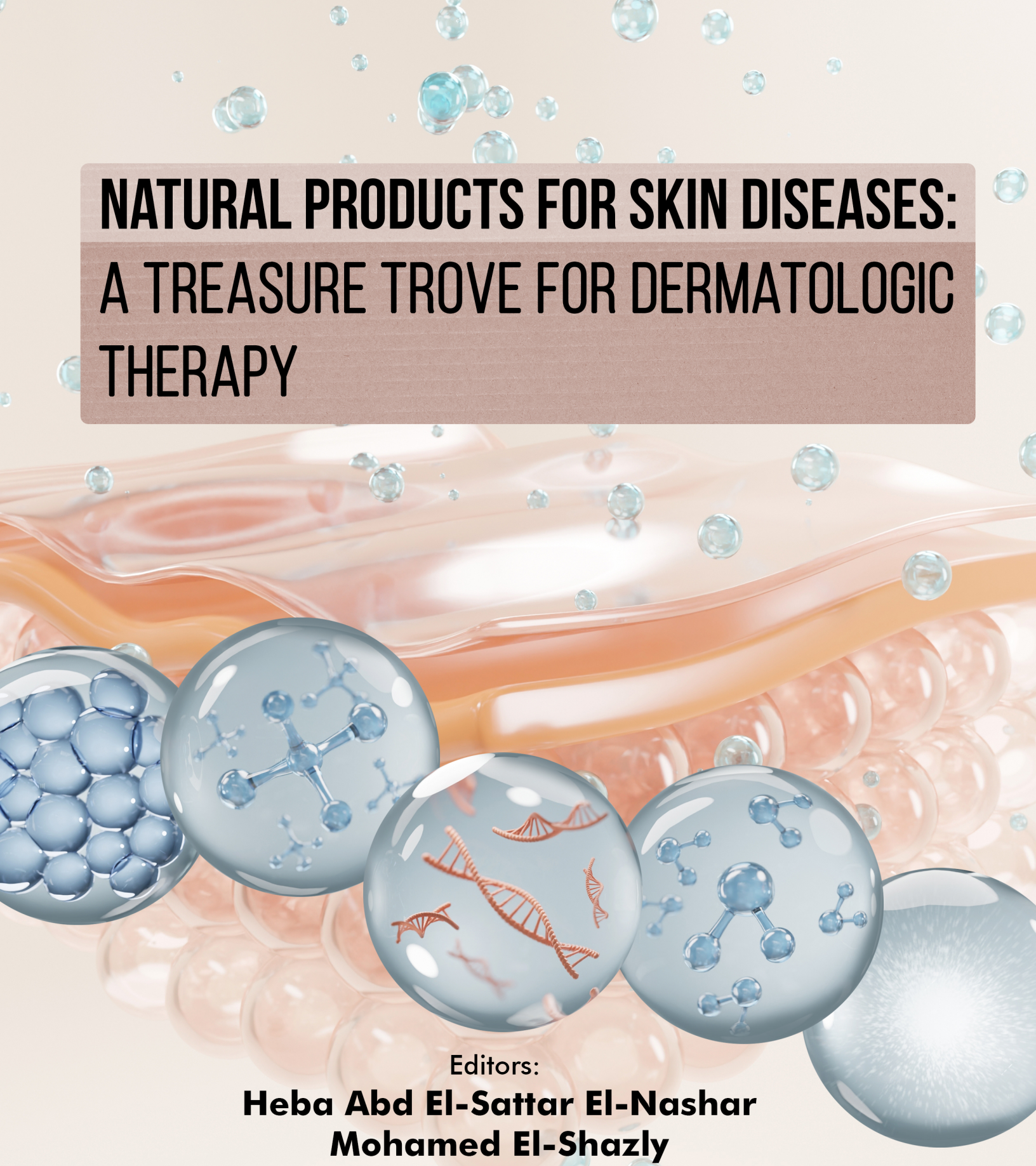
NATURAL PRODUCTS FOR SKIN DISEASES: A TREASURE TROVE FOR DERMATOLOGIC THERAPY



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FOREWORD

In a world where modern medicine continues to advance at an unprecedented pace, it is easy to overlook the timeless wisdom that nature has to offer. Plants, with their vast array of bioactive compounds, have been used for centuries by various cultures to address a myriad of health issues. Among their many applications, the treatment of skin diseases stands out as an area where these botanical wonders have consistently proven their efficacy.

In this comprehensive volume, we embark on a journey to explore the remarkable potential of plants in treating skin diseases. Assembled within these pages are the collective efforts of esteemed researchers, each contributing their expertise to shed light on different facets of this fascinating subject.

Chapter 1 opens our exploration, focusing on the essential topic of protecting our skin from harmful radiation. The authors guide us through the ways in which natural compounds can act as a shield against the damaging effects of the sun and other environmental factors.

Moving on, Chapter 2 delves into the challenging domain of burns, presenting insights into the potential of natural products to address these complex cases. By unraveling the secrets of traditional remedies, the authors offer a fresh perspective on tackling this persistent medical concern.

Chapter 3 takes us on a historical journey through the treatment of wounds, revealing the enduring efficacy of natural remedies. In a world increasingly reliant on synthetic pharmaceuticals, this chapter serves as a reminder of the healing potential rooted in our botanical heritage.

The significance of skin pigmentary anomalies cannot be understated, and Chapter 4 addresses this crucial aspect of skin health. The authors examine the role of natural products in managing these conditions, providing valuable insights for both practitioners and those seeking effective solutions.

In Chapter 5, we encounter the age-old challenge of scabies, and the authors explore how herbal medicines have historically been employed to alleviate this distressing skin condition.

The pursuit of beauty and self-care is a timeless endeavor, and Chapter 6 takes us into the world of natural cosmetics. With a focus on future applications, this chapter highlights the potential of botanicals in transforming the skincare industry.

Chapters 7 and 8 push the boundaries of innovation, exploring the realm of nanoparticle skin delivery and smart drug delivery systems for natural products. As technology continues to advance, these chapters present a glimpse into the promising possibilities that lie ahead.

As we journey through these chapters, it becomes evident that the study of plants in the context of skin health is both rich and dynamic. The contributors to this book have poured their knowledge and passion into their respective fields, resulting in a collective work that is both enlightening and inspiring.

It is with great pleasure that we present this book, hoping that it will serve as a valuable resource for researchers, healthcare professionals, and all those seeking to harness the healing power of nature for the benefit of healthy skin.

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PREFACE

Mother Nature has always been the treasure trove for biologically active compounds that helped humanity to survive and thrive. Medicinal plants have played a major role in the development of human civilizations. Since antiquity, humans have been searching for natural sources to cure diseases, and found their target in medicinal plants. The Egyptian, Greek, Indian, Chinese, and Aztec civilizations relied heavily on the use of medicinal plants to cure human and animal ailments. Medicinal plants have been used to treat all types of disorders, including cardiovascular, digestive, skin and kidney disorders. Skin disorders differ from other disorders by being external, can be detected by the naked eye, medicinal plant extracts can be easily applied to the disorders, and the healing effect can be easily tracked. Skin is the largest organ in the human body and the first line of defense against traumas, infections and radiation. Skin is a dynamic organ with millions of cells dying and regenerating regularly. It is affected by a plethora of disorders and should be treated to avoid the spread of invasion to internal organs.

