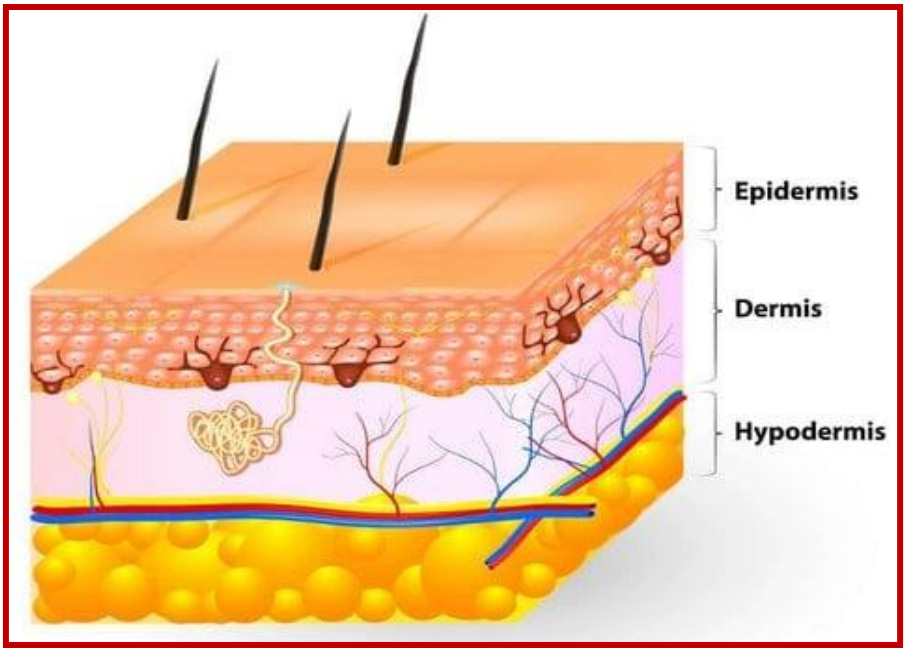

Figure 2: The layers of human skin

The first physical defence against external pathogenic agents, the skin is made up of three layers: epidermis, dermis, and hypodermis. In order to lose the protective properties of this tissue, wounds are characterised as disruptions in the continuity of the skin caused by mechanical, chemical, or thermal injury. The goal of the wound-healing process is to reinstate the damaged tissue's integrity and to regenerate missing epithelium. It is a dynamic and complex process that generally takes place in four overlapping steps: haemostasis, inflammation, tissue proliferation, and regeneration. Honey have been used to cure wounds since the beginning of time, mostly due to its antibacterial characteristics. In addition to its broad spectrum of antibacterial action against typical wound-infecting microbes, honey has been proven to be effective against antibiotic-resistant bacteria and was able to restore the efficacy of some medications against bacteria that had previously acquired resistance[3].

NATURAL PROPERTIES OF HONEY

Honey is a naturally occurring humectant, which means it can draw in and hold moisture. Honey is a great moisturiser because of its inherent ability to hydrate. Because pure honey is non-irritating, it can be used to

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make products for babies and people with sensitive skin. According to scientific research, honey has a significant amount of antioxidant qualities. Our body uses antioxidants to get rid of free radicals or other molecules that destroy healthy cells when they fly around inside of them. Utilizing honey aids in both skin rejuvenation and damage prevention for the skin. Since honey contains a lot of sugar, less moisture is available for bacterial growth. The lack of protein and low pH deprive bacteria of the nitrogen necessary for growth. The presence of hydrogen peroxide and natural antioxidants in honey significantly slows the growth of bacteria. When honey touches human skin, hydrogen peroxide is released. Glucose oxidase, an enzyme introduced by honey bees and found in honey, produces hydrogen peroxide. Natural honey is free of additives and preservatives, and it can even be consumed unaltered and unprocessed as it is found in nature. According to recent medical research, honey is a powerful antimicrobial agent that can inhibit the growth of specific bacteria, making it a useful ingredient in the treatment of minor acne flare-ups [4].

1.1 What is honey:

Honey is a naturally occurring sweet substance made by honeybees from plant nectar, plant secretions, or excretions of insects that feed on living plants. The bees collect these materials, alter them by mixing them with particular plant materials, and then generate honey[5]. Honey is a naturally occurring material created when honeybees of the genera Apis and Meliponini collect, process, and store the nectar and sweet deposits from plants in the honeycombs[6]. Honey has medicinal properties, and "apitherapy" is the term used to relate the use of bee products directly from the hive[7]. Honey have been used by humans for a very long time as a medication as well as a food [8].

Synonyms: Madhu, Mel

Biological source: Sugary secretion deposited in honey comb by the bees Apis mellifica and Apis dorsata and other species of Apis

Family: Apidae

Geographical source: Africa, Australia, New Zealand, California and India.

