Ingredients of Moisturizers

Subjects: Dermatology | Others

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Moisturizers are one of the most widely used preparations in cosmetics and have been extensively used to soften the skin for consumers. Moisturizers work effectively in combating dry skin which may cause pain, tightness, itch, stinging, and/or tingling. Knowing the characteristics and interactions of active ingredients with the skin will allow for better utilization of available moisturizers.

Keywords: moisturizers ; emollients ; cosmetics ; dry skin

1. Introduction

There is a growing body of literature that recognizes the importance of moisturizers. It is essential for a wide range of fields, such as cosmetics and pharmacy [1]. Moisturizers are very popular dermatological products prescribed due to their proven efficiency to prevent and treat various dermatological conditions [2][3]. The terms “moisturizer” and “emollient” are often used interchangeably despite occlusives and humectants being usually included in moisturizers with the purpose of increasing the water-binding capacity of the stratum corneum (SC) of the skin [4].

Moisturizers are widely used for both normal and dry skin [1]. Application of these preparations can increase the water content in the stratum corneum, hence exerting its most vital action, which is moisturizing action aside from maintaining a normal skin pH, and allowing the lipid bilayers in the skin to more easily normalize and re-establish their capacity to connect corneocytes together and allow for moisture retention in the intercellular spaces [1][5][6]. Subsequently, the hydration interrupts the dry skin cycle, making the skin surface smooth, soft, pliable and more extensible [1][6]. In addition, some other plausible actions exerted by moisturizers include anti-inflammatory action by blocking cyclooxygenase activity, antimitotic action, antipruritic action via downregulation of cytokines, photoprotective action, antimicrobial action and wound healing [6].

Moisturizers are seldom associated with health hazards compared to prescription topical drugs despite being applied on large surface areas of the body for a long duration. To date, few studies have used observational data to indicate that various ingredients with different characteristics are used in the preparation of moisturizers [4]. Therefore, dermatologists should consider characteristics, such as aesthetic beauty, which influence patient adherence, in addition to predicted clinical efficacy. Irritation and allergenicity, which affect safety and tolerability, are also factors to consider when making moisturizer recommendations to prevent unnecessary discomfort [4]. Moisturizers are often associated with a variety of discomforts, such as burning sensations, tightness, stinging and itching. The most common side effect is skin irritation, which is described as subjective sensations or sensory reactions with or without indications of inflammation [2].

2. Ingredients of Moisturizers

Emulsifiers, moisturizing agents, polymer/thickeners, sensory modifiers, and preservatives are among the ingredients used in commercially available moisturizers [7][8]. Humectants, occlusives, and emollients are the three main types of moisturizing ingredients (**Table 1**) [7].

In addition to such ingredients, advanced benefit ingredients including vitamins, antioxidants, lipids, or sunscreens are often included in the formulation of moisturizers [7].

Humectants draw and bind water due to their chemical nature, making them hygroscopic conditioning agents, that will most likely pull water from the deeper epidermis and dermis [7][9]. The presence of several hydroxy (−OH) functionalities allows them to be water-soluble in nature, besides having the capabilities to absorb and retain water in the molecules within the stratum corneum (SC), supplying moisture to the skin tissues and improving skin hydration [7][10]. They also have the ability to draw water from the dermis into the epidermis while also trapping water from the atmosphere.

Humectants, when used without an occlusive agent, will only increase water loss from the injured skin surface in a low humidity environment [11][12][13]. This is because occlusive agents help to slow down the loss of moisture from the skin [13].

Humectants are not easily retained on the skin by wash-off items, such as cleansers even though they are important moisturizing ingredients in leave-on formulas. Despite that, they are still recommended to be used as leave-on products, especially humectants with a prolonged transepidermal water loss (TEWL) impact and the application should be at least twice a day or more based on skin dryness severity [14][15]. Ingredients that exhibit humectant properties are glycerin, lactic acid, panthenol, butylene glycol, propylene glycol, sodium pyrrolidone carboxylic acid (PCA) and urea [16].