Medicinal plants have been used to treat skin disorders and to improve skin condition. They have also been used in cosmetic preparations to remove wrinkles, black spots and provide a radiant appearance. In the current book, we take the reader on an enjoyable journey of medicinal plants treating skin-related disorders. The first chapter reveals "How to protect skin from harmful solar radiation." Pathologically solar radiation having UVA (320–400 nm) and UVB (290–320 nm) wavelengths may lead to serious hazards, especially to the skin. On one side, sunlight is essential for Vit D creation but on the other side, continuous exposure to it may lead to risk from sunburn to skin cancer. UV radiation can produce harmful compounds called free radicals or reactive oxygen species or ROS, which leads to skin cancer and premature aging. Traditionally herbal formulations and herbal extracts have been used as a sunscreen for photoprotection for a long time and are considered more vigorous compared to allopathic topical preparations due to their complex composition and high sun protection factor or SPF value. Vitamins C and E and flavonoids herbs not only show antioxidant properties but also indicate a strong potential against adverse skin reactions ensuing UV exposure. The second chapter clarifies "Natural products and burns: A tough case to crack". Burns are a type of skin injury that occurs due to close contact with a heat source or corrosive chemicals. The use of natural products to treat burns dates back to ancient civilizations. In this chapter, naturally derived products from plants, animals and fungal sources are discussed. The extraction and preparation methods, burn healing mechanisms, clinical studies, and pharmaceutical formulation are covered. The third chapter discusses "Wound healing". Wound healing is quite a complicated process in the human body, consisting of the action of constricting injured blood vessels, activating the immune system, angiogenesis, remodeling, *etc*. Under intensive mechanical stress, a fibrotic scar, which is unfavorable with respect to the beauty of the skin, can be formed to patch the wound. Moreover, chronic wounds due to the disruption in wound healing is another clinical problem for patients with diabetes or vascular diseases. Of note is that natural remedies, especially natural products, are demonstrated to be able to elicit certain positive effects on many aspects of wound healing. The fourth chapter discusses "The role of natural products in the management of pigmentary anomalies". The skin is one of the most important organs of the human body. Dermatological ailments and pathologies are of importance for public health because, since to represent physical damages, they manifest emotional and psychological repercussions, which sometimes present higher costs than the former. Some of the most important pathologies are eczema, psoriasis, acne, rosacea, vitiligo, pyoderma, scabies, tinea capitis, dermatitis, reactions of poisonous insect or reptile bites hives, pigmentary anomalies, and injuries such as burns and scars. These skin and subcutaneous disorders were the 4th leading cause of nonfatal

disease burden worldwide in 2010 and 2013, emphasizing the role of dermatology in the ever-expanding field of global health. The fifth chapter deals with "Treatment of scabies with herbal medicines". Scabies has been acknowledged as a neglected tropical disease by the world health organization. Scabies is the most stereotypically occurring skin disease in developing countries, greatly contributing to mortality and morbidity worldwide. More than 0.3 billion of the global population is getting affected with a high prevalence rate in tropical countries that have poor resources. Skin is the largest organ of the body which acts as the instinctive fencing between external and internal conditions playing a significant role in some crucial biological processes like protecting from chemical and mechanical injuries. Scabies also cause a wide range of skin ailments such as abscesses, impetigo, and cellulitis, consequently leading to critical abnormal conditions like rheumatic heart disease, septicemia, and kidney disease. The sixth chapter summarizes "Back to the Roots: Natural cosmetics and their future applications". Numerous concerns have been raised on the side effects of the prolonged usage of synthetic compounds in cosmetics production, including skin damage due to inflammations, rashes, and itching, just to mention a few. These skin side effects have been reported to be linked to the breakdown of homeostasis of the repair system against deoxyribonucleic acid (DNA) and tissue destruction and these can lead to accelerated aging, melanogenesis, cell senescence or even cancer of the skin. Efforts to overcome these problems associated with synthetic cosmetics have led to the use of natural cosmetics of plant and animal origin. The seventh chapter discusses "Natural products and nanoparticle skin delivery". The use of synthetic products is usually associated with side effects, while natural products are also not completely without demerits, including poor solubility and/or stability. The application of nanoparticles is cutting across all human endeavors, with product development not being an exception. Skin disease treatment is one aspect of medicine that is as distinct as it usually involves topical application, and eventual absorption onto the skin surface. The use of nanoparticles has proven to be an effective way to solve the problems associated with the use of natural products in skin care and treatment. The eighth chapter deals with "Smart drug delivery systems for the topical administration of natural products". The effectiveness of natural products in the treatment and prevention of human diseases has been widely demonstrated by the world scientific community. The skin is often subject to the onset of pathologies induced by chemical or physical insults, such as the collateral effects of certain drugs, tumors, or photo-induced damage. The current treatments of skin diseases are focused, in most cases, on the systemic or oral administration of the drugs, since the classic topical administration does not allow it to reach the pharmacological objectives.

We covered in this book a wide array of skin disorders and how to treat them using medicinal plants. We included researchers from different countries to discuss their experience in using medicinal plants for the treatment of skin disorders. This book will guide researchers all over the world to understand the value of medicinal plants in treating skin disorders and how to move forward in their research.

ACKNOWLEDGEMENTS

The authors would like to express their deep appreciation for the professional assistance of the assistant editors and the publishing house. We are also grateful to our families for their

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Dedication

To

THE SOUL OF MY FATHER,

Who taught me to trust in ALLAH,

encouraged me to believe in myself

MY MOTHER,

A strong woman whose loving spirit always sustains me.

&

MY HUSBAND AND MY LITTLE ANGLE LAYLA

A constant source of love, concern, support, strength, never-ending motivation, and patience.

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CHAPTER 1

How to Protect Your Skin from Harmful Radiation

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Abstract: Our interaction with the sun is still equivocal, to say the least. We like its soothing influence on the body and soul, but we are afraid of its highly hazardous heating ability and the long-term skin damage that can emerge from chronic sun exposure. Scientists are consistently seeking to enhance sunblock products in accordance with a need for better skin protection from the sun. Once human skin is exposed to solar ultraviolet radiation (UVR), the synthesis of reactive oxygen species (ROS) skyrockets. The influx of ROS leads to oxidative stress by mutating the natural equilibrium toward a pro-oxidative state. Alteration in proteins and lipids, stimulation of inflammation, immunodeficiency, DNA damage, and activation of signaling pathways that influence gene transcription, cell cycle, proliferation, and apoptosis are all illustrations of the detrimental effects of oxidative stress. This chapter provides new insight into several Phyto-products having an antioxidant activity to suppress the UV rays impact, the relationship between UVR-aging, current understanding of the regulation of constitutive human skin pigmentation and responses to UV radiation, with emphasis on physiological factors that influence those processes.

Keywords: UV rays, Skin, pigmentation, Microbial Products, Plant Extracts, Aging.

INTRODUCTION

The skin is the body's largest organ and works as the body primary line of protection against external problems, such as UV rays, toxic compounds, traumas, oxidative stress, and pathogens [1]. Keratinocytes are the epidermis main cellular component, but it also comprises melanocytes, Merkel cells, gamma delta T-lym-

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phocytes, and Langerhans cells. Keratinocytes in the epidermis's basal layer retain their potential to proliferate, establishing the spinous and granular layers. Keratinocytes terminally differentiate into corneocytes, leaving the granular layer. Corneocytes (compact keratinocytes without nuclei) and the intercellular lamellar compartment (lipids) contribute to the construction and function of the stratum corneum in the epidermis's outer layer (SC) [2]. Ultraviolet (UV) radiation is regarded as a complete carcinogen and one of the most prevalent oncogenic exposures for humans. Several physiological changes occur after exposure of skin to UV rays, like skin pigmentation, upregulation of free radicals, skin cancer, and skin aging [3]. Natural ingredients are endless sources of antioxidants that have been used as alternative remedies by people since the beginning of humanity [4].