Honey is a concoction of sugars created by honey bees from nectar, or the naturally occurring sugar solutions found in flowers and other plant secretions. The bee enhances the final product's achievable density by inverting the sucrose in the nectar, increasing the process' caloric density efficiency. The water in it is evaporated by honey bees, who also add enzymes to make it into a pleasant liquid [9].

Purity of honey:

Visual inspection and non-professional tests are unreliable for determining the purity of honey. Honey can be easily tested for adulteration by heating 10 g of it with sodium bisulphite and barium. If barium sulphate precipitates, honey contains sugar or jaggery[10].

1.2 Types of honey:

Depending on whether the honey is harvested from the same source of plants, or from sources of several plant types, honey can be either a single flower or many flowers. Honey's colour and consistency rely on the source and can it might be dark brown, black, etc. All honey has roughly the same composition, including sugars like sucrose and fructose, minerals, vitamins, and a number of enzymes like Invertase, diastase, and catalase. Apiary honey and wild honey are the two main varieties of honey. Hive bees from India make honey, Apis millifera, the European bee, and Apis cerana indica grown in hives and extracted using modern methods is known as apiary honey. They are open and cost nothing made of alien substances. Those rock bee rock honeys come from Apis cerana indica's natural nests, Apis dorsata, or woodlands and gathered using the unrefined technique of compressing the Forest honeys refer to combs. Due to the significant amounts of wax, pollen, and eggs (bee larvae), bee parts, and plant components present, these honeys are discoloured. To remove the dispersed particles, more processing of the honey is required. Granulation occurs naturally that occurs when the glucose in honey crystallises. Honey in granules can be melted slightly to get liquid honey [10].

1.2.1 Comb honey: It is honey in its purest, most natural form, filled by bees into a comb of beeswax. It is the only raw type of honey available.

1.2.2 Liquid honey or extracted honey: It is the honey that had occur squeezed out of the honeycomb by centrifuging it in a honey extractor after the natural wax caps have been removed.

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1.2.3 Granulated creamy honey: This is made by combining one part of pure, finely ground honey with nine other parts of storing the resulting concoction at about 57 degrees Celsius until it turns firm and creamy.

1.2.4 Comb honey: It is placed in a jar with liquid honey around it is chunk honey.

Although honey is accessible from bees in its raw form, which can be used, it is typically processed to enhance its preserving properties. Although unprocessed honey tastes nicer, it is more likely to ferment since yeast is present. Normally, processing temperatures for honey are higher than 160 °C. After processing, honey is filtered. The natural propensity of honey to granulate is lessened and its appearance is improved by filtering. However, processing and filtration at high temperatures remove any naturally existing enzymes [4].

1.3Honey as a remedy:

Honey's therapeutic benefits have long been understood. The Indian medical system Ayurveda refers to honey as the "nectar of life" and suggests using it to heal a variety of illnesses, including diarrhoea and ulcers. A healthy breakfast suggestion for the morning is honey, lemon juice, and hot water. It was used in Egypt to embalm the deceased and as an ingredient of cosmetic cosmetics. Honey have been utilised as an adjuvant to hasten the healing of wounds that are infected, burnt, and ulcerated [10].

Does honey need to be sterile?

Gamma radiation can be utilized to sterilise honey without affecting its antibacterial properties. Standard testing has verified that honey is sterile, and clinical research has not yet identified any consequences, such as allergies, after its utilisation in wounds and burns. Therefore, honey can be used as unprocessed and undiluted[11].

1.4 Honey's Nutritional Value:

The main components of honey are water and carbohydrates. Additional vitamins and minerals are present in trace concentrations. In addition to niacin, honey contains calcium, copper, riboflavin, iron, magnesium, potassium, and zinc. A mixture of phenolic acids and flavonoids can also be found in honey. Antioxidants like this get rid of the body's potentially harmful free radicals [2].

- Calories per teaspoon: 64
- 0 g of total fat
- NaCl: 0 mg
- 17g of total carbohydrates
- 16g sugars
- 0g protein [2].

1.5 Applications in therapy and Honey's Health Benefits:

Most frequently, Honey is applied topically as antibacterial agent to treat infections in a variety of different kinds of wounds. These consist of:

- Leg sores
- A pressure sore
- Diabetic foot sores
- Infection from a wound caused by trauma or surgery [2].

Honey's Health Benefits:

- Combat acne
- Fighting infection
- Combat colds
- Healing burns
- Lower your cholesterol
- Without a bladder infection
- Declining arthritis pain
- Relieve toothache
- Clean sinuses
- Improve fertility
- Improve digestion

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- Combat fatigue
- Support for weight loss
- Improve immune system

Honey's antibacterial characteristics come from its high acidity, hydrogen peroxide action, and low water activity, which results in osmosis [2].

Natural honey's historical usage:

According to drawings from the Stone Age, humans have been using honey for approximately 8000 years [12]. Ancient Chinese, Greeks, Assyrians, Egyptians, and Romans utilised honey to cure wounds and digestive disorders [6]. Listed here are a few of the health advantages of honey that were known to ancient people [12].