Glycerin is the most extensively used humectant found in most moisturizers [5][9][13][17]. The increase in hydration varies from 1% to 25% or more, with the highest improvement seen between 20% and 40% depending on the chassis [7][18]. Glycerin has been shown to help in barrier regeneration, including stratum corneum integrity, stability, and mechanical properties, in addition to the hydrating properties on the skin surface [7][19]. Desmosomal degradation has also been shown to be aided by glycerin [7].

Panthenol is a viscous liquid that is colorless, clear and odorless. In tissue, it is converted to D-pantothenic acid (vitamin B5). Panthenol has the ability to facilitate wound healing and fibroblast proliferation in addition to its humectant properties [16]. Other commonly used alcohols with humectant properties include butylene glycol [20] and propylene glycol [21][22]. Propylene glycol has been regarded as a penetration enhancer that is occasionally used as a solvent and vehicle for compounds that are unstable or water-insoluble [22]. However, propylene glycol has been shown to be a sensitizing agent that contributes to irritation and contact dermatitis [16]. Propylene glycol is more irritating compared to butylene glycol [16].

Occlusive agents help maintain a moisturized state in the stratum corneum (SC) by avoiding excessive water loss from the skin's surface (**Table 1**) [7][9][13][17][23]. Although they are not 100% occlusive, they permit water transfer that is required for the normal functioning of the skin [7]. The increased water content has the effect of speeding up barrier recovery [7][24]. Since most occlusive agents lack hydroxy functional groups in their chemical structure, they are unable to bind to water [7]. They can, however, efficiently seal moisture into skin as they can form uniform hydrophobic films [7]. Ingredients that exhibit occlusive properties include petrolatum, lanolin, mineral oils and silicone derivatives [16]. Petrolatum, also known as petroleum jelly, is the most popular occlusive [7][13][17][25]. Petrolatum is a semi-solid at room temperature, consisting of a highly refined mixture of short and long-chain alkanes, microcrystalline wax, and mineral oils. Petrolatum liquefies when applied to the skin and penetrates the SC, where it recrystallizes, creating a robust interstitial occlusive structure that results in a significant reduction of transepidermal water loss [7]. The hydrocarbon content in petrolatum is hydrogenated during the refining process to produce oxidation-resistant molecules, from liquid to solid waxes. This contributes to the long shelf life [26]. Nonetheless, the greasy texture poses a significant disadvantage for most occlusives and petrolatum [16]. On top of that, PAHs (polycyclic aromatic hydrocarbons) are a type of contaminant that can be contained in petrolatum; various studies have discovered that long-term exposure is associated with cancer, besides allergies and skin irritation [27].

Lanolin, a naturally occurring keratin conditioner, is made up mostly of sterol esters, but also acids and sterols [28][29][30][31]. It can compensate for several of the shortcomings of petrolatum with comparable efficacy that can be detected 14 days after the substance has been discontinued [28]. Its appeal stems from its ability to spread, as well as its melting point being near to skin temperature and its ability to absorb water [28]. Because of the role of these materials in skin biology, the sterol content is also significant [32][33].

Lanolin tends to penetrate and incorporate itself into the stratum corneum's lipid structure, which explains its long-lasting effects [28]. It is also known as wool alcohol and is not commonly used in the preparation of moisturizers due to its unpleasant odor, allergenic potential, and high cost [34][35]. Mineral oils (paraffinum liquidum) have a better texture, but they can only minimize TEWL by 30%. Silicone derivatives, such as cyclomethicone and dimethicone, have a less greasy feel, are hypoallergenic, and are commonly used in "oil-free" formulations [32][34][36]. The word "oil-free" means that the products contain neither vegetable nor mineral oils added [16].