The international cosmetics market is expected to reach $429.8 billion in profits by 2022, with a compound annual rate of 4.3% to 2022. (Research and Markets). America, Europe, and Asia–Pacific are the three largest worldwide cosmetics sectors. India is an emerging marketplace for a diversity of cosmetic products in Asia–Pacific, and it has developed swiftly in recent years. Due to globalization and industrialization, solar radiations affect skin tones, that's why the main target of the population is to preserve the skin nature from damage *via* the application of cosmetics. Cosmetics are the chemical derived from natural sources (microbial as well as Phyto-products) that can regain the nature of skin by targeting various metabolic pathways like inhibiting ROS formation, modulating the expression of oxidative stress-responsive enzymes such as heme oxygenase-1 (HO-1), activating the Nrf2/HO-1 antioxidant pathway, upregulating antioxidative enzymes superoxide dismutase 2 (SOD2), catalase (CAT) and glutathione peroxidase 1 (GPX1), boosting of xanthine oxidase (XO), reducing nicotinamide adenine dinucleotide phosphate (NADPH) oxidase (Nox), inhibiting interleukin-1β (IL-1β), interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α), nuclear factor-kappa B (NF-κB), stimulating the DNA Repair process and promoting immune response [5].

This chapter provides new insights into the molecular defense mechanism of skin against UV rays, types of UV rays, UV rays as a biological evolution in the skin, types of natural products used in skin photoprotection, and the relationship between skin pigmentation *vs*. UV rays.

DETRIMENTAL EFFECT OF UV RAYS ON HUMAN SKIN

Ultraviolet rays, a type of electromagnetic radiation, contain high-energy packet photons, coming from different sources, including sunlight, sunlamps, and sunbeds, into an atmosphere that a living community utilizes for survival. When ultraviolet (UV) radiation engages with the human body, it has multiple health

benefits, including the synthesis of vitamin D3 and the potential for UV photons to be employed in treatments for skin ailments [6]. The electromagnetic spectrum of UV light coming from the sun has three characteristic regions, each specifies by a distinct wavelength range, as shown in Table **1**. UVC radiation is the shorter wavelength area of the UV spectrum, UVB is the medium wavelength zone, and UVA is further divided into UVA1 and UV2, having lower frequency waves. The ozone layer in the stratosphere serves as a buffer against destructive radiation. Due to the ozone layer's high transparency, only a small quantity of UVB radiation affects the earth's biosphere. Human activities on either side have eroded the ozone layer, enabling a considerable portion of UVB radiation to reach the stratosphere [7].

Table 1. Classification and spectrum of Ultraviolet radiation.

Categories	Wavelength (nm)	Nature of Wavelength	Absorption by the Ozone Layer	References
UVA1	315-340nm	Longer wavelength	0%	[8]
UVA2	340-400nm	-	0%	[7]
UVB	280-315nm	Medium wavelength	95%	[9]
UVC	200-280nm	Shorter wavelength	100%	

UV radiation can cause disorders such as skin cancer, eye cancer, immunosuppression, immunotoxicity and genotoxicity [10]. There is a positive correlation between the penetration depth and the damage intensity. UV radiation mainly causes damage to human skin because, in skin layers, many biomolecules are absorbed in the UV range, and UV rays have a limit on transmission. It is shown in Table **2** that muscles, bones and internal organs are least to be affected by UV radiation, as these are lying at a distance greater than the penetration range of UVR. Human skin is a remarkable physical barrier and plays an important role in protection, providing a large absorbing surface area for UV exposure. Due to the shorter wavelength and high frequency, UVA gets penetrated deep into the dermis and epidermis, which induces tanning effects by darkening the melanin functional components of human skin [9]. UVA also significantly participates in the premature photoaging of the skin cells by destroying the biological structure in the corium.

UV-Induced Damaging Mechanisms

During transmission of light rays through skin layers, two specific types of cellular molecules, namely photosensitizers and, chromophores, absorb UV electromagnetic radiation, which exerts numerous biological effects like unstable the concentration of reactive oxygen species. The absorption of UV light by these

CHAPTER 2

Natural Products and Burns: A Tough Case to Crack

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Abstract: Burns are a type of skin injury that occurs due to close contact with a heat source or corrosive chemicals. The use of natural products to treat burns dates back to ancient civilizations. This chapter discusses naturally derived products from plants, animals and fungi sources. The natural origin, chemical composition, burn healing mechanisms, clinical studies, and used pharmaceutical formulation are also covered.

Keywords: *Aloe vera*, *Areca catechu*, *Arnebia euchroma*, Berberis, *Boswellia carterii*, Burns, *Centella asiatica*, *Cinnamomum camphora*, Healing mechanism, Honey, *Hypercium perforaturm*, *Lawsonia inermis*, *Malva sylvestris*, *Melaleuca alternifolia*, *Myrtus communis*, *Olea europaea*, *Plantago major*, Propolis, Sacchachitin, *Sesamum indicum*.

INTRODUCTION

According to recent reports from the American Burn Association (ABA), more than 400,000 United States (US) residents have suffered from burn injuries, and require medical treatment annually [1]. Around 70% of burns occur at home, and children are more exposed to burns than adults [1]. Similarly, the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) disclosed that the mortality rate associated with burns is around 10,000 deaths per year in the US, mainly due to burn-related infections [2, 3]. Unfortunately, higher rates were documented in low- and middle-income countries [2, 3], which shed light on the need for proper awareness, prevention, diagnosis and treatment approaches.

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The World Health Organization (WHO) defines burns as an injury to the skin or other organic tissue primarily caused by heat or due to radiation, radioactivity, electricity, friction or contact with chemicals. Thermal (heat) burns occur when some or all of the cells in the skin or other tissues are destroyed by hot liquids (scalds), hot solids (contact burns), or flames (flame burns) [2]. Burn classifications are usually subcategorized based on many classification systems such as skin integrity and depth of injury using the old system (*i.e.*, degrees) or new (*i.e.*, partial *vs*. full-thickness injuries) [4, 5]. Factors that aggravate burn injuries include the temperature of the causative agent, exposure duration, number of involved skin layers (*e.g.*, epidermis and dermis) and blood supply to the injured area [5]. Fig. (**1**) summarizes the burn classifications based on the old and new systems. Unfortunately, it is not always easy to determine the depth of burn during the first incidence period (*e.g.*, the first 48 to 72 hours). The tolerance for heat on different body surface areas is not the same, *i.e.*, the tolerance of heat on the palms of the hands, soles of the feet, and back can bear high temperatures for a long time, as compared to the eyelids [5]. The skin of children and the elderly is thinner than adults, and less tolerable to injuries [4].

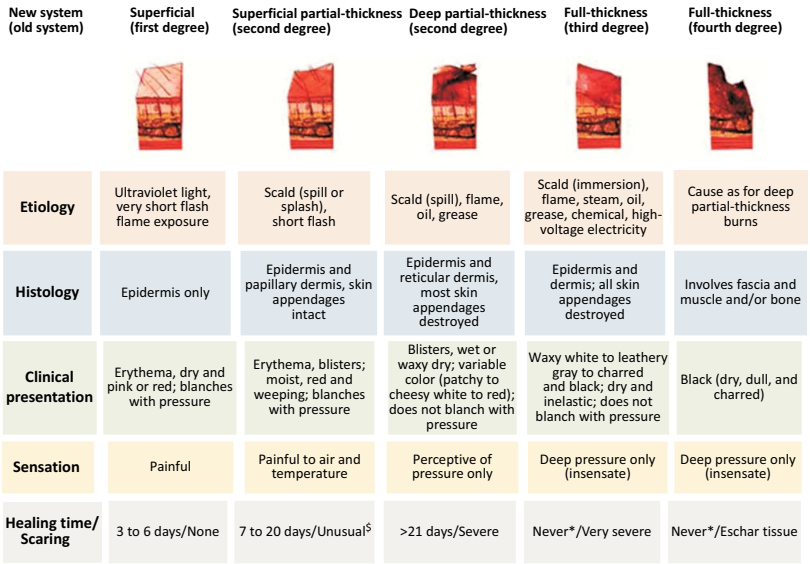

Fig. (1). Classifications of burns based on the wound-depth using the old and new systems. This figure has been adapted from Abazari *et al*. [4] (***Note***: *No spontaneous healing. $Potential pigmentary changes, moist, elastic. Eschar tissue (hard and inelastic)).

