

## **Dead Sea Mineral-Based Cosmetics — Facts And Illusions**

**Ze'ev Ma'or, Shlomo Magdassi, Dov Efron And Shaul Yehuda**

Research and Development, Dead Sea Laboratories, Mitzpeh Shalem, Dead Sea Medical Research Center, Naveh Zohar, and <sup>3</sup>Casali Institute of Applied Chemistry, The Hebrew University of Jerusalem, Jerusalem, Israel

**ABSTRACT.** Modern Dead Sea cosmetics have developed in order to meet the demands of new regulations, technical opportunities, and today's consumer expectations for higher quality standards and proven performance. As an example of the application of this approach, the authors describe the development of a new cosmetic formulation, based on "Osmoter", a special Dead Sea mineral composition, and the evaluation of this formulation's effect on the depth of skin wrinkles, by a controlled assay. Possible mode of action is discussed.

*Isr J MedSci* 1996;32 (Suppl 3):28-35

**Keywords:** Dead Sea; minerals; ions; skin; cosmetics

Although more than 40 different cosmetic brands based on Dead Sea minerals are sold worldwide, little scientific data relating to their beneficial effects have been published. That the minerals present in the water of the Dead Sea have the capability of improving skin is undeniable. These skin-improving capabilities have an enormous commercial potential.

Facts, hypotheses and legends abound, together contributing to the understanding of the mechanisms of these capabilities. Although dreams and fantasy will always be a factor in the motivations of consumers, this review presents the facts beyond the legend of the Dead Sea and its capabilities.

### **Modern Cosmetics —' From Art To Science**

"A cosmetic product", as defined by European Council Directive 76/768/EEC, is "any substance or preparation intended for placing in contact with the various external parts of the human body (epidermis, hair system, nails, lips, and external genital organs) or with the teeth and mucous membranes of the oral cavity with the intention, exclusively or principally, of

cleaning, perfuming or protecting, to keep such parts in good condition, change their appearance or correct body odors". While dermatologic products are free to use "cure" claims, the above-mentioned definition still limits cosmetic producers to using only "care" claims. However, "prevention", "protection" and even "healing" claims are no longer off limits for use in describing cosmetics.

### **Cosmetics Consumers' General Expectations**

In general, when buying a new cosmetics product the consumer wants to believe that the product will leave them feeling more attractive, whether such claims are written on the packaging or not. The consumer has spent money on the product and expects the cream in the jar to eliminate wrinkles, arrest the skin's natural maturation, nourish lifeless skin cells, and so on. For some, a good cream may indeed seem like a dream come true. But in reality nothing, not even Dead Sea minerals, can possibly fulfill each and every consumer expectation.

### **In Search of Real Consumer Expectations**

Dead Sea Laboratories Ltd., creator-of *Ahava*, the top-selling Dead Sea mineral cosmetic line, has attempted