1.6 Honey in Indian system of Ayurveda:

Ayurveda is a composite word made up of the words ayus, which means "life" or "life principle," and Veda, which means "a system of knowledge." As a result, the name "Ayurveda" loosely translates to "knowledge of life [13]."Honey was regarded by the ancient Vedic civilisation as one of nature's most amazing gifts to humans. According to ancient Ayurvedic writings, honey traditionally helps people with poor digestion. Additionally, it has been underlined how effective honey is in treating annoying coughs. Ayurvedic specialists consider honey to be beneficial for maintaining healthy teeth and gums. It has a hypnotic effect, which have been used for millennia to cure insomnia. In the past, Ayurvedic practitioners recommended honey for anaemia, all lung imbalances, and burns and wound healing, and cardiac pain. Ayurvedic practitioners have historically utilisation of honey to treat numerous eye conditions. When administered daily to the eyes, it improves vision. Additionally, honey is known to help reduce cataracts [12].

1.7 Honey in earliest Egypt:

The most widely used medicine in Egypt was honey, which was cited 500 times in 900 cures [6]. A common wound salve is prescribed in the Smith papyrus, an Egyptian text from between 2600 and 2200 B.C., and calls for a combination of mrht (grease), byt (honey), and ftt (lint/fibre), transliterated from hieroglyphic symbols [14]. Nearly all Egyptian medications included milk, wine, and honey. Ancient Egyptians made a sacrifice of honey to their gods [12]. Additionally, they embalmed the corpses using honey. Because of its antibacterial characteristics, honey was used to treat infected wounds. Additionally, honey was applied topically as an ointment[12].

1.8 Honey in earliest Greece:

Oenomel is a traditional Greek beverage made from unfermented grape juice and honey. It is occasionally used as a traditional treatment for gout and specific neurological illnesses [12]. Hippocrates, an ancient Greek physician, advocated a simple diet and favoured the uses of honey in the formulations of oxymel (vinegar and honey) for pain relief, hydromel (water and honey) for thirst, and a mixture of honey, water, and several medicinal components for acute fevers [14]. Additionally, he utilised honey for contraception, wound healing, baldness, topical antisepsis, scar prevention and treatment, cough and sore throat treatment, eye issues, and laxative activities [12].

1.9 Honey in Islamic medicine:

The Islamic medical system views honey as a nutritious beverage. According to the holy Qur'an, " Your Lord also instructed the bee to construct its chambers on hills, trees, and human habitations; then to eat of all the earth's produce; then to decipher its Lord's broad routes with wisdom; A drink of many colours that contains healing for men emerges from within their bodies; undoubtedly, this is a sign for those who think. Furthermore, the Islamic prophet Mohammad (SA) recommended utilising honey to treat diarrhoea.[15]. Nearly 1000 years ago, the famous Iranian scholar and physician Avicenna suggested one of the best therapies for tuberculosis is honey [12].

II. ACTIVE CONSTITUENTS

These are some examples of honey active principles: minerals, primarily potassium, magnesium, phosphorus, calcium, iron, and copper; sugars, primarily fructose and glucose; vitamins, amino acids, and proteins such as ascorbic acid, biotin, thiamine, pantothenic acid, and nicotinic acid; enzymes such as diastase, invertase, glucose oxidase, and catalase; phytocompounds derived from botanical sources; and other minor constituents . Most of the methods through which these components affect the skin tissue are unknown. The high fructose and

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glucose content, which forms hydrogen bridges with water and preserves the moisture of the skin's horny layer, is primarily responsible for the hydrating effect. Additionally, the presence of amino acids, primarily proline, but also arginine, alanine, glutamic acid, aspartic acid, lysine, glycine, and leucine, as well as organic acids, primarily gluconic acid but also, to a lesser extent, lactic, citric, succinic, formic, malic, acetic, maleic, and oxalic acids, contributes to the ability to hydrate [1].

Since it is well recognised that the biological characteristics of a particular type of honey are influenced by the flowers that produce the nectar, botanical sources play an important role in the cosmetic industry. Pollen analysis is frequently used to determine them [16]. Acacia honey, which is composed of black locust (Robinia pseudo acacia L.), is most frequently used in cosmetics. This variety of honey contains more fructose, a more soluble sugar, than glucose, which lowers the likelihood of crystal formation in the finished cosmetic product. Manuka honey was first used in cosmetics due to its strong antibacterial and antifungal properties, which have potential uses with regard to the infectious diseases including acne and other skin maladies in dermatology. However, additional aspects of this honey's skin-care abilities have been researched, such as its ability to build collagen and support skin regeneration processes[1]. The contribution of phytocompounds to the selection of honey's benefits is little understood. The strongest antioxidant and radical-scavenging properties are often seen in darker honeys, which are higher in phenolic components such flavonoids and tannins [17]. Multifloral, sunflower, almond, chestnut, and eucalyptus honeys were all found to contain phenol, with levels ranging from 194.9 to 1636.3 mg Gallic Acid Equivalents (GAE)/kg and overall antiradical activity ranging from 61 to 940 mg GAE/kg [18]. Multifloral honey was shown to contain flavonoids in quantities ranging from 1.23 to 2.93 mg of catechin equivalents (CE) per 100 g in another investigation [19]. Based on the decrease in polyphenol oxidase activity, sweet clover (Melilotus officinalis (L.) Pall.) It was also discovered that honey have high antioxidant activity[20]. Gallic, p-coumaric, protocatechuic, caffeic, and ferulic acids were found in high concentrations in buckwheat honey after particular components were isolated from it[1].