Emollients are water-insoluble materials, such as oils and lipids that do not form an occlusive film [7][37]. The molecular weight of the substance may often distinguish an emollient from an occlusive [7][38][39]. They are often utilized because of their ability to smooth and soften skin and give it a silky texture [7][38]. They are mostly made up of lipids that are close to the skin's intercellular lipids, and they can possibly replenish the lipid matrix that is damaged [7][40]. By substituting the main lipid components, the moisturizers' combinations of ceramide, fatty acids and cholesterol can help fix lipid bilayers damaged by solvents, soaps and harsh dry or cold weather conditions [41]. Ingredients that exhibit emollient properties include cetylcaprylic/capric triglyceride, cetearyl or cetyl alcohol, or oils, such as soybean, sunflower seed and grapeseed

oil [7]. The double bond numbers in a fatty acid and their distribution along the carbon chain are the most important characteristics [26]. The degree of unsaturation has a significant impact on handling ease. Unsaturated fatty acids are more readily oxidized compared to saturated fatty acids [26]. Consumer desires, relevant benefit and therapeutic use, as well as the ideal sensory experience, all influence the form and level of emollient [7].

Table 1. Common active ingredients present in moisturizers.

Emollients	**Fatty emollients (Octyl stearate, jojoba oil, propylene glycol, castor oil, glyceryl stearate), dry emollients (Isopropyl palmitate, decyl oleate, isostearyl alcohol), protective emollients (Isopropyl isostearate, diisopropyl dilinoleate) and astringent emollients (octyl octanoate, cyclomethicone, isopropyl myristate, dimethicone)**	**[32] [42] [43] [44]**
Humectants	**Alpha hydroxyl acids (Lactic acid and glycolic acid), glycerine (glycerol), sodium pyrrolidine carboxylic acid (PCA), allantoin, honey, panthenol, propylene glycol, butylene glycol, PEG, hyaluronic acid, aluminium lactate, sodium lactate, urea, gelatine and sorbitol**	**[6][41]**
Occlusives	**Hydrocarbons (Mineral oil, petrolatum, caprylic/capric triglyceride, paraffin, squalene), fatty alcohols (Stearyl alcohol, cetyl alcohol, lanolin), fatty acids (Stearic acid, lanolin acid), polyhydric alcohols (Propylene glycol), vegetable waxes (Candelilla, carnauba), phospholipids (Lecithin), sterols (Cholesterol) and wax esters (Lanolin, beeswax, stearyl stearate)**	**[32] [42] [43] [44]**
Exfoliants	**Lactic acid, urea, malic acid**	**[41]**

The amounts of occlusives, humectants and emollients in a moisturizer determine its effectiveness [7][45]. A decent moisturizer should provide a good balance of all three [7][29][46]. To replenish and preserve moisture, a combination of these ingredients in sufficient quantities is required in order to provide an atmosphere that allows for skin barrier repair [7][47]. Since the thickness can be controlled independently of effectiveness, this mixture can be created as a cream or lotion [7].

Emulsifiers are necessary for the stability of moisturizers. Moisturizers are generally formulated either as emulsions or kinetically stabilized colloidal suspensions of two immiscible liquids (**Table 2**) [7][48]. This means there is no discernible phase distinction and the in-use experience remains constant during the product's shelf life [7][49]. Emulsifiers may be anything from small monomeric surfactants to large polymeric fragments, surfactants, and aggregations of lamellar liquid crystal [7][50]. Emulsifiers have long carbon chains, similar to those found in skin lipids, which allows them to have skin benefits [7][51]. As a matter of fact, the closer the emulsifier's chemistry is to skin lipids, the more skin benefit it can provide [7]. Emulsifiers can be categorized into nonionic and ionic emulsifiers [26]. Depending on the surface-active component of the compound, the ionic groups are classified into anionic or cationic [26][52][53]. Long-chain fatty acids, such as stearic acid and palmitic acid, are an example of widely used anionic emulsifiers [26][54]. In the preparation of cream, the acids are often partially neutralized with cationic excipients, and their concentrations can vary from 1 to 10% [26][55]. The epidermal tissue also contains fatty acids with a chain length of 14 to 22 carbons [26][55]. Cholesterol which is another lipid bilayer component can be utilized as a nonionic emulsifier in moisturizers [22][26][56]. The hydrophilic activity of nonionic emulsifiers is primarily based on ether linkages and hydroxyl groups [26][57]. Nonionic emulsifiers generally result in less skin irritation compared with ionic emulsifiers [26]. Ingredients that are commonly used as emulsifiers include ethylene glycol monostearate, Laureth 4 and 9, nonoxinols and octoxinols [58]. However, there is a newer method for delivering active ingredients into the epidermis known as liposome dispersion which results in better action [6].