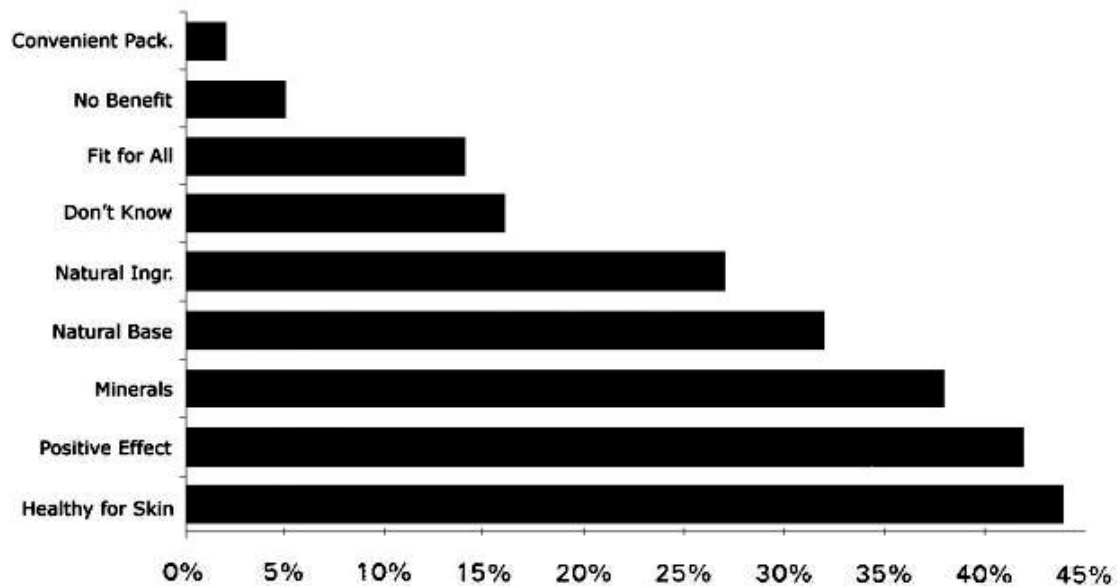


Fig. 1. Survey of consumer perceptions of Dead Sea cosmetics (Prepared by Mutagim for *Ahava*, 1995).

to evaluate consumer expectations about the Dead Sea and Dead Sea mineral cosmetics.

What do consumers expect from Dead Sea mineral-based cosmetics? In a survey of 317 tourists in the areas of the Dead Sea, Eilat and Jerusalem, 70% had a positive perception of products based on natural ingredients from the Dead Sea. When asked to name the benefits of (he products, 79% of those surveyed noted some benefit; 86% mentioned a positive, healthy influence on the skin; 59% slated the natural ingredients; while 38% noted minerals as a benefit (Fig. 1) (April 1995, Mutagim Institute, for *Ahava*, the Dead Sea Laboratories).

In a survey of 80 retailers in Israel on cosmetics based on Dead Sea minerals, 94% has a positive impression of these products. When asked to note the products' benefits, the following answers were given: contains active ingredients (23%), customers love (he products (17%), requested by customers (14%), recommended by doctors (14%), and contains natural products (14%). (March 1995, Mutagim Institute, for *Ahava*, the Dead Sea Laboratories)

Thus, the success of Dead Sea cosmetics and the consumer expectations of them can be attributed to benefits as expressed by both the consumers and the retailers. These include: mineral content, active ingredients, natural ingredients, doctor recommendations, and their healing capabilities for healthier skin.

#### Dead Sea Cosmetic Claims History

When the first Dead Sea mineral-based cosmetic products were introduced into the marketplace in the 60's, the manufacturers were apprehensive as to consumer reaction. Promoting raw materials such as black mineral mud and dour crystal salts as the unique selling point seemed to be an unlikely way to sell products that are supposed to increase moisture and enhance beauty. Furthermore, the fact that the name of the source of this unique ingredient included the word "dead" was hardly an appealing feature. Consequently, the marketing and

advertising people had to find a way to reduce consumers' misgivings regarding these somewhat bizarre products. And to create a concept that would make it perfectly clear that these products are safe to use and even glamorous. The legend of Queen Cleopatra's cosmetics industry, once located at the Dead Sea, seemed to be ideal for this purpose.

The history of using Dead Sea minerals for beauty purposes began in the 1st century BC, when Cleopatra, the most beautiful woman in the ancient world, gained exclusive rights to the Dead Sea's valuable mineral ingredients. At her command, pharmaceutical and cosmetic manufactories were built and operated for the manufacture of beauty products. In fact, the remains of these factories, according to archaeologists, can still be seen along the Dead Sea shores.

This evidence of Cleopatra's cosmetics venture allowed all Dead Sea cosmetic producers to claim that they are following in the footsteps of Cleopatra and are the heirs to her secret formulas for timeless beauty. The unexpected commercial success of the first Dead Sea cosmetic products in the late 1980's encouraged many companies to adopt this legend. As competition increased, the once fascinating story of Cleopatra began to appear rather banal. Marketing departments therefore had to look for newer and more unique selling points.

#### The "Pure and Natural" Claim

"Pure and natural" is one of the oldest claims in the cosmetics business. It is a trend that wanes, then returns. Marketing professionals constantly seek new attributes, but they always return to the ascertainment "pure and natural".

