

THE SCOPE OF MINERAL OIL IN PERSONAL CARE PRODUCTS AND ITS ROLE IN COSMETIC FORMULATION

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Synopsis

White mineral oil is a commonly used ingredient in nearly all types of personal care products, from emulsions to anhydrous cosmetics. It provides many benefits to personal care formulations, including moisturization and emolliency, and is safe and effective for topical use. Interestingly, the purification process of mineral oil permits it to be considered "natural" when compared with the purification of other natural ingredients.

Riassunto

Ultima classe di principi attivi di uso cosmetico, gli alfaidrossiacidi sono al centro di molte ricerche e di molte attese. Ne viene descritta la composizione chimica, il probabile meccanismo d'azione e le varie possibilità di impiego nella Dermatologia Cosmetologica.

Introduction

White mineral oil has long been recognized as an important part of many cosmetic formulations. Its unique feel, ready availability, and low cost have enabled it to be used in a variety of health and beauty aid products, from bath oils to hair care products, to skin care cosmetics. Today, I will review the role of mineral oil in cosmetic preparations, with emphasis on its beneficial characteristics.

The mineral oil used in personal care (white mineral oil) is a highly purified material obtained from the refining of crude oil. It consists of a complex mixture of straight- and branched-chain saturated hydrocarbons and cyclic saturated hydrocarbons. The concentrations of these constituents, as well as their molecular weights, determine the physical characteristics of the oil, such as viscosity, boiling range, and carbon number distribution.

Before discussing the applications of mineral oil, I would first like to give a little background on the processing and purity of white mineral oil and where this material fits relative to the current trend of "natural" cosmetics.

Processing, purity and nature

While the source of mineral oil (crude oil) often leads to criticism of its use, one must remember that the great majority of consumer products used worldwide, from plastic bottles and ink pens to automobile tires, telephones, and fabrics are prepared from petrochemicals. The white mineral oil used in cosmetic products is essentially extracted and purified from the crude oil mixture, not unlike the extraction and purification of vegetable oils. Whereas vegetable oils are often obtained from solid materials, white mineral oil is obtained from a liquid source. The purification of mineral oil involves distillation, hydrogenation, and extraction. What remains is a hydrocarbon liquid of sufficient purity which enables it to be topically applied to the skin of an infant with no dilution by other ingredients. The purity of white mineral oil also is

evident from its allowed use in the United States as an over-the-counter orally administered laxative. Needless to say, its taste leaves something to be desired. White mineral oil is a pharmacopeia-recognized ingredient, and it also should be noted that, unlike some plant-derived oils, the consistency of mineral oil does not vary from season to season or from year to year.

The purification of white mineral oil also relates to the "natural movement" which has been gaining more and more prominence within cosmetics during the past several years. While the focus on natural goods has been evident in several other industries for many years, only recently has such a high level of concern been seen in the personal care industry. The popularity of The Body Shop and similar stores is evidence of the focus on natural products. Many cosmetic product manufacturers stress the natural aspect of their products, even when the products are distributed by others.

Often, the debate between natural and synthetic arises within the cosmetic community, with the general feeling that "natural" products must be better since they have not been adulterated by chemical processing. For example, such a debate was presented at a 1993 Cosmetic, Toiletry, and Fragrance Association meeting in the United States, between Dante Rutstrom of Eastman Chemical Company and Alban Muller of Alban Muller International. The natural issue also is being cited in many journals and trade magazines. An article in the January 1993 issue of *Cosmetic Dermatology* addressed what was called the misperception of natural cosmetics.¹ The October/November 1994 issue of *Cosmetics & Toiletries Manufacturers & Suppliers* contained an article on consumers and the "natural" labels in skin care products.² And the list goes on and on.

In the midst of these emotionally-charged discussions, few people have been able to decide where mineral oil belongs. How is "natural" defined? Some people insist that it means that no animal products have been used or that no animal testing has been done. But this really doesn't address what is natural. Pharmaceuticals which are 100% synthetic

contain no animal products, but no one would consider them “natural”. Some people imply that natural can only mean plant-derived, but if this is true, then naturally-occurring inorganic materials such as talc, titanium dioxide, and mica are relegated to the “synthetic” category.