Polymers are another class of materials used to enhance moisturizer stability and alter thickness, texture, and sensory feel [7][59]. Synthetic polyacrylate-type polymers or natural polymers, such as starch may be used [7][60]. Depending on the emulsifier and polymer used, the appearance and texture of emulsions vary significantly, independent of their effectiveness [7].

Water, is the most essential and commonly used raw material in the formulation of moisturizer cream as it is readily available and low cost [61][62]. Water is utilized as a solvent in skin creams to dissolve other ingredients; it must be free of contaminants and microbes [61][62]. Oil-in-water emulsions or water-in-oil emulsions are formulated depending on the amounts of water phase and oil phase used [61].

Niacinamide (Vitamin B3) is an inactive ingredient included in moisturizers that is the water-soluble physiologically active form of vitamin B3 used in many moisturizers and has a range of dermatological therapeutic benefits [7][63][64]. Niacinamide boosts ceramide production, decreases hyperpigmentation, has anti-inflammatory and antibacterial properties, and aids in anti-aging [7][65]. Flushing is a possible side effect of niacinamide-containing products. The offender ingredient is niacin, a form of vitamin B3 that can show up as a contaminant if raw material quality is not monitored properly [7][66].

Alpha hydroxy acids (AHAs), an additional ingredient in moisturizers, are commonly referred to as “fruit acids”. They are a group of substances containing organic carboxylic compounds that include citric acid, glycolic acid, malic acid, lactic acid, and tartaric acid, all of which are naturally derived [7][67]. At different concentrations, AHAs have been used to improve desmosome resolution and induce desquamation, with beneficial effects on the epidermis and dermis [7][68]. AHAs are available at lower concentrations ranging from 5 to 10% that can be used on a daily basis to improve barrier function and improve the skin appearance related to wrinkling, sun damage and hyperpigmentation. Meanwhile, higher concentrations ranging from 20 to 70% are used as chemical peels [7]. Concerns have been raised about the efficacy of using AHA in everyday skincare items. Studies demonstrated an increased sensitivity to UV after using AHA-based products, prompting the recommendation of sun protection when using AHA-based products [28].

Peroxisome proliferator-activated receptors (PPARs) are transcription factors that are ligand-activated, having effects on skin barrier growth and maintenance, as well as increasing keratinocyte differentiation [7][69][70]. They increase epidermal thickness and synthesis of filaggrin, as well as the development of barrier-important lipids, such as ceramide and fatty acids, resulting in anti-aging benefits [7][69][71]. Unsaturated fatty acids that are naturally-occurring, such as conjugated linoleic acid (CLA), are examples of PPAR ligands [7]. When exposed to sunlight, such compounds oxidize quickly and lose efficiency [7].

Antioxidants, such as vitamins C (ascorbic acid) and E (α -tocopherol) are effective for protecting the skin from oxidative stress from the environment, such as UV rays and emissions [7][72]. However, when exposed to sunlight, they become unstable [7][73]. There are more stable types of these vitamins available, such as vitamin E acetate and magnesium ascorbyl phosphate [7][74][75]. However, inside the skin, these must be absorbed and transformed into the active form [7]. Since tartaric acid, citric acid, ethylenediaminetetraacetic acid, and its salts have minimal antioxidant activity, they serve as chelating agents, enhancing the effectiveness of antioxidants by reacting with heavy metal ions [6].