Accordingly, a different classification system was released by the American Burn Association (ABA) based on severity, which subcategories the burns into three types (minor, moderate, and major). This system depends on the degree of injury, which is presented as a percentage of the total body surface area (%TBSA)

involved in the burn [5], considering the patients' age and complications. However, superficial (first-degree) burns are not included in the percentage TBSA burn assessment. The ABA clarified that the most common method to estimate the second and more profound degrees of burn is by using the "Rule of Nines." As demonstrated in Fig. (**2**), the adults' distinct anatomic regions represent approximately 9% or a multiple thereof of the TBSA. While, in the infant or child, the "Rule" deviates because of the large surface area of the child's head and the smaller surface area of the lower extremities [5, 6]. Finally, the classification of burns is pivotal for the appropriate management of the burns, the required time for healing, and the anticipation of consequences such as infections [6, 7].

Burn Healing Mechanism

The healing process of skin burns can primarily go through four stages that involve coagulation which resembles the homeostasis phase, followed by the inflammatory process that is led by mononuclear cell infiltration, and then cellular proliferation that would be in the form of tissue epithelialization, fibroplasia, angiogenesis, and granulation tissue formation [8]. The final phase would be the scar formation or collagen protein deposits at the burned site [8].

Immediately after a burn occurs, the infiltration of dendritic cells, which are considered a major part of innate and antigen-specific immunity, would occur to support the process of burn healing *via* protecting the wound from being infected and promoting cellular proliferation [9]. This process includes the activation of keratinocytes, fibroblasts, and endothelial cell proliferation that will mediate new skin formation *via* re-epithelialization, collagen secretion to constitute a new extracellular matrix, and new blood vessel formation, *i.e.*, angiogenesis, respectively [9]. In a murine burn model, dendritic cells played a significant role in transforming growth factor β (TGF-β) to release early following a burn injury to support cell proliferation [9].

Historical Treatments of Burns

The earliest descriptions of burn injuries and treatments were found in cave drawings [10], but the entire knowledge of burn treatments comes from the old medicine of the Egyptians, Greeks, Romans, and other peoples of Asia, which is limited but applicable [11].

Before 2500 BC, burns were treated with the milk of mothers who had given birth. Writing inventions enabled ancient Egyptian doctors to write their observations down on papyrus scrolls [11, 12]. Treatment recommendations were found in ancient Egyptian writings, known as the Smith and Ebers papyri, dating to about 1500 BC [10, 12]. One of the oldest burn treatment records was

CHAPTER 3

Wounds and Natural Remedies: A Long Way of Effective Treatment

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Abstract: Wound healing is quite a complicated process in the human body, consisting of the action of constricting injured blood vessels, activating the immune system, angiogenesis, remodeling, *etc*. Under intensive mechanical stress, a fibrotic scar, which is unfavorable with respect to the beauty of the skin, can be formed to patch the wound. Moreover, chronic wounds due to the disruption in wound healing are another clinical problem for patients with diabetes or vascular diseases. Of note is that natural remedies, especially natural products, are demonstrated to elicit certain positive effects on many aspects of wound healing. In this chapter, global mechanisms, the role of natural remedies and newly emerging therapeutic targets regarding wound healing are presented, and the remaining hurdle for the natural product-based treatment in wound healing is also introduced.

Keywords: Non-coding RNAs, Diabetes, Fibrotic scar, Natural products, Skin, Wound healing.

INTRODUCTION

Skin is the first barrier protecting mammals from a wide array of external detrimental factors, such as bacteria and toxins. However, skin is susceptible to trauma, which impairs its protective effect and makes mammals vulnerable to environmental toxins. Therefore, maintaining the integrity of the skin is quite important. Generally, wound healing, which is a spontaneous self-repairing process, is initiated after wounding to restore the integrity of the injured skin without creating any "marks" on skin surface, while under certain stressful circumstances, a fibrotic scar is formed in a short period to patch the wound and thereby maintain the skin integrity. Just as every coin has two sides, the fibrotic scar is unfavorable for the beauty of the skin, and therefore elimination of skin

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scars caused by mechanical stress, especially those induced by physical surgeries, has always been the attention-attracting research field [1].

To successfully complete skin wound healing, a quite complicated process comprising hemostasis, inflammation, angiogenesis, re-epithelialization, and remodeling is implemented through synchronizing various cell types with different roles (Fig. **1**). Disrupting any section of the wound healing process will lead to delayed wounding healing or chronic wounds. For example, for patients with other chronic diseases, such as diabetes, ectopic expression of some cytokines due to the nature of the disease in cells participating in wound healing evidently suppresses wound healing and makes it quite an intricate process [2].

Natural remedies, including therapies based on herbal medicines and natural products, have been used for the treatment of human ailments for generations. For the treatment of wound healing, some traditional natural therapies, such as honey, especially stingless bee honey [3], have been adopted since ancient times. Meanwhile, modern scientific studies have demonstrated that a variety of natural products also have positive effects on wound healing. For example, curcumin is proven to be able to enhance granulation tissue formation, collagen deposition, tissue remodeling, *etc.* [4]. Therefore, in this chapter, the mechanism of wound healing and the role of natural remedies in every phase of wound healing are presented. Moreover, the newly-emerging therapeutic targets and hurdles for natural products becoming an effective treatment for wound healing are also discussed.

THE MECHANISM OF WOUNDING HEALING: A COMPLICATED AND SYNERGETIC PROCESS

Once the wound is inflicted, hemostasis is initiated in the first place by contracting the injured blood vessels and forming a fibrin clot. Briefly, in the hemostasis phase, vasoconstrictors are released by injured cells to contract the smooth muscle and thereby provisionally suppress bleeding. However, the contracture of the smooth muscle itself is not sufficient enough for the complete stoppage of bleeding under most circumstances, and thereby the formation of a thrombus is crucial for hemostasis. Generally, the subendothelial matrix is exposed due to the rupture of blood vessels, triggering the initiation of thrombus formation. Platelets, whose aggregation and anti-thrombotic agents like nitric oxide inhibit attachment to the endothelial lining under normal circumstance, can either bind to the subendothelial matrix or aggregate through G protein-coupled receptors, integrins and glycoproteins. Meanwhile, platelets produce von Willebrand factor (vWF) that can also bind to the subendothelial matrix, and platelets can also bind to the vWF attached to the subendothelial matrix through

their surface receptors to form a structurally heightened complex on the subendothelial matrix. In addition, blood coagulation Factor X, which is a vitamin K-dependent serine protease that plays an essential role in blood clotting, can be activated and lead to the cleavage of fibrinogen to fibrin, and the cross-linked fibrin can capture platelets aggregated to each other to form a thrombus. All these aforementioned processes collectively induce a complete stoppage of bleeding.