While it is likely that no definitive answer exists to the question, “What is natural?”, a reasonable definition of “natural” would be one which describes a material as being essentially unchanged from its naturally occurring state. That is, a natural material is one whose bulk chemical structure has not been significantly changed through synthetic chemical processes. Using this definition, many products which are undoubtedly natural (such as titanium dioxide) are retained in the “natural” category.

Since no one has yet invented the infamous Philosopher’s Stone of alchemical lore to permit transmutation of lead into gold, an assumption which most everyone would agree is valid is that gold is natural. Interestingly, when gold ore is removed from the earth, it often contains as little as 0.04 ounces of gold per ton of ore. A separation and refining process is needed to make the gold fit for use, yet the resulting gold is not synthetic -- it is still natural.

Similarly, the white mineral oil used in cosmetics is only a small fraction of the entire crude oil. A separation and refining process is needed to make the white mineral oil suitable for its intended use, and again, since the mineral oil has not been synthesized from other ingredients, it is indeed considered natural.

How does this apply to cosmetic formulation? Often a bias exists for incorporating natural materials in a cosmetic product, or for using only ingredients which are known to be present in human skin. The utilization of ceramides in skin creams is one example of adding compounds present in skin to a particular cosmetic formulation. Professor Stig Friberg of Clarkson University reported in 1994 that straight-chain hydrocarbons like those found in mineral oil are naturally-occurring materials in a variety of living organisms.³ These hydrocarbons

have been detected in red ants, in shark livers, and in pig livers. Plants also produce hydrocarbons, with up to 27% being found in the cuticular waxes of plant leaves. The human spleen forms straight-chain hydrocarbons at up to 6% in certain instances.

The types of hydrocarbons which are found in both plants and animals indicate that they are produced *in vivo*. Hydrocarbons also are naturally present in human stratum corneum, which is comprised of many types of lipids, with hydrocarbons making up about 3 to 4%. Thus, the use of mineral oil in skin care cosmetics is another example of incorporating natural materials, especially those which occur naturally in healthy skin.

Mineral Oil Applications in Cosmetics

The types of cosmetics in which mineral oil is found are almost as numerous as the cosmetic products which are marketed today. White mineral oil finds use in all areas of personal care, even in the most unexpected applications.

We all are aware of its incorporation in general skin care cosmetics, where mineral oil is used at levels ranging from less than 1% to almost 100%. This is true for baby products, such as baby creams, lotions, diaper rash ointments, and baby oils. Hand and body care cosmetics also include mineral oil at a wide variety of percentages. Hair care products, especially ethnic products such as pomades, brilliantines, and relaxers, typically contain high levels of mineral oil. However, it may be surprising to note that white mineral oil is occasionally formulated into conditioners and shampoos as well, albeit at much lower levels. Makeup products, including pressed powders, mascara, eyeliner, and foundations, all can contain significant amounts of mineral oil, even up to 60%. Eye makeup remover often contains very high levels of mineral oil, or it may even be essentially 100% white mineral oil. This very useful hydrocarbon material can be found in shaving creams and lotions at up to 50%, as well as in the non-stinging

emulsion-type after shave lotions.

While shampoos and conditioners were mentioned previously, other bath products also incorporate mineral oil. Likely the most frequent use of white mineral oil in bath products is in bath oils, which often contain close to 100% mineral oil. Interestingly enough, some soaps even contain mineral oil, but only in very small amounts.

Other topical applications of mineral oils include lip products, such as lip balm and lipstick. Due to the reason for applying the lip product, mineral oil typically is found at higher concentrations in lip balms than in lipsticks. Epilation waxes and depilatory products also may contain mineral oil at moderate levels. Depending on the method of application, deodorants and antiperspirants may include white mineral oil, generally from 1 to 50%.