Hyaluronic acid (HA), a disaccharide polymer, is an essential part of the extracellular matrix, which helps keratinocytes proliferate, migrate, and heal wounds [7][76]. Due to its various hydroxyl moieties, HA is extremely hygroscopic and is frequently touted as a skincare wonder ingredient [7][77][78]. Because of its high molecular weight, topically-applied HA is unable to penetrate deeply enough into the skin to exert its biological effects [7].

Botanical substances are also used in the formulation of moisturizers [6][79][80]. However, the use of herbal extracts in moisturizers has not always been justified by clinical trials [81][82]. Instead, they could be added for marketing purposes to pique consumer interest in natural ingredients’ alleged skin benefits. Aloe vera is the most well-known (*Aloe barbadensis* Miller leaf extract) [6]. The chemical compositions of different aloe species vary, and several investigations on the constituents do not specify the species studied [22][83]. Most of the customer’s understanding of aloe’s effectiveness is based on anecdotal evidence [22][84][85]. Burns and skin ulcers healing, as well as antibacterial and anti-inflammatory properties, are all proposed benefits of aloe vera, but there is not sufficient evidence available to back up its usage [22][86]. Several studies on the effectiveness of aloe vera components have yielded contradictory findings, necessitating further clinical research with vehicle controls [22].

Allantoin is a compound that can be found in comfrey roots. It is a synthetic derivative called aluminum dihydroxy allantoinate [87][88]. It has been promoted as a moisturizer and keratolytic [6][89]. However, there is not sufficient evidence available to back up its usage. Oatmeal (*Avena sativa*) baths for calming rashes have been used by nurses for decades [6]. Meanwhile, the husk of oats can also be used as an exfoliant [28].

Bioflavonoids or plant-derived polyphenols, due to their antioxidant properties, are becoming more common in topical products [90]. Vitamin E, ascorbic acid, ubiquinol, and uric acid are all antioxidants found in normal skin. Their levels in the skin are affected by oxidative stress, and topical antioxidant therapy has been suggested to be beneficial to the skin. For instance, red tomato (*Lycopersicum esculentum*) contains an open-chain, unsaturated carotenoid that possesses protective effects against UV rays [22]. However, it remains to be proven how effective they are for reducing oxidative stress in the skin [6].

Fragrances and coloring agents are used more for their aesthetic value than for their moisturizing properties (**Table 2**) [6][91][92]. Such ingredients include benzoin resin, cinnamates, cinnamic acid and menthol. Coloring agents produce subtle hues and other optical effects, resulting in greater acceptance, though they can sometimes cause irritant dermatitis [6]. Certain moisturizers have fragrance ingredients incorporated in the form of masking agents, preventing the brain from perceiving their odor, even though they are advertised as “fragrance-free” or “unscented” [93][94]. Many unlisted fragrance ingredients are irritants that can cause allergies, extreme headaches, and asthma symptoms [27][95]. Perfumes can

aggravate asthma in children and even lead to its development. It is the second most common source of allergy symptoms in patients [27].

Preservatives are used to kill or inhibit microorganism growth that is accidentally introduced during manufacturing or use [96]. Pathogens and nonpathogens are also possible contaminants [97][98][99]. The ideal preservative should have a wide spectrum of activity, be stable in the product, safe to use and have no effect on the product's physical properties [100]. Since no single preservative can satisfy all of these criteria, a mixture of substances is commonly used [4]. Ingredients that are widely used as preservatives in moisturizers include parabens (methyl-, propyl-, ethyl- and butyl-paraben) and phenoxyethanol [6].

Previous research has suggested that parabens can pose serious health risks, especially to humans (**Table 3**). As a result, there is an increasing market for preservative-free cosmetics [101][102]. Natural compounds, such as plant extracts or essential oils, may be used to replace parabens and address the issue of microbial purity in cosmetics [101]. Parabens are a form of preservative that easily penetrates the skin and is suspected of interfering with hormone function, resulting in endocrine disruption [27][103]. They interrupt male reproductive functions besides having the ability to mimic estrogens, the female sex hormones [27][104].