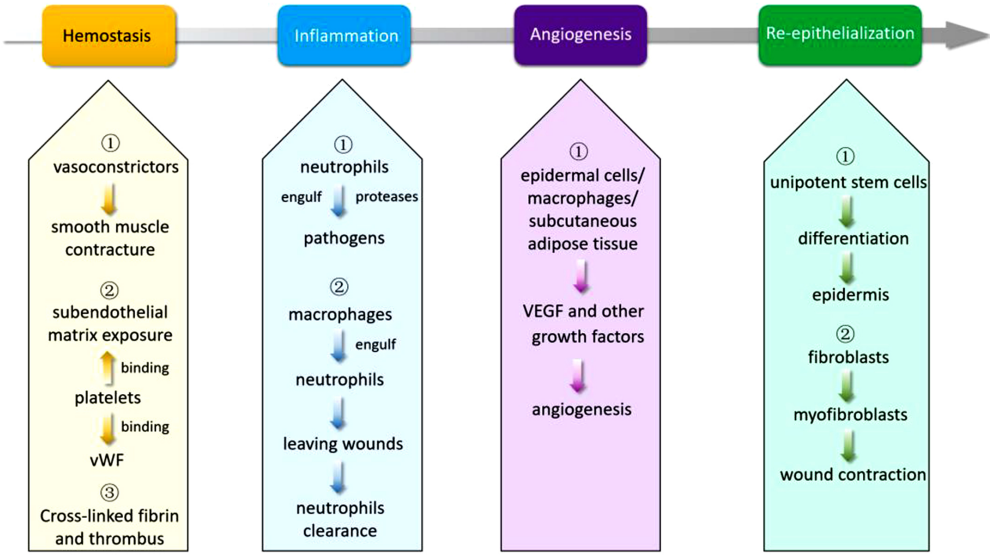

Fig. (1). Key stages of wounding healing regarding the closure of acute and/or chronic wounds.

Inflammation is another crucial phase of wound healing. Inflammatory cells, especially neutrophils, can be recruited to the wound due to a set of factors produced by resident cells instantaneously after the moment when the wound occurs, including calcium waves, hydrogen, lipid mediators, *etc*. The recruited neutrophils at the wound site can prevent the invasion of pathogens by releasing proteases, producing neutrophil extracellular traps, and forming a phagocytic cup that can engulf antigens. Meanwhile, in the phase of inflammation, macrophages can produce pro-inflammatory factors, such as IL-6, IL-1β, and TNF-α, to combat infection. However, on the contrary, a prolonged phase of inflammation is detrimental to wound healing, such as the uncontrolled cutaneous neutrophilic inflammation in pyoderma gangrenosum [5]. Thus, clearance of neutrophils is also important for wound healing. To achieve the resolution of inflammation, neutrophils can either be engulfed by macrophages through efferocytosis or leave the wound through the reverse-migration process.

CHAPTER 4

The Role of Natural Products in the Management of Skin Pigmentary Anomalies

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Abstract: The skin is one of the most important organs of the human body. Dermatological ailments and pathologies are important for public health because they cause physical damage and emotional and psychological repercussions that sometimes present high healthcare expenses. Some of the most common pathologies are eczema, psoriasis, acne, rosacea, pyoderma, scabies, tinea capitis, dermatitis, reactions of poisonous insect or reptile bites hives, pigmentary anomalies such as vitiligo, albinism, tinea versicolor, melasma, acanthosis nigricans, and café au Lait spots, such others, can cause serious damage to health, for which extensive pharmacological treatments have been proposed; however, they have serious side effects such as steroid treatments, so in certain regions of the world, medicinal plants are used to treat dermatological complications, where ethnopharmacological records date to treat or aid skin conditions, mainly burns and scars. These effects are due to their anti-inflammatory, healing, antimicrobial, and antioxidant properties, where the compounds most studied have been phenolic (flavonoids such as phloretin), vitamins, and essential oils (terpenes). Some species that stand out are the genera *Dendrobium, Aloe, Acalypha, Acanthus, Achillea, Actinidia, Calendula, Bulbine, Heparinum, Sanguisorba*, and *Buddleja*, among others. This chapter summarizes the most recent information regarding the potential of natural products as biopharmaceutical agents against some of the most evaluated skin pigmentary anomalies.

Keywords: Alkaloids, Antioxidant, Botanicals, Cosmetic, Cosmeceuticals, Dermatology, Ethnopharmacology, Flavonoids, Melanogenesis, Natural Products, Phototherapeutic, Phytochemistry, Phytomedicine, Pigmentary Anomalies, Secondary Metabolites, Skin Care, Skin Diseases, Terpenes, Topical.

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INTRODUCTION

The skin is one of the most important organs of the human body; it protects from damage and covers the internal organs, muscles, and bones. It is made up of several layers, such as the epidermis, dermis, and subcutaneous tissue. In turn, these are made up of numerous glands and strata, where the *Stratum corneum* stands out, responsible for receiving the first contact with irritants, organisms, and toxic products [1]. Pigmentation is due to the mixture of melanin (quantity and distribution), oxyhemoglobin, and carotene [2, 3].

The skin can suffer pathologies and alterations, causing serious damage to health; these can be due to genetic defects, chronic degenerative pathologies, inflammation, infections, reactions to medications, exposure to toxic products, poisonous animal bites, and light UV. Some of the most frequent conditions in clinical practice are vitiligo, ichthyosis, psoriasis, impetigo, atopic dermatitis, freckle, contact dermatitis, pityriasis alba, tinea versicolor, melasma, cutaneous lupus erythematosus, urticaria, granuloma annulare, hematomas, cold panniculitis, and acne. In addition, pigmentation-related conditions are divided into hyperpigmentation which is the increase in melanin production and the number of melanocytes; and hypopigmentation, related to the reduction in skin pigmentation and mixed conditions [1, 3 - 5]. The most common conditions/disorders are shown in Table **1**.

Table 1. Pigmentation disorders and conditions [1, 2, 4, 6].

Disorder/Condition	Pathogenesis/Causes	Characteristics	Pharmacological Treatment and Therapy
Melasma	Pregnancy (stimulates melanocytes), use birth control pills, phenytonin, hepatic disease, endocrine disorders	Acquired condition, characterized by changes in the pigmentation of the face and arms, mainly in pregnant women, with well-demarcated patches.	Bleaching cream with a hydroquinone, tretinoin, azelic acid, kogic acid, licorice extract, pulsed light, sunscreens (SPF< 30).
Vitiligo	Selective destruction of melanocytes	Vitiligo is acquired during a person's life, making it a psychologically depleting condition. This is characterized by completely losing skin pigmentation, the lesions are characterized by well-demarcated depigmented macules and patches, which occur mainly around the feet, hands, elbows, eyes, and genitals.	Psoralens, UVA-UVB light, monobenzone, camouflage cosmetics, sunscreens, potent steroids.

(Table 1) cont.....

Disorder/Condition	Pathogenesis/Causes	Characteristics	Pharmacological Treatment and Therapy
Albinism/piebaldism	Autosomal recessive condition in which reduced melanization and number of melanosomes	It is a congenital disorder of the hypopigmentation type, which manifests in the hair, skin, and eyes. On the other hand, piebaldism is partial albinism characterized by presenting a white forelock and a circumscribed congenital leukoderma. The lesions appear as a triangular patch of depigmentation and white hair on the frontal scalp, they can manifest other macular ones on the extremities, flanks, face, and neck.	Sunscreens use, and strict sun avoidance from childhood.
Acanthosis nigricans	Related to obesity and endocrine disorders	Hyperpigmentation disorder manifests as marked lines on the skin's surface, with a leathery and warty appearance. Four forms of manifestation have been identified, the benign one that is related to hyperinsulinemia or insulin resistance, the hereditary, endocrine-associated acanthosis nigrans, and the malignancy-related one.	Hypoglycemic drugs, contraceptives, glucocorticoids.
Café-au-lait	Unclear, associated with neurofibromatosis	It manifests in the form of macules, which can be related to neurofibromatosis type 1, McCune-Albright syndrome, polyostotic fibrous dysplasia, endocrinopathy, hyperthyroidism, and precocious puberty.	Copper vapor laser, frequency-doubled 1064-nm neodymium-doped yttrium aluminum garnet, Q-switched ruby laser, Q-switched alexandrite laser, erbium-doped YAG, and pulsed-dye laser.