Table 1: Components of honey with known or suspected effects on skin: [1]

Constituents	Characteristics
Sugars	Hydrating, antimicrobial
Amino acids	Humectant
Organic acids	Humectant
Vitamins	Nourishing, antioxidant
Minerals	Nourishing
Proteins	Antimicrobial
Phytocompounds	Phytocompounds

III. APPLICATIONS OF HONEY

a. **Physical properties of honey:**

Along with its composition and flavour, honey has a number of significant characteristics. Honey that has just been extracted is a thick liquid. Its viscosity varies with content and is dependent on a diverse array of components especially given the water concentration. Viscosity is a crucial technical factor while processing honey because when honey is extracted, processed, pumped, set, filtered, mixed, and bottled, it decreases honey flow. Another characteristic of honey is hygroscopicity, which refers to the substance's capacity to take in and retain moisture from its surroundings. But the identical hygroscopicity might cause issues while processing or keeping due to an excessive water content, making preservation and storage difficult. When the relative humidity of the air is above 60%, Normal honey will absorb moisture if it has a water content of 18.8% or less. Honey ranges in heat conductivity starting with 118 to 143x10 Cal/cm2 /sec/o C13. Therefore, one may determine how much heating, chilling, and mixing is required to treat a specific volume of honey, including prior to and following filtration or pasteurisation. Honey's surface tension varies depending on where it comes from and is likely caused by colloidal materials. It contributes to the foaming properties of honey along with high viscosity. Liquid honey can be translucent and without colour (as water) or it can be dark amber or even completely black. The many shades of honey are all essentially shades of golden or amber; they mimic different

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concentrations or dilutions of cameralized sugar, which has previously been used as a colour reference. The quantity of pollen or other suspended particles, determines transparency or clarity, its colour changes depending on the plant's age, type, and storage conditions. Burgget noted that honey's hyperosmotic properties—which result from its high solids content and little moisture content—prevent the development of yeast and bacteria by sucking the from the creatures, the water which kills them through desiccation [21].

b. Dermatological properties:

Since ancient times, empirical research has supported using honey to cure burns and wounds. These traditional usage' astounding effectiveness has sparked curiosity in more contemporary professional methods of wound healing[22]. Honey's unique physicochemical substances make it an excellent wound dressing because they enable it to hydrate damaged tissue, combat microbiological infections, reduce inflammation, and stop gauze from adhering to wounds [23]. Numerous studies on the capability of honey to heal wounds have emphasised its antibacterial characteristics[24]. A variety of nations' official pharmacopoeias include honey, and c-irradiated, medical-grade honey is sold on the market. Honey is mostly used in dermatology because of its antimicrobial properties [25]. Varying varieties of honey may have different antibiotic properties, which are believed to be most often influenced in conjunction with low water activity, low pH, and the generation of hydrogen peroxide by the metabolic agent glucose oxidase. It has been demonstrated that honey distillates are similar to commercial antimycotic medications with regard to the vaginal candidiasis. Additionally, honey varieties with either hydrogen peroxide or nonperoxide antibacterial activity has been successfully used to treat superficial mycoses including ringworm and athlete's foot [1]. Additionally, Clinical experiments have utilised honey to cure contact dermatitis, herpes, skin rashes, and acne [26].

c. Cosmetic properties:

Honey is involved in the International Nomenclature of Cosmetic Ingredients (INCI) under the names of “Honey” or “Mel” (CAS no. 8028-66-8) and is classified as an emollient/humectant/moisturizing product. Honey is contemplate especially acceptable for skin care, and its systematic use is thought to remain the skin young and delay wrinkle development. Honey is hygroscopic, antibacterial, and antifungal, nurtures the skin, and helps control the upper protective skin layer's gently acidic ph. Because of its humectant qualities, it can be utilised as a natural ingredient in a number of moisturising products, while its cleansing properties can be employed in skin soaps, bath and shower products, face creams, and lotions. Honey also has anti-irritant and demulcent characteristics that make it particularly suitable for infants and other people with sensitive skin. Similar to this, the moisturising and anti-irritant properties of sun care and sun screen products temper the effects of the radiation-blocking ingredients [1]. Additionally, dry, intermediate-moisture, and hydrogenated honeys are used during the creation of soaps and cosmetics[27]. In addition to the creation of derivatives, honey is refined using a variety of methods, such as membrane processing, to reduce viscosity and prevent cloudiness[28]. Due to its stickiness, thinness, and liquefaction, honey alone, which is present in common uses, is rarely applied to skin in the cosmetics sector. Honey is most frequently used in products like lip ointments, cleaning milks, moisturising creams or gels, after-sun, shampoos, conditioners, and tonic lotions in concentrations among 1 and 10% [29]. Higher concentrations can be done through combining honey with oils, gelling agents, and emulsifiers, which can result in mixtures that contain up to 70% honey while still performing satisfactorily for application [26]. A pharmaceutical formulation as a topical therapy for mycoses, acne, and other skin conditions has been developed using a combination of antimicrobial essential oils and honey. According to a patent, this mixture can be useful to hydrotherapy as well as moisturising, anti-aging, and slimming creams, soaps, hair care products, and mouthwash [30].