It is almost impossible today to formulate cosmetic blends that have a stable consistency, are contamination free, easy to apply, have a pleasant feeling plus a delicate fragrance, and still be 100% natural (1). Although Dead Sea cosmetics contain

natural Dead Sea active ingredients, the "100% natural" claim often used by manufacturers usually hides the fact that they also contain synthetic components, including preservatives, fragrances, emollients, surfactants, and even oils and waxes.

### **The Sea Claim — Old Yet Trendy**

Dead Sea mineral-based cosmetics can be considered a unique part of the "Sea" cosmetics trend, which is also related to "natural" cosmetics. The sea as a natural source of healing is quite an old concept. In 1750 Richard Russell presented his thesis on "the Therapeutic Effect of Seawater" at Oxford. In 1869, the term "thaiassotherapy" bringing together the sea and medicine, was coined by the French physician LaBonardier d'Arachon (2).

Another "sea" claim is related to the legend of how the very unique Dead Sea was created. It is said that around the time of Sodom and Gomorra, when God changed the sweetwater lake to salt, a special biochemical substance with hormone-like vitality was left in its waters by the creatures that were unable to survive the sea's transformation. This substance is yet to be confirmed by scientific methods.

### **The Ecology Claim**

As ecology continues to be a serious and popular concern, the "desert environment", with its clean dry air, was recently added to the list of natural Dead Sea claims. Thus cosmetic producers now proudly declare their cosmetics to be "from the healthiest environment on earth".

#### **Performance Claims in Cosmetics**

Although emotions are always involved in consumer decisions, today's consumers are more rational in their buying habits. People are willing to pay for a cosmetics product only when they are adequately convinced that it will be good for their skin. Marketers try to demonstrate real and measurable skin-improving effects. If they claim "It was good for Cleopatra", consumers ask: "Will it be good for me?". Performance is the key word in contemporary cosmetics marketing. New claims are mainly related to prevention, protection and treatment activities that affect the skin. The most popular claims today are "moisturizing" and "wrinkle reducing".

New European legislation drafted "The 6th Amendment", to be in effect as of 1 January 1997, which obligates cosmetic producers and marketers to scientifically prove their declared performance claims.

The new rules force major cosmetics companies to invest time and money before they can boast performance claims. Companies utilize huge budgets for Research and Development (R&D) before a new cosmetic product can be launched onto the market. Der-matologic tests, as well as physiologic

and laboratory research, are now essential parts of the cosmetics development process. This investment in science may raise the products' prices. However, it also leads the cosmetics industry into a new age — the age of technical knowledge, and a better understanding of how the bioactive ingredients work and the physiologic effects on the skin.

### **Anti-Wrinkle and Skin-Soothing Effects of Dead Sea Minerals**

Based on conversations with many people after they bathed in the Dead Sea's salty water, the Dead Sea Laboratories R&D staff has attempted to assess and validate the "baby smooth skin" they reported feeling. A liquid gel enriched with Osmoter® (Dead Sea Laboratories), a natural Dead Sea mineral complex, was specially developed. Using a laser profilometric modern technique, a well-known European der-matologic research institute, Dermatest, was asked to compare the following three cosmetic preparations:

- A basic gel with no active agent, as a control.
- An anti-wrinkle gel, which contained anti-wrinkle active agents, including locust bean gum, glyco-proteins and fruit extracts.
- The same anti-wrinkle active gel enriched with 1% of a unique natural composition of Dead Sea water, Osmoter.

Each preparation was applied daily for 1 month to 20 female volunteers, aged 20-65. Ten of them had sensitive and the other 10 normal skin. Changes in skin surface were evaluated by comparing skin status before and after treatment. Wrinkle depth was checked in 45,000 skin points, on the skin of each volunteer, using a computerized laser profilometric system, according to ISO 4287/1 "Surface roughness terminology, part 1: Surface and parameters".

The results were very encouraging (Fig. 2). The average control gel effect was a reduction in wrinkle depth of about 11% after 1 month of skin treatment, compared with 27% for the active anti-wrinkle gel. The active anti-wrinkle gel enriched with the Dead Sea ingredient Osmoter reduced wrinkle depth to more than 40% in an average of 20 women. These results were found to be superior to 45 leading cosmetic products in smoothing the skin's surface and reducing wrinkle depth and skin roughness (3).