Lastly, white mineral oil is used in sun products, from the very high concentrations found in tanning oils (nearly 100% mineral oil), to the more moderate amounts normally used in sunscreens, sunblocks, and after sun products (about 1 to 40%).

Moisturization

Probably the most common function that mineral oil plays in cosmetics is one of moisturization. While mineral oil adds other important properties to a cosmetic formulation, moisturizing the skin is usually its primary purpose, with its other functions being strictly secondary.

Excluding color cosmetics and what we'll define as "specialized" products such as antiperspirants, deodorants, and sunscreens, moisturization, for most people, is the main reason why they purchase a general skin care cosmetic product. The need for a product to combat dry skin and its associated itchiness, redness, and irritation leads the typical consumer to look for an emulsion cream or lotion which has a good skinfeel. It has been known for decades that efforts to overcome dry skin usually involve applying a moisture barrier to the skin surface which will retard the loss of water from the stratum corneum through evaporation. The reduction of this transepidermal water loss is what is

meant by the term "moisturization", even though no water is actually added to the skin. Kligman has defined a moisturizer as "a topically applied substance or product that overcomes the signs and symptoms of dry skin."⁴

Bath oils are the simplest and one of the most effective methods for treating general skin dryness. In 1961 and 1963, Taylor reported his attempts to quantify the deposition of mineral oil onto human skin, and determined that bath oils based on mineral oil adhere to skin better than similar products formulated with vegetable oils.^{5,6} The importance and efficacy of mineral oil as a moisturizer is clearly evident when it is used in this manner. In fact, because of this effectiveness in reducing water loss from skin and because of its economy, availability, and safety, white mineral oil is likely the most widely used oil in bath oil products.

A large portion of the cosmetic market is controlled by leave-on skin care products which are typically emulsions. Depending on the purpose of the product and the regional culture to which it is being marketed, the emulsions will be either water-in-oil or oil-in-water. The oil-in-water emulsions are generally preferred because of their dry, non-oily feel upon application to the skin. Water-in-oil emulsions are more difficult to stabilize, and low-viscosity water-in-oil emulsions frequently prove troublesome to prepare. Despite these drawbacks, water-in-oil emulsions are sometimes favored for sunscreens due to their resistance to washoff, and in dermatological creams and lotions since a higher percentage of oil-phase, barrier-forming ingredients are usually present in the formulation. In the case of oil-in-water emulsions, the water evaporates not long after application, and the actual "moisturizing" is performed by the remaining oil-phase ingredients.

Contrary to common belief, esters and silicones are not very good moisturizers, especially when compared to mineral oil. When mineral oil is an ingredient in the oil phase of an emulsion, the moisturizing benefits come from the mineral oil, not from any other oil phase ingredients like esters or silicones. In 1993, Frömder and Lippold showed that,

after application, mineral oil reduces *in vitro* transepidermal water loss to a significantly greater extent than silicone and certain esters which are commonly used in skin care cosmetics.⁷ The esters evaluated were caprylic/capric triglyceride, dibutyl sebacate, and cetearyl octanoate. The silicone was dimethicone with a viscosity of 100 cSt. Mineral oil reduced transepidermal water loss to 86% of the original state, whereas the other ingredients lowered it to only 91-98% of the value prior to lipid application.

In another 1993 article, Strüßmann and coworkers at Akzo verified the low water vapor permeability of mineral oil relative to 14 esters, thus revealing mineral oil's moisturizing properties.⁸ These selected esters included isopropyl myristate, isopropyl palmitate, octyl palmitate, and oleyl oleate. The water vapor permeability of oleyl oleate was 4 times higher than that for mineral oil, and isopropyl myristate allowed a moisture penetration *ten times* higher than mineral oil.

While these studies were performed on pure ingredients, Blanken and coworkers reported in the journal *Contact Dermatitis* that emulsions based on mineral oil reduce skin vapor loss much better than emulsions containing linoleic acid-based oils.⁹ In fact, the higher the content of linoleic acid in the emulsion, the greater the skin vapor loss. It was stated that, for the mineral oil-containing emulsion, the reduction of skin vapor loss probably occurs with a concomitant increase in the hydration state of the stratum corneum, again showing that mineral oil acts as a "moisturizer" to the skin.