d. Antimicrobial activity:

The enzymatic glucose oxidation reaction and a few of its physical characteristics are the primary factors for honey's antimicrobial activity, [31] but other elements such as high osmotic pressure/low WA, Low protein content, a high carbon to nitrogen ratio, a low redox potential because of the abundance of reducing sugars, an acidic environment, and viscosity that restricts Other chemical compounds, such as phytochemicals and dissolved oxygen can also show honey's antimicrobial activity [32]**.** In addition to terpenes, pinocembrin, benzyl alcohol, 3,5 dimethoxy 4 hydroxybenzoic acid (syringic acid), methyl 3,5 dimethoxy 4 hydroxybenzoate (methyl syringate), 2 hydroxy 3 phenyl propionic acid, 2 hydroxybenzoic acid, 3,4,5 trimethoxybenzoic acid,

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and 1,4 dihydroxybenzene, several items with weak antimicrobial levels have also been found [33]. Honey has the smallest dose required for fully inhibiting growth, according to numerous studies that found its antibacterial effect to be minimal inhibitory [33]. Investigations revealed that Manuka honey can considerably reduce the risk of Staphylococcus aureus and Escherichia coli [34].

Honey's antibacterial properties are mostly attributed to production of hydrogen peroxide by an enzyme that bees add to the nectar, however some floral sources also include other antibacterial elements. Catalase, an enzyme found in human tissues and serum, decomposes hydrogen peroxide. This enzyme does not degrade the antimicrobial substances found in nectar. It may be advisable to use Manuka honey as it contains hydrogen peroxide activity in addition to the component that comes from the nectar until comparative clinical studies are carried to identify which class of antibacterial activity is the more effective. Because the enzyme when honey turns into hydrogen peroxide is destroyed by heating and exposure to light, unpasteurised honey should be used, and it must be stored in a cool place and protected from light. If it is necessary to warm honey to liquefy it, it should be heated to no more than 37°C. If it is considered necessary to sterlise honey, this can be done by gamma irradiation without decreased antimicrobial effectiveness. Commercially, gamma-irradiated Manuka honey is offered. Manuka honey may contain a uniquely high level of an antibacterial component from nectar that is not broken down by catalase. Staphylococcus aureus is highly susceptible to this antibacterial element's effects. Manuka honeys, like all honeys, vary greatly in their strength. Due to the fact that more than half of Manuka honey on the market lacks any appreciable level of this component, producers of Manuka honey employ a "UMF" rating ('Unique Manuka Factor'), which is equivalent to the percent phenol with the same activity against Staphylococcus aureus[35].

- **Potential antibacterial agent:**

Honey has long been utilised as conventional treatment for microbiological diseases [35]. Manuka honey (L. scoparium) has been the subject of research, and it has demonstrated to be efficient against a number of infections that affect people, like Escherichia coli (E.Salmonella typhimurium), Enterobacter aerogenes, and E. coli strep throat [36]. However, due to increased antibacterial action, local production (therefore availability), and improved selectivity against medically essential pathogens, the newly discovered honeys may outperform or resemble Manuka honey[37]. The coagulase negative staphylococci are more vulnerable than Enterococcus species with Pseudomonas aeruginosa (P. aeruginosa) to honey with equivalent antibacterial efficacy, and they are quite similar to S. aureus in this regard[38]. A measure of the minimum inhibitory concentration (MIC), amount required for bacterial inhibition, whereas the method of disc diffusion primarily serves as a qualitative evaluation of identifying bacteria's susceptibility to antimicrobial drugs[39].