This research, not yet published, will enable marketing professionals to support, with data, the Dead Sea's anti-wrinkle claim. Since an anti-wrinkle effect is one of the most desired effects from the consumer point of view, it is quite certain that Dead Sea mineral-based products will continue to be at least as successful in its sales in the future as they are today.

### Effective Concentrations of Dead Sea Minerals

In order to achieve an effective cosmetic preparation, several technical difficulties still have to be overcome. The high electrolyte concentration in the Dead Sea water is very problematic in cosmetic formulation and product stabilization. This fact may explain why many Dead Sea products have a very small amount of minerals. In some of these products Dead Sea minerals are not really active ingredients but simply "decoration" for marketing purposes.

### Formulation of Cosmetics with Dead Sea Components

Over the past few years, thousands of units of cosmetic products containing either Dead Sea Mud (DSM) or various compositions of minerals from Dead Sea water have been marketed.

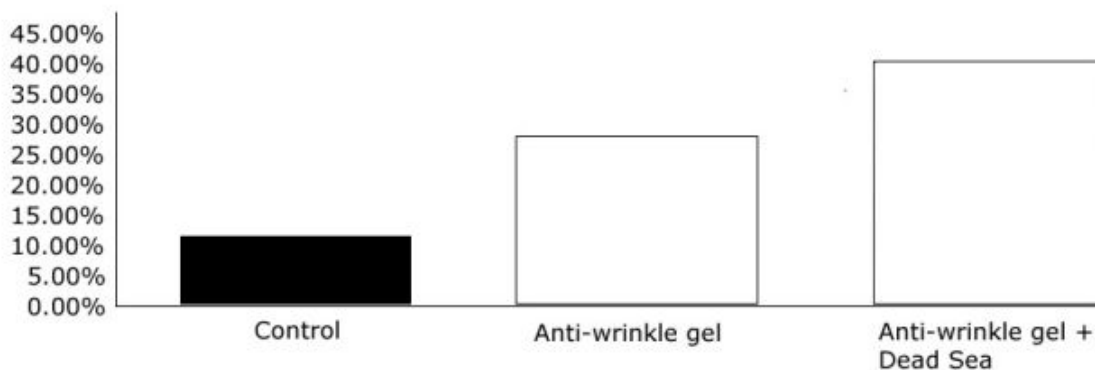
The first group of products, which contain high concentrations of DSM, mainly comprises various

types of body and face masks that are highly viscous dispersions. The second group comprises various lotions and creams, in the form of oil-in-water and water-in-oil emulsions that contain minerals from the Dead Sea at low concentrations. The third group of products is composed of one-phase aqueous solutions that also contain minerals at low concentrations.

The composition of Dead Sea minerals (4-6) is very unique, as shown in Table 1. The concentration of divalent cations, magnesium and calcium is very high compared with the monovalent cations, mainly sodium and potassium. In addition, the ionic strength of the solution is very high. These two factors have a tremendous negative effect on the formation and stability of dispersions and emulsions, and strictly limit their concentration to a few percent of the weight of conventional cosmetic formulations.

According to the "DLVO theory" (7), stabilization

Fig. 2. Antiwrinkle and skin-smoothing effects after 4 weeks of treatment (% improvement), as tested by computer-aided laser profilometric analysis of skin surface



Water source	Cl (mg/l)	Mg (mg/l)	Na (mg/l)	Ca (mg/l)	K (mg/l)	Br (mg/l)
Dead Sea	224,900	44,000	40,100	17,200	7,650	5,300
Mediterranean Sea	22,900	1,490	12,700	470	470	76
Ocean water	19,000	1,350	10,500	400	390	65