These conditions are normally characterized by presenting skin lesions, changes in tonality, and hyper or hypopigmentation, and may or may not be accompanied by the presence of other chronic degenerative pathologies, such as diabetes in the case of acanthosis nigricans, which represents greater harm to the patient, also represents emotional damage, lowering self-esteem [5]. In Table **1**, we summarize the most common skin pigmentary anomalies and their conventional pharmaceutical treatment.

CHAPTER 5

Treatment of Scabies with Herbal Medicines

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Abstract: Scabies is a chronic and serious community disorder caused by a parasite commonly known as a mite *(Sarcoptes scabiei var hominis*). The long-term infection may lead to chronic complications such as septicemia, acute post-streptococcal glomerulonephritis, heart disease, and secondary infections. The majority of novel medicinal agents from various plant sources are responsible for the management and treatment of several types of chronic disorders. The safe and cost-effective alternative treatment strategy is the use of medicinal plants that plays a potential role against a variety of diseases due to the presence of numerous types of active phytochemicals with no or negligible adverse effect. This study gives a unique summary, including a correlation between traditional medicinal plants and their derived active phytochemicals for the significant treatment of scabies. The literature search was carried out *via* search engines through different databases, including Google Scholar, PubMed, Medline, ScienceDirect, *etc*. A large number of medicinal plants and their active medicinal agents have been reviewed with remarkable therapeutic effects against scabies. There are some limitations due to insufficient data related to limited pre-clinical and clinical trials in this particular area. This review provides a baseline to explore the therapeutic potential of these medicinal plants against skin diseases, especially scabies. However, extensive studies are required to identify, authenticate, and characterize the bioactive compounds present in these plants, which may lead to value addition in pharmaceutical industries by providing a cost-effective way of treatment with minimal side effects.

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Keywords: Burrows, Clinical Study, Epidemiology, Future Prospective, Herbal Medicines, Mites, Natural Products, Skin diseases, Scabies, *Sarcoptes scabiei var hominis*, Therapeutic Agents, Transmission, World Health Organization.

INTRODUCTION

Human scabies (also known as seven-year itch) is a highly contagious and itchy ectoparasitic skin infestation caused by microscopic scabies mites - *Sarcoptes scabiei var. hominis* and it is a public health concern in all countries, regardless of socioeconomic class [1, 2]. The scabies mite tunnels into the epidermis and lays eggs, provoking an immunological reaction in the host that results in severe itching and a rash. Scabies mites can live for up to two months on a human. Scabies mites rarely live longer than 48-72 hours outside a human. If scabies mites are exposed to a temperature of 50°C (122°F) for 10 minutes, they will die. Scabies infestation can be worsened by bacterial infection, resulting in skin sores that can lead to more serious complications such as septicemia, cardiovascular disease, and chronic renal disease. With respect to the Individual Countries' requests and the Council's suggestions, by the World Health Organization (WHO)- Strategic and Technical Advisory Group (STAG), scabies and other ectoparasites were added to the list of Neglected Tropical Diseases (NTDs) in 2017. In March 2018, the WHO NTDs Worldwide Working Group on Monitoring and Evaluation suggested that a global scabies burden be determined, diagnostic criteria are developed and, interim guidelines for public health interventions be issued (Table **1**) [3, 4].

Table 1. What exactly is scabies?

• Scabies is a skin rash caused by tiny bugs called mites.
• *Sarcoptes scabiei var. hominis* is the parasitic mite that causes human scabies.
• To lay eggs and the mite penetrates the skin.
• Scabies burrows beneath the skin and causes itching & tiny red lumps.
• Physical contact is an easy way for the mites to spread to other people.
• Scabies can also be contracted by touching scabies-infected towels, beds, or clothing.
• The rash is quite itchy to the point of being infuriating.

Scabies Epidemiology

Scabies is among the most frequent dermatological disorders, popular for a large percentage of skin illnesses in underdeveloped nations. It is appraised that it affects greater than 200 million individuals worldwide at any given moment, while additional research is required to quantify the current burden. In current scabies-associated work, prevalence estimates covered from 0.2 percent to 71 percent. Throughout many tropical regions with insufficient resources, scabies is

prevalent, with a 5–10% proportion among youngsters. Scabies infestation and its possible consequences put a significant financial burden on healthcare systems [5]. Cases are infrequent in high-income economies, but outbreaks in health facilities and vulnerable groups cost national health services a lot of money. Scabies is found all over the world. Little youngsters in places with limited resources are among the most exposed to scabies and their related issues. Infestation rates are much higher in hot, tropical countries, especially where there is a high prevalence of overpopulation and poverty and when access to treatment is constrained (Table **2**) [6].

Table 2. Scabies epidemiology.

• At every given time, 2 billion people globally are thought to be affected by scabies.
• Scabies affects 5-10 percent of youngsters in resource-limited regions.
• Scabies can affect people of all ages and socioeconomic backgrounds.
• Scabies is present throughout the world, but it is much more prevalent in warm, tropical nations and densely populated locations.
• Scabies outbreaks are common in places like nursing homes, extended-care facilities, and jails.

Symptoms

The mature female of the scabies mite burrows into the epidermis' top layer, where it lays eggs. In 3–4 days, the eggs hatch, and in 1–2 weeks, the adult mites emerge. After 4–6 weeks, the patient develops an allergic reaction to mite proteins and feces found in the scabies burrow, resulting in severe itching and redness. The majority of people are afflicted with 10–15 mites (Table **3**). Mostly in finger webs, wrists, upper and lower limbs, and waistline region, there is frequently intense itching, linear burrows, as well as vesicles [7, 8].

Table 3. How can you know if you have scabies?

• The itching gets progressively worse over time, especially at night.
• A rash of tiny red lumps that occasionally appear in a line.
• The lumps are most commonly found on the fingers, wrists, and arms, but they can appear anywhere on the body (except on the face of an adult).
• The rash can also appear on the cheeks, scalp (particularly behind the ears), palms of the hands, and soles of the feet in babies.
• The rash may be extremely minor in older people, making it difficult to see.
• Scabies can spread all over a person's body if he or she has HIV.

In infants and young children, a much more widespread rash may cover the palms, soles of the feet, ankles, and occasionally the scalp. Inflammatory scabies nodules can be found on adult males' penis and scrotums, as well as around females' breasts. Burrows could be seen in close contacts who still haven't displayed

CHAPTER 6

Back to the Roots: Natural Cosmetics and their Future Applications

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Abstract: Numerous concerns have been raised on the side effects of the prolonged usage of synthetic compounds in cosmetics production, including skin damage due to inflammations, rashes, and itching, just to mention a few. These skin side effects have been reported to be linked to the break-down of homeostasis of the repair system against deoxyribonucleic acid (DNA) and tissue destruction. These can lead to accelerated aging, melanogenesis, and cell growth senescence or even cause cancer of the skin. Efforts to overcome these problems associated with synthetic cosmetics have led to the use of natural cosmetics of plant and animal origin. Natural cosmetics have been found to contain essential oils and other extracts that can alleviate or inhibit skin-associated problems, such as eczema, allergy, acne, dryness, and discoloration, while also containing anti-aging, anti-tyrosinase, antioxidants, and anti-inflammatory substances. In this chapter, some cosmetics products from plants (herbs) and animal extraction are highlighted alongside their applications in skin care. At the same time, also, the future perspectives and recommendations of these natural extracts are proffered.