- **Diameter of the inhibitory zone:**

To ascertain their zone diameters of inhibition, various honey samples (5%–20%) were tested against E. coli O157:H7 (12 mm–24 mm) and S. typhimurium (0 mm–20 mm) (ZDI)[40]. For S. P. aeruginosa, S. aureus, and E. Moreover, it was discovered that the ZDIs of Nilgiris honeys were (20-21), (15-16), and (13-14) mm, respectively[41]. Agbagwa and Frank Peterside[33] examined various samples of honey from Western Nigeria, Southern Nigeria, Eastern Nigeria, and Northern Nigeria and compared their capacities to stop Proteus mirabilis (P. mirabilis) growth with an average of ZDIs (5.3-11.6) mm, (1.4-15.4) mm, (4.4-13.5) mm, and S. aureus, P. aeruginosa, E. coli, and (9.1-17). Against gram-positive bacteria including S. aureus, Bacillus subtilis, and Bacillus cereus as well as gram-negative bacteria like E. coli, P. aeruginosa, and S. enterica serovar Typhi, raw and processed honey extracts both displayed ZDI (6.94-37.94) mm[42].

- **Inhibitory minimum concentration:**

The results of the MIC assay showed that for MRSA isolates, ulmo (Eucryphia cordifolia) honey had a lower MIC (3.1% - 6.3% v/ v) than Manuka honey (12.5% v/v), whereas the same MICs (12.5% v/v) were seen for E. coli and Pseudomonas pathogens[43]. While MICs for tualang honey ranged from 8.75% to 25%, those for Manuka honey ranged from 8.75% to 20% against a variety of pathogenic gram-positive and gram-negative bacteria[44]. For both clinical and environmental isolates of P. aeruginosa, Manuka, heather, khadikraft, and local honeys had MICs of 10% to 20%, 10% to 20%, 11%, and 10% to 20%, respectively [45]. A. millifera honey's MIC against S. aureus varying from 126.23 to 185.70 mg/ml, while Tetragonisca angustula honeys varying from 142.87 to 214.33 mg/ml[46].

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IV. MARKETED FORMULATIONS CONTAINING HONEY

Table 2: Various marketed formulations using honey:

Sr.no	Brand name	Ingredients	Applications
1.	Himalaya Purifying neem face wash	• Honey • Neem leaves • Turmeric • Rose water	• A thin humectant and nutrient that is used to give facial masks, creams, and lotions body. • Exceptionally helpful for oily and acne-prone skin, antibacterial, antifungal, anti-inflammatory, and antiseptic. • It protects the skin from a variety of skin illnesses, provides radiance to the face, and has antibacterial and antifungal properties. • In addition to being a solvent, it also contains antibacterial and antiseptic qualities that help to treat acne [47].
2.	Lip balm	• Honey • Bees wax • Sesame oil • Rose oil	• Hydrates the lips and aids in retaining moisture. • Excellent for softening skin. • Helps to give your lips a consistent tone. • Moisturizer [48].
3.	Semi-synthetic Anti acne Face wash	• Honey Cinnamon • Nutmeg Lemon Peppermint oil	• Honey moisturises skin while having antibacterial and antimicrobial properties. • Cinnamon is a great acne therapy since it has antifungal, antioxidant, and antibacterial properties. • Nutmeg's anti-inflammatory properties aid to soothe skin irritation and balance oily skin. • Lemon possesses anti-inflammatory, antibacterial, and virus-killing properties. • Menthol is contained in peppermint oil. Along with anti-inflammatory and scent qualities, it offers a cold sensation and a feeling of freshness [49].
4.	Ayurvedic face wash	• Honey • Neem Extract • Turmeric Extract • Propyl paraben • Rose Water	• Thickening agent, emollient, antiseptic and astringent, nutritive. • Antibacterial, Antiseptic. • Anti-inflammatory, Antibacterial and improve fairness. • Preservative • Solvent [50].
5.	Povidone Iodine gel	• Povidone Iodine • Honey • Polyethylene Glycol-400 • Polyethylene Glycol-4000	• To treat or prevent skin infection. • To promote rapid and improved healing. • Humectant, solvent, emollient or preservative. • Acts as an osmotic agent that increases fecal water content.

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Honey is a common constituent in many formulations, including Avaleha and Ayaskriti. Honey acts as a barrier against bacteria and infection by forming a viscous barrier, or a sticky layer, between itself and the other chemicals in the product. Honey has an acidic pH of 4.0, which inhibits the growth of some bacteria like E. coli. The 0.5–0.6% water content of honey prevents bacterial development. Glucose and an enzyme are found in honey called Glucose Oxidase, which, in the proper circumstances, the enzyme glucose oxidase can convert glucose to high osmolality and hydrogen peroxide, which make the microbial growth ineffective [51].

1. Formulation & evaluation of herbal anti-acne face wash was performed by Vinayak Kumbhar and Abhyangshree Mane.

In the belief that they are safer and have fewer adverse effects than synthetic ones, natural therapies are more widely accepted. The demand for herbal formulations is rising on the global market. The formulation and evaluation of a natural anti-acne face wash combining neem leaves (Azadirachta indica), turmeric (Curcuma longa), liquorice root, shahi jeera, orange peel, and hydro-alcoholic extract of nutmeg fruit are the subjects of the current study (Myristica fragrance). Although there are several topical herbal treatments for acne on the market, they advocate creating pure herbal formulations without the use of any synthetic ingredients. The literature has described the plants' significant antioxidant, anti-inflammatory, and antimicrobial capabilities. It is a really good effort to build using a herbal face cleanser that contains aqueous extracts of nutmeg seed, liquorice root, turmeric rhizomes, and neem leaves[47].