According to several studies, when methylparaben is applied to the skin, it will interact with other chemicals, causing skin aging and damage to DNA [27][105]. However, when consumed, parabens in food are metabolized, making them less estrogenic [106]. Meanwhile, parabens in cosmetics are applied directly to the skin and absorbed into the body. They then bypass the metabolic process, entering the bloodstream and body organs intact [103][107]. They have been linked to cancer and neurotoxicity among other health issues [27].

In order to resist contamination and microbial growth, products without preservatives added have to depend on low water activity, such as high alcohol concentration, low pH, and/or other agents that are not considered preservatives, such as essential oils [22][108]. However, other types of inconveniences can result from such formulations, such as insufficient preservation, poor cosmetic properties, or the risk of other adverse reactions [22][109]. When an allergy reaction is suspected, substances, such as ethylhexylglycerin and caprylyl glycol are normally used to replace preservatives (**Table 3**) [22].

Sunscreens are also included in moisturizer formulations due to media coverage provided on carcinogenicity and the accelerated skin-aging effects of sunlight [110][111]. The utilization of sunscreen products has increasingly widened not only in sunscreens but also in other cosmetics, such as moisturizers, where they can cause photocontact and contact allergic reactions [111][112][113]. Certain antioxidants, such as retinol palmitate, tocopherol (vitamin E) acetate and ascorbic acid (vitamin C), are utilized more specifically in sunscreen and moisturizing products to avoid aging [110][114]. However, in such preparations, they are uncommon causes of allergic contact dermatitis (**Table 3**) [110][115][116]. However, the low incidence of confirmed cases of allergic reactions may be due to a lack of recognition of a contact allergy or photoallergy to sunscreen products, as a differential diagnosis of a primary sun intolerance is not always evident [110]. Highly toxic para-aminobenzoic acid agents have been substituted by compounds, such as titanium dioxide, cinnamates and zinc oxide [6].

Table 2. Common Inactive Ingredients.

Thickeners	**Carbomer, sorbitol, oleic acid, xanthan gum, isostearic acid, stearic acid and glyceryl stearate**	
Buffers	**NaOH, TEA, maleic acid and citric acid**	**[39]**
Solvent	**Water**	
Preservatives	**Potassium sorbate, rice bran oil, phenoxyethanol, disodium EDTA, propylparaben, methylparaben and vitamin C (L-Ascorbic Acid)**	**[4][39]**
Lipids	**γ-linoleic acid**	**[41] [117]**
Fragrance	**Hazelnut fragrance**	**[41]**
Colorants	**TiO2**	**[41] [118]**
Emulsifiers	**Cetearyl alcohol, sorbitan monolaurate and cetyl alcohol**	**[41] [119]**

Table 3. Adverse effects of moisturizers.

Adverse Effect	Plausible Causes	References
Cosmetic acne	Water in oil preparations that contains occlusive oils	[42][120]
Irritant reactions	Propylene glycol, solvents, proteins in vegetable oils, urea, hydroxyl acids	
Allergic contact dermatitis	Preservatives, propylene glycol, fragrances, sunscreens, lanolin, vitamin E, Kathon CG, herbal products (Aloe), chamomile oil, olive oil, tea tree oil	
Subjective irritation	Humectants (urea, lactic acid, PCA), preservatives (sorbic acid, benzoic acid)	
Photosensitivity eruptions and photomelanosis	Sunscreens, fragrances, hydroxyl acids, preservatives	
Occlusive folliculitis	Mineral oils, petrolatum	
Contact urticaria	Fragrances, balsam of peru, preservatives (sorbic acid)	
Poisoning in burn patients	Propylene glycol	
Intoxication	Salicylic acid	

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