Table 1. Comparison of major elements in the Dead Sea, the Mediterranean Sea and ocean water (4-6)

of dispersions or emulsions can be described as the result of the combined attraction and repulsion forces between the particles or droplets that are dispersed in continuous phases. For example, oil-in-water emulsions can be stabilized by the absorption of ionic surfactants onto the oil droplet surface which may become positively or negatively charged (7). The electric surface potential, which is often represented as Zeta-potential (Z), will cause repulsion between the approaching droplets. If the repulsion forces overcome the attraction forces, the emulsion will be stable (8). The magnitude of Z is strongly dependent on electrolyte concentration,

and on the valence of the counter ion in the solution (cations, in case of negatively charged emulsions). Therefore, the electrical repulsion is significantly reduced in systems that contain high concentrations of electrolytes in general, and divalent counter ions in particular. This results in difficulties in formulating a cosmetic emulsion that contains electrolytes from the Dead Sea, which is rich in magnesium and calcium divalent cations at high concentrations, and will be stable for the minimum 3 years required shelf-life of a cosmetic product. In addition, the high concentration of electrolytes may cause salting out and precipitation of various

components of any cosmetic preparation. This may also affect the texture and the appearance of the product, its viscosity, hydrophilic-lipophilic balance, crystallization, etc. These problems can be overcome to a certain extent by using non-ionic polymeric surfactants, and by carefully selecting the various components to be used. These procedures are currently being developed at the Dead Sea Laboratories. Similar considerations may be applied to concentrated Dead Sea mud dispersions. However, due to the very high viscosity of these systems, and the addition of some protective colloids, instability problems are minimized even at relatively high salt concentrations. The Dead Sea salts may also cause problems in the formation and stabilization of the third group of products, which are composed of one aqueous phase. For example, a facial toner may contain some water-soluble additives and surfactants that may precipitate or change their solution properties, such as viscosity and spreadability.

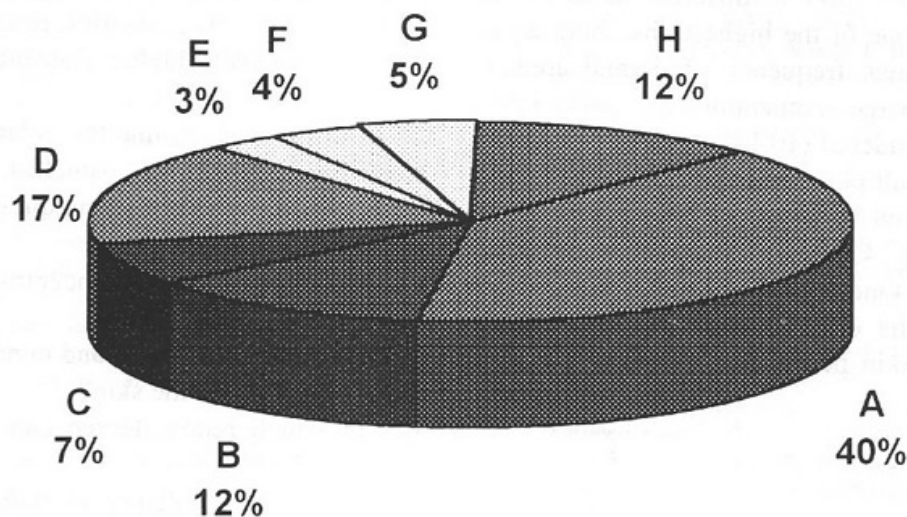
In conclusion, it appears that the physicochemical properties of cosmetics based on Dead Sea components are strongly dependent on the concentration and composition of the minerals. In formulating such products one should take into consideration the effect of each component of the Dead Sea minerals, and its interaction with the various ingredients of the specific cosmetic preparation.

#### The Mode of Action of Dead Sea Minerals in Cosmetics

The role of Dead Sea minerals in human skin metabolism is not yet well established. To date, all theories can only be presented with the caveat "scientists suggest..." or "experts believe..." . Physiologists assume that specific ions from minerals play important roles, mainly as co-factors in enzymatic regulation activities in the metabolism of healthy skin. For example, there are indications that magnesium ( $Mg^{++}$ ) is a co-factor for phosphate-transferring enzymes and participates in c-AMP c-GMP balancing regulation, potassium ( $K^+$ ) may enhance  $CO_2$  transport, and calcium ( $Ca^{++}$ ) is thought to regulate cell membrane permeability. Zinc may participate as co-factor in cell proliferation enzymatic regulation (9-14). In some *in vivo* and *in vitro* tests, magnesium bromide, magnesium chloride, and potassium bromide exhibited inhibition of skin proliferation after dermal application (11-13).