2. Formulation and evaluation of Ayurvedic face wash was performed by Amit Ingle and Mayuri B. Meshram.

Neem leaves with rhizomes of turmeric, Nutmeg seed, Liquorice root, Honey, Orange tincture, Lemon juice, Xanthan gum, Orange peel extract, Rose water, Propyl paraben, Methyl paraben, and Sodium lauryl sulphate were among the ingredients used to produce the Ayurvedic face wash. Various physical criteria, including wash ability, colour, pH, viscosity, spread ability, and an irritancy test, were examined for the prepared face wash. The compositions they were found to be uniform and simple to wash. The face wash's formulation has a pH that is slightly alkaline and in keeping with healthy physiology. Among the most popular acne remedies is the herbal face wash, which not only moisturises skin but also acts as a cleanser. They are ideally utilised for the physiology of dry and oily skin. It offers a variety of vital nutrients that are necessary for sustaining healthy skin function. Additionally, it enhances the skin's natural radiance. The soothing ingredient Xanthungum was utilised in the make-up of the herbal face wash, which was made from a variety of herbs including Neem, Turmeric, Nutmeg, Liquorice, and Honey. It benefits the face in positive ways[50].

3. Formulation and evaluation of lip balm by using honey and sesame oil to lighten the dark lips was performed by Nishigandha Waykule, Prachet Bagewadikar and Somasharan Kale.

The compositions of daily lip care products contain heavy metals and preservatives. The heavy metals have negative effects on the lips because they leak through their pores and may accidentally cause internal ingestion. The innovative method of formulating cosmetics was created in response to the growing global demand for natural goods whose manufacture is safe for the environment and human health. While lip balm is a cosmetic item similar to lipstick that prevents dry lips, nourishes lips, and shields lips from environmental elements. Lip balm is resistant to changes in outside temperature and other elements. Lip balm is a beauty product that can be used by anybody and is not gender specific. The current lip balm formulas satisfy every requirement for the nourishing and safeguarding of lips. During the stability tests, the formulation maintained in the refrigerator and at ambient temperature exhibits similar behaviour. Storage in these circumstances was taken into account, and as the product's functionality was preserved, it was determined to be adequate. It was determined that using an herbal lip balm could be a superior alternative for treating a variety of lip problems[48].

4. Formulation and Evaluation of Semi-synthetic Antiacne Face wash was performed by Arbaz S. Shikalgar , Sharvari P. Shendage, Aachal S. Shinde, Sanket S. Shinde Sajida S. Dhage, Akshay R. Yadav, Dr. Chandrakant S. Magdum.

Acne, pimples, and cyst acne have raised concerns because they are a common condition for both adults and teenagers due to their daily lives. Use a hygiene routine that includes face wash, scrub, and moisturiser to maintain clear skin. Chemical-based formulations have a diverse array of unfavourable consequences after being used a very long time by people all over the world. On the other hand, herbal therapies have been used in India for centuries and have never had any negative side effects. Aloe Vera, turmeric, and many other herbs and

spices are widely available in India. The purpose of the current study was to develop and assess a semi-synthetic acne face cleanser. Like any other drug, natural therapies are favoured to synthetic ones. Consumers choose Ayurvedic herbal or semi-synthetic facewashes and other skin care products, according to a survey of natural skin care products. The purpose of this project is to create a semi-synthetic facewash that people of all ages can use on a daily basis. Both the outside and the inside of the skin benefit from its upkeep and feeding[49].

5. Honey-Based Medicinal Formulations was performed by Md Lokman Hossain 1, Lee Yong Lim 1, Katherine Hammer 2, Dhanushka Hettiarachchi 1 and Cornelia Locher.

Honey is a concentrated natural product that honeybees (Apis millifera) make from blossom nectar. It includes about 200 chemicals with a range of biological or pharmacological actions, such as hypoglycaemic, anti-inflammatory, antibacterial, and antioxidant benefits. However, there are certain challenges when using plain honey for therapeutic purposes, such as maintaining the necessary therapeutic concentration for an appropriate amount of time due to the issue of liquefaction and leaking. Researchers have responded to this by using honey in a variety of formulations, such as hydrogels, dressings, ointments, pastes, or lozenges. Following a succinct review of the chemistry and therapeutic uses of honey, this study concentrates on non-commercial various disease-specific honey formulations as well as in vitro, in vivo, and clinical research. Additionally, it discusses the utilisation of honey formulations in addition to the supporting data. Through randomised controlled trials and case studies, clinical studies have also demonstrated Honey's effectiveness. As a result, there is substantial evidence in favour of using honey as a therapeutic agent for a range of illnesses. The assessment did, however, point out that there is room to investigate a larger range of honey-based compositions employing several types of honey. It is intended a review article has that improved understanding of the current honey-based formulations, identified knowledge gaps, and offered evidence-based justification for further investigation of innovative honey-based pharmaceuticals[52].