Keywords: Cosmetics , Anti-microbials, Antioxidants, Anti-ageing, Collagen, Cosmeceutics, Microalgae, Natural clay, Plant, UV-protection.

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INTRODUCTION

Cosmetics are regarded as any substance or preparation intended to be placed in contact with the various outer parts of the human body or even with the tooth whitening and the mucous membranes of the oral cavity with a view, exclusively or mainly, to clean, perfume, change their appearance and/or correct body odors and/or protect or keep them in good condition. Cleansing shampoos, perfumes, skin moisturizers, whitening creams, hair colors, and other constituent elements meant for use in cosmetic applications are included as cosmetics. By this definition, cosmetics are often used to take care of body parts, but their usage alone does not benefit users [1 - 4]. For more than two decades, the research and development in the cosmetic industry are becoming huge. These have resulted in an extensive range of skincare products that treat signs of aging, inflammation, and other skin disease-related issues. The end-users of these cosmetics are now more oblivious about their appearance, thereby making efforts to accept the new societal paradigm shift, which has led to the present greater demand for natural cosmetics [5]. The recent paradigm shift and growth in the demand for cosmetics of natural component extraction have activated the search for plant extracts containing extraordinary sources of bioactive compounds, as these natural cosmetics have been perceived to be healthy for the skin [6]. This has brought about the development of cosmeceuticals, which combine the esthetical properties of a cosmetic with the efficacy of a dermatological drug [7].

In recent times, natural sources-based cosmetic ingredients are topping the list of newly-launched cosmeceutical products, chiefly due to the end-user acceptance of outstanding efficiency and reduction in side effects as several firms are actively involved in the evaluation of the efficacy of an identified natural product or discovery of a novel molecule from various natural sources [8]. This is in addition to the several reported side effects of synthetic chemicals used in the formulation of synthetic-based cosmetics [9 - 11]. Of the several sources of natural products for cosmetic production, herbs- and marine-algae-derived materials are highly valued ingredients, while animal-derived materials are under stringent monitoring due to animal rights regulations.

Natural ingredients in cosmetics play significant roles such as anti-inflammatory, anti-aging, anti-tumor, antioxidant, *etc.* For instance, *astaxanthin* from *Phaffia rhodozyma, Thraustochytrids,* and *Rhotorula spp.* is an antioxidant, while purified hyaluronic acid from *S. thermophilus* is used for anti-aging [12]. Several plants (herbs) have reportedly been utilized for cosmetics formulations. For example, the natural cosmeceutical potentials (antioxidant, anti-enzymatic, antimicrobial, anti-inflammatory, and photoprotection potential) of *Grateloupia turuturu* were reported [13], while Pipattanamomgkol *et al.* [14] also revealed the hair dyeing

ability of *Cleistocalyx nervosum var. paniala* fruit. The extracted product was incorporated into the stable base of hair coloring spray and was found to be efficiently stained, with persisting ability even after five-cycle washing. Furthermore, the extracts from *Zingiber cassumunar Roxb*. rhizome was also researched for cosmetic potentials by Li *et al.* [15]. The team investigated the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging, HDFa collagen secretion promotion, tyrosinase inhibition, and NO generation inhibition activities of the extract and reported that *Z. cassumunar* possessed remarkable HDFa collagen secretion promotion and tyrosinase inhibition activities. The antioxidant and cytotoxicity of extracts from alfalfa herb and *Medicago sativa L*. were also reported by Zagórska-Dziok and coworkers [16]. A higher inhibitory effect on free radicals existing in the outer environment of the fibroblasts and keratinocytes cells was reported by the team, while a reduction in the intracellular reactive oxygen species (ROS) level was observed, which may have a potential contribution to the reduction of the cellular oxidative stress. More also, the anti-aging, skin-whitening, and antibacterial potentials of *Rosa chinensis* cv. 'JinBian' extracts were evaluated [17]. The study revealed that all the isolated compounds exhibited moderate to remarkable high antioxidant, anti-bacterial, and tyrosinase inhibitory activities, making *R. chinensis* a potential for cosmetic formulation. Additionally, herbal (black) soap made from non-timber forest- (NTFPs) and agro-processing waste products (APWPs), and some value-addition products (VAPs) have been reported [18]. This "black" soap is most widely used by locals in Southwest Nigeria for cosmetics, medicinal and cultural purposes. The herbal (black) soap was produced from saponified freshly-cultivated palm oil (palm kernel oil) mixed with some dried cocoa pods, cassava peels, palm oil bunches and lye. Further analysis revealed that the conductivity ranges from 18,200-47,150 (μS/cm), indicating the extent of dissolved ions in the soap materials, which then permeate into the skin and nourish it when used. Locally, this soap has been used in curing skin diseases such as ringworm, eczema, prosiasi, and wounds, as well as being used as an anti-fibroid drug when formulated with other local materials. Other plants reported for cosmeceutical applications include *Trichilia catigua* [19], *Anthriscus cerefolium,* and *Anthriscus sylvestris* [20], *Achillea biebersteinii* Afan [21], *Achillea millefolium* L [22], *Spirulina*, *Palmaria Palmata*, *Cichorium Intybus*, and *Medicago Sativa* [23] *Thunbergia laurifolia* Lindl [24], *Vitis vinífera* L, *Dirmophandra mollis* Benth, *Ruta graveolens* L, and *Ginkgo biloba* L [25], *Allium fistulosum* [26], Arabica coffee cherry [27], *Aloe vera* (L.) [28 - 30], amongst several others.

The several compounds of terpenoids, phenolics, polyphenolics, vitamins, selenium, polysaccharides, and volatile organic compounds found in several mushroom species (*Lentinula edodes*, *Ganoderma lucidum*, *Sparassis latifolia*, *Grifola frondose*, *Wolfiporia extensa*, just to mention a few, have also been

CHAPTER 7

Natural Products and Nanoparticles in Skin Delivery

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Abstract: Some synthetic drugs are usually associated with side effects, while natural products may be characterized by poor solubility and/or stability. The application of nanoparticles, cutting across all human utilities with drug development is no exception. Skin disease treatment is one aspect of medicine that is so distinct in the sense that treatment usually involves topical application involving eventual absorption onto the skin surface. The use of nanoparticles has proven to be an effective way to solve the issues with the use of natural products in skin care and treatment. This effectiveness has been shown to be due to efficacy in the properties of these natural products, including solubility, stability, permeability, toxicity, side effects, the release of active ingredients-and biocompatibility. This section examines the role of nanosized natural products in treating skin disorders.

Keywords: Skin treatment, Nanoparticles, Nanosized natural products, Skin disorder, Cosmetic dermatology.

INTRODUCTION

In the past, natural products derived from plants and animals were used for decoration and protection of the skin; *Impatiens balsaminal Linn* for the nail, indigo for the eyebrow, *etc*., and some animal oils were used as skin moisturizers [1, 2]. There are both, deficiencies in action and difficulties in applications attached to natural products cosmetics. Chemical ingredients are less safer, contain less metal concentration, and are less affected by environmental factors than natural products cosmetics. Natural product cosmetics are prone to contamination, produce toxic compounds, and experience loss of value. There are no standardized quality control measures for natural products in cosmetics, and the ions, acids and mucopolysaccharides which may be present in natural products, make formulations inaccurate as they break down lotions and creams.