Minerals can restore moisture because of their hygroscopic characteristics. Thus, minerals, if absorbed into skin cells, may enhance intracellular water capacity, and add water to the skin tissue from within. For this reason Dead Sea minerals are thought to be an important contribution to the skin's natural moisturizing factor (NMF) (15) (Fig. 3).

Assuming electrolytes can be absorbed into skin, either by passive or active means, dermal application of mineral-rich cosmetics can be very useful. For



- A 40% = free amino acids
- B 12% = pyrrolidone carboxylic acid
- C 7% = urea
- D 17% = ammonia, uric acid, glucosamine, creatinine and other organic substances
- E 3% = magnesium and calcium (1.5% each)**
- F 4% = potassium**
- G 5% = sodium**
- H 12% = lactates, chlorides, phosphates, citrates, formiates.

Fig. 3. Composition of the skin's natural moisturizing factor (15).

example, for some skin disorders that are related to a specific mineral shortage, regular daily application of a Dead Sea mineral-rich cosmetic preparation may help to heal the problematic skin (11-13).

### Mineral Skin Penetration

Electrolytes can be absorbed into the skin from brine, from a bath with dissolved salts, or from a mineral-rich preparation. The skin is a multilayered bio-membrane with certain absorption characteristics. As a dynamic living tissue, its absorption parameters are susceptible to constant changes. Many factors and skin conditions can rapidly alter the parameters. There is reasonable evidence that corneum cell walls are involved in the semi-permeable membrane system and are responsible for the osmotic properties of the corneum. The penetration of electrolytes through the stratum corneum occurs in between the horny cells. There are models that demonstrate specific ionic absorption through the human skin barrier. Penetration of Na<sup>+</sup> and Cl<sup>-</sup> ions, for example, is at least 100 times lower than that of water, however sulfide ionic cutaneous absorption is 10 times higher than water itself (16). Concentration is a key (10,17). When applying a cosmetic blend, the relevant concentration is the concentration gradient, the "cascade" between each specific dissolved ion, outside and inside the skin surface. During the absorption process, a partitioning of minerals occurs from the vehicle to the skin (10,14). The nature of the vehicle, namely the type of cosmetic preparation (for example, a lipophilic cream or a hydrophilic gel), is significant in determining the kinetics of mineral skin penetration. Another important factor is the pH value in the various micro-environments of the skin. Ions in varying valences and cations in combination with different anions penetrate to differing extents. There are major differences in the extent of skin penetration

in different areas of the body. The face is one of the highest absorbing areas. Exposed surface area, frequency of dermal application, skin type, skin age, temperature, and contact time should also be considered (10,14). A schematic representation of the multiple factors involved in the percutaneous absorption of a common cosmetic ingredient is given in Fig. 4. Thus, the most relevant factors in the absorption kinetics of Dead Sea minerals to human skin are the concentration cascade and the characteristics of skin penetration of the specific ion (10,14,16-18).

### Conclusions

Following the proven worldwide commercial success of Dead Sea mineral-based cosmetics, advanced technical and scientific support for marketing claims will serve to ensure the reliability and safety of these products. In turn, these products will become attractive to today's intelligent and informed consumer. By applying advanced technical know-how, conducting performance tests, and exploring the physiologic factors behind the undeniable skin-improving capabilities of Dead Sea minerals cosmetics, researchers will be able to use a relatively higher concentration of Dead Sea minerals in their products. In order to determine the potential contribution of Dead Sea minerals to cosmetics, investigations will have to answer the following questions:

- What is the optimal concentration of each specific ion in skin cells?

What concentrations and conditions may be toxic or irritating to the skin?

- In which redox degree can each ion be easily absorbed?
- What could enhance or reduce these ionic skin penetrations?
- Which are the optimal delivery systems for the various ionic components?