6. Honey-based hydrogel: In vitro and comparative In vivo evaluation for burn wound healing was performed by Reham F. El-Kased1, Reham I. Amer2, 3, Dalia Attia4 & M. M. Elmazar.

Since ancient times until the present, Honey has been employed in cure wounds. In this study, a hydrogel made of honey was created, and its antibacterial and wound-healing abilities were tested equally in vivo and in vitro. The pH, spread ability, swelling index, in-vitro release, and antibacterial activity tests were performed on the produced formulas. The pH ranged from 4.3-6.8 and the spread ability was between 5.7- 8.6cm, respectively.

The maximum antibacterial activity was seen in the 75% honey-chitosan hydrogel. Using burn-induced wounds in mice, this solution was tested for in-vivo burn healing. The formula's antibacterial and burn healing properties were assessed in comparison to those of commercial products. Burns healed most quickly with a 75% honey-chitosan hydrogel, it was discovered. This study demonstrates that honey, when added to a hydrogel matrix made of chitosan, has a beneficial effect on regulating wound healing. The hydrogel wound dressing that has been made, which contains 75% honey, will not only serve as a covering to offer a clean, moist environment for healing, but it will also directly aid in promoting tissue regeneration and recovery.

These design criteria created a different honey-chitosan hydrogel delivery system that is affordable, non-toxic, natural, and effective and can get closer to clinical availability for wound healing[53].

7. Formulation and evaluation of herbal body lotion was performed by Banerjee, D., Kumar, M., & Mukopadayay, S.

The need for standardisation and the makeup of herbal products in everyday life are the main topics of this article. The mix of herbal items will always have the best impact on our daily lives as compared to the composition of any single product. Herbal ingredients are not only more effective in treating skin dryness than synthetic ones, but they can also partially replace synthetic bases. The cosmetologist is responsible for promoting and encouraging the creation and usage of truly herbal cosmetics. It is quite simple to apply to the surface of our bodies and very easily absorbed. In terms of body surface area, it has less adverse effects [depending on the type of skin]. As herbal formulations are in high demand to satisfy the demands of the expanding worldwide market, the key factor is that the herbal constituents demonstrated notable differences in activity[54].

8. Formulation of an antibacterial topical cream containing bioengineered honey that generates reactive oxygen species was performed by Connor O'Farrell, Thomas J. Hall, Liam M. Grover, and Sophie C. Cox.

SHRO is a highly desired biomaterial due to the pressing need for innovative antimicrobial therapeutics that can combat microorganisms that have gained resistance to existing antimicrobial medications, such as antibiotics. SHRO is a highly sought-after biomaterial because to the pressing need for novel antimicrobial therapeutics that can combat infections that have become resistant to antibiotics and other commonly used antimicrobials. By repurposing SHRO into a topical cream that generated reactive oxygen species in situ, this study hoped to address the need for alternate topical infection therapies to current antibiotics. Contact angle measurements that showed good topical spread ability and favourable surface wetting backed up this result [55].

9. Antioxidant Activity of Three Honey Samples in relation with Their Biochemical Components was performed by Lee Suan Chua,1 Norul Liza A. Rahaman,1 Nur Ardawati Adnan,1 and Ti Tjih Eddie Tan2.

Three types of honey used often in Malaysia—tualang, gelam, and acacia honey—were examined for their antioxidant properties based on free radical scavenging, reducing power, and bleaching inhibition. The biochemical components of the honey samples, such as total phenol, total flavonoid concentration, and total water-soluble vitamins, were associated with their antioxidant ability (vitamin B1, B2, B3, B9, B12, and vitamin C). Inhibition of -carotene bleaching (r = 0.9508), ferric reducing antioxidant power (r = 0.9910), and DPPH free radical scavenging activity (r = 0.9276) were all substantially linked with the total flavonoid content of honey samples. Several phenolic acids, as well as flavone (quercetin), flavanone (pinobanksin-3-O-butyrate), and organic acids were discovered in honey samples utilising the quick screening approach with UPLC-MS/MS. These substances, in addition to vitamins, were likely the main elements boosting the antioxidant capacity of honey samples [56].

V. CONCLUSION

Honey is one of nature's most popular treatments for skin. Since history, it has been employed for a broad range of medical uses. Honey's antibacterial and humectant properties play a significant role in dermatology, with its antibacterial properties being the most well-known. Due to its significant antibacterial and antifungal features, which have potential applications with regard to the infectious disorders including acne and other skin conditions in dermatology, Manuka honey was initially utilised in cosmetics. Additionally, it was found that honey has a significant antioxidant capacity and aspects of honey's skin-care properties have been analysed, including its capacity to promote skin regeneration and create collagen.

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