These results indicate what consumers have long known: that mineral oil is one of the best moisturizers available, and probably the most popular one in the world. In the United States, many of the top-selling skin care products in the low-priced market contain mineral oil as a moisture barrier, and a top-selling product in the high-priced market also contains mineral oil as the primary moisture barrier. Not only is mineral oil one of the world's most common moisturizers (that is, an emulsion's primary barrier ingredient), it is also one of the most commonly used emollients.

Emolliency

Emolliency is a very difficult concept to describe. It is related to other skinfeel terms and seems to affect moisturization. Emolliency can be described as the overall skinfeel of a cosmetic product as it is spread onto the skin, from initial application through the entire rub-in process. It is related to moisturization to the degree that soft, supple skin is evidence of a well-hydrated stratum corneum. A good emollient will confer a smooth, pleasant feel to the skin, both initially and for a period of time after application. Some scientists relate emolliency so closely to moisturization that emollients have been described as bland, fatty substances that render skin softer and more pliable.

Many skinfeel characteristics of a cosmetic product have been used in attempts to quantify (or at least estimate) emolliency. Such variables include slip, texture, spreadability, absorption time, stickiness, smoothness, friction, and oiliness. Evaluation of mineral oil alone gives predictable skinfeel characteristics. For example, it has very low stickiness and excellent slip. Its spreadability is high, but so is its oiliness. It has low friction, high absorption time, and good smoothness. Mineral oil is used very often as an emollient in many cosmetic products, not just skin care formulas, because it has many desirable skinfeel properties and reducing its drawbacks is not a difficult task. As mentioned before, cost, safety, and availability also play a role in a scientist's choice of ingredients. These factors are no less important when it comes to decisions regarding emollients.

An interesting feature of mineral oil is the relation between its spreadability and its moisturizing abilities. Materials with low surface tensions are substances which have high spreadability. However, these ingredients normally provide poor moisture barriers on skin. Examples of these substances are isopropyl myristate, caprylic/capric triglyceride, and octyl palmitate. Typically, oil-phase ingredients which produce good moisture barriers are heavy, waxy materials which spread poorly. White mineral oil strikes a nice balance between spreadability and moisturization which is not common

in esters or other lipophilic materials. Its spreadability is similar to many esters used in cosmetics, but its moisturizing properties are unsurpassed by other hydrophobic liquids. Additionally, mineral oil can be obtained in a variety of viscosities, so its spreadability can be tailored to the cosmetic being formulated while retaining the benefits of moisturization.

While no one ingredient is ideal for every application, mineral oil is often used as a primary building block for cosmetic skin care emulsion formulations due to the pleasant feel it leaves on the skin. Its natural oiliness, which provides moisturization, is easily minimized or eliminated by incorporation of the mineral oil in a well-designed emulsion, without affecting its moisture barrier advantages. When added to an emulsion, mineral oil also enhances the product's smoothness, lowers its friction during application, and can reduce the stickiness of certain formulations.

Slip, Shine and Safety

As mentioned earlier, white mineral oil is a useful ingredient for adding "slip" to cosmetic products. Very often, a certain formula containing desired ingredients may be too tacky on the skin, or drag during application. Several ingredients exist which add slip, with silicones being some of the more well known ones. However, mineral oil can add the necessary characteristic of lowered friction at a fraction of the cost of silicones. Its oiliness and natural lubricating properties are the very qualities which are needed in order to add "slip" to a cosmetic formula.

White mineral oil is often used as part of cleansing creams, primarily as the lipophilic agent which carries away dirt and oils from the skin's surface. In this application, slip is very important to give the consumer a proper skinfeel during the cleansing process. A soft, moisturized-feeling skin is desired after using cleansing creams. Tautness and dryness are not desired when using these products, so mineral oil is the ideal ingredient for such use. It also is used to carry ingredients toward the skin in

many nonprescription topical pharmaceutical ointments. Again, low friction (that is, "slip") during use of the product is desired in order to provide good skinfeel and ease of application.