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As a result, it is very essential to consider a clean production process and quality analysis for natural products.

In addition, some skin whitening products have low stability and slow efficacy, and there isthe formation of hazardous compounds due to the nature of the ingredients used whereas, natural products as active ingredients in a whitening agent are safe, mild, long-lasting and highly effective. A drug is composed of both the active ingredient and the vehicle, both of which determine its efficacy. If every other factor is constant, the use of natural materials in the drug delivery to the skin would facilitate product consistency and effective penetration through the skin [3]. The inclusion of natural products in drug formulations can be in a number of semi-solids, such as ointments, rubber plasters, and gel plasters (Fig. **1**).

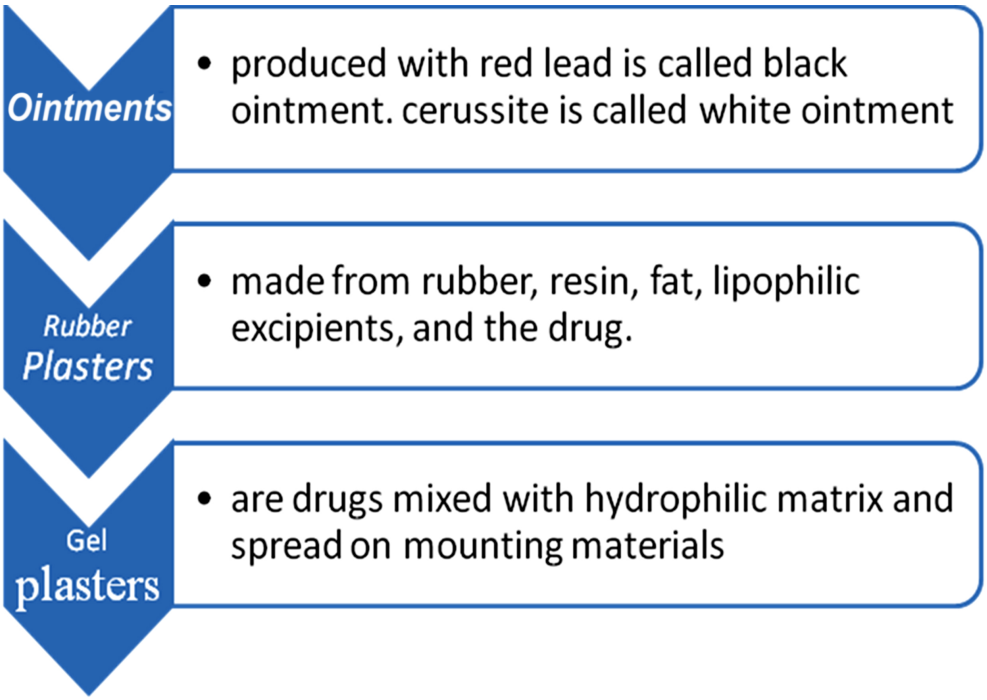

Fig. (1). General compositions of some natural products in transdermal drugs.

Novel Applications in Natural Product Transdermal Delivery

The applications of natural products have been extensively developed to include the development of nanoemulsion, microneedles, lipid nanoparticles, dendrimers and liposomes (a class of delivery vectors). The introduction of novel technology like supercritical fluid extraction, microwave-assisted extraction and ultrasonic

extraction coupled with nanosize drug delivery,has enhanced the persistent solubility and bioavailability issues attached to natural products. The nanoscaled size of the drug has improved the transdermal permeation of active ingredients in the drug compared to the conventional ones. Natural products are considered environmentally sustainable and ecologically friendly. Varieties of cosmetics products are composed of biosynthetic materials, which pose threats to the environment both at the manufacturing and disposal stages. The incorporation of cosmetic formulation agents innaturalproducts has brought a drastic decrease in the tonne of generated waste [4].

Natural products can also be used as potential antibacterial agents when incorporated into wound dressings [3, 5]. Most of these natural products are principal natural ingredients that are extracted from flowers, plants, seeds and roots. However, chemical instability and low bioavailability have been severely hampering the clinical application of most of them. In most cases, they can be easily oxidized, hydrolyzed, and polymerized by light, high temperature, and alkaline conditions due to their structural characteristics. The high polarity directly leads to the difficulty of transmembrane transport, resulting in low bioavailability. To address these problems, new drug delivery systems have been developed to improve the therapeutic efficacies of most lipid-based carriers, such as microemulsions, self-emulsifying systems, nanoparticles, chitosan, and the combination with other drugs, which may have a good application prospect [6].

Significance of Nanomaterials in Research

In recent times, nanotechnologyhas redirected and opened new fonts in major research in this modern society of ours. The classic top-down approach is already being put into extinction by the bottom-up approach from the ongoing miniaturization of processes at the nanoscale. Nanomaterials have found applications in plethoral of fields in science ranging from catalysis, medicine, sensing, and optoelectronics to mention but a few. Currently, the three main areas of development include: building specialized structures whose dimensions are controlled on a nanoscale; nanobiotechnology, *i.e.*, the manipulation of living systems using nanoscale engineering); and nanoelectronics involving the development of microelectronics for devices, such as radio frequency identification (Fig. **2**).

The production of materials at the nanoscale increases both the cost of production and improves the properties therein. In the areas of medicine and pharmaceutical industries, nanotechnological methods are under implementation but in the fields of biomedical and cosmetic fields, the enormous potentials are yet to be fully harnessed [6, 7].

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Heba Abd El-Sattar El-Nashar

Prof. Heba Abd El-Sattar El-Nashar is an assistant professor of pharmacognosy and phytochemistry in the Faculty of pharmacy, Ain Shams University with a general grade of excellent with honor in 2011. She is teaching undergraduate and postgraduate courses of pharmacognosy at Ain Shams University. In 2020, she received her Ph.D. degree in the field of natural products chemistry including isolation, structure elucidation and biological evaluation of secondary metabolites from plants. In addition, she is now working on various research plans in natural product chemistry as well as drug discovery. Her current interest is on 'plant-derived bioactive secondary metabolites.

Mohamed El-Shazly

Prof. Mohamed El-Shazly graduated from the Faculty of Pharmacy, Ain-Shams University, Cairo, Egypt, with a general grade of excellent with honors in 2000. In 2006, he received his master's degree in nanomolecular science from Jacobs University Bremen, Bremen, Germany, and he was offered a position at the same institute to complete his Ph.D. focusing on the synthesis of pharmaceutical intermediates and natural products. In 2009, he received his Ph.D. and went back to Egypt to join the Department of Pharmacognosy, Faculty of Pharmacy, Ain-Shams University. In 2011, he received an offer to work at the Graduate Institute of Natural Products, Kaohsiung Medical University, Kaohsiung, Taiwan. He spent there 2.5 years working as a postdoctoral fellow. In 2015, he was promoted to associate professor at the Department of Pharmacognosy, Faculty of Pharmacy, Ain-Shams University. In March 2021, he was promoted to full professor in pharmacognosy and natural products chemistry.

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Prof. Nouran Mohammed Fahmy graduated from the Faculty of Pharmacy, Ain-Shams University, Cairo, Egypt, with a general grade of excellent with honor in 2011. In 2015, she received her Master's degree and in 2020 she received her Ph.D. in pharmacognosy and chemistry of natural products. Currently, she is working as an assistant professor in the Department of Pharmacognosy, Faculty of Pharmacy, Ain-Shams University. Her research work is focused on isolation and structural elucidation of natural products from natural sources, and determination of their biological activity.