The "slipperiness" of white mineral oil enhances its spreadability as well. When used in hair dressings, mineral oil reduces friction during application. The same is true for anhydrous products such as tanning oils and baby oils. The ease of application of the cosmetic product (its slip) is one reason why white mineral oil is often used in these products.

Quite often, consumers of hair dressings, in particular ethnic consumers, want a long-lasting shine in their hair. Mineral oil has long been a commonly-used ingredient in ethnic hair dressings for many reasons. Moisturization and slip have been mentioned, but shine also is important. Of course, the prevailing fashions determine how much shine is desired, but very few, if any, other cosmetic ingredients can provide long-lasting shine along with moisturization and slip to a hair care product.

The safety of white mineral oil is often called into question, particularly of late. However, in topical use, the safety of mineral oil is quite clear. During the last 50 years, millions of people have safely used mineral oil in topical products. In fact, a 1994 white paper published in the U.S. by the CTFA stated that "topical use of white mineral oils does not represent a local or systemic toxicity risk to humans."

White mineral oil has been tested and shown to be noncomedogenic in both the rabbit ear assay,¹⁰⁻¹² a common method for determining comedogenicity, and in humans¹¹ (the true test of comedogenicity). It has been recommended as a moisturizer for acne-prone skin,¹⁰ and has been reported as being nonacneogenic.¹³ In fact, attendees of an American Academy of Dermatology Invitational Symposium on Comedogenicity concluded that "neither the consumer nor the physician can assess whether the formulation will be acneogenic by simple inspection of the product or by examining the list of ingredients. Furthermore, the product's physical characteristics, such as oiliness or viscosity, are not in

themselves predictors of an acnegenic response.”¹³ Mineral oil also has found widespread use as a carrier for anhydrous ingredients and products in human patch tests, which also attests to its safety. The structure of the molecules in mineral oil also play a role in its safety in cosmetic formulations. Thermal decomposition of the product rates as a concern during cosmetic formulation and preparation. A more obvious safety concern is poor preservation and subsequent contamination of the product by microorganisms while in use by the consumer. The inertness of white mineral oil allows cosmetics containing this material to be formulated with a minimum of preservatives. Due to the lack of unsaturation in its hydrocarbon constituents, mineral oil is quite stable and very resistant to thermal and oxidative degradation. In addition, the lack of heteroatoms in mineral oil makes it less supportive of bacterial growth than more reactive species such as synthetic esters and vegetable oils. One final note about the safety of mineral oil should be mentioned. Baby oil, consisting of mineral oil and less than 0.02 percent fragrance, has been used as an extremely safe and effective agent for removing hot bitumen tar from human skin, including the face.¹⁴ Other removal agents which are used, such as acetone, alcohol, and kerosene, are highly toxic in large quantities and act harshly on the injured skin. Removal of bitumen with these agents is laborious and time-consuming, often taking up to 48 hours in some cases. In one example of using baby oil, a worker had boiling bitumen tar splatter on his face, forearm, and hand, for a total of 4 percent of total body surface area. Baby oil was used to remove the bitumen by applying it to the bitumen surface. Once dissolved, it was washed with soap and water, all within an hour and a half. The patient was discharged just 24 hours after admission.

Conclusion

White mineral oil has been shown to be a highly effective material for adding moisturization and other beneficial characteristics to skin when used

in cosmetic products. Its low cost and safety are important, particularly when today's consumer is looking for a good value in personal care products. Every type of skin care emulsion, from cleansing creams to lotions to sunscreens, can use mineral oil, and its use in anhydrous liquid cosmetic products such as baby oils is unrivaled. White mineral oil has been used successfully for decades and likely will be used for many years to come, as more cosmetic scientists rediscover the benefits it provides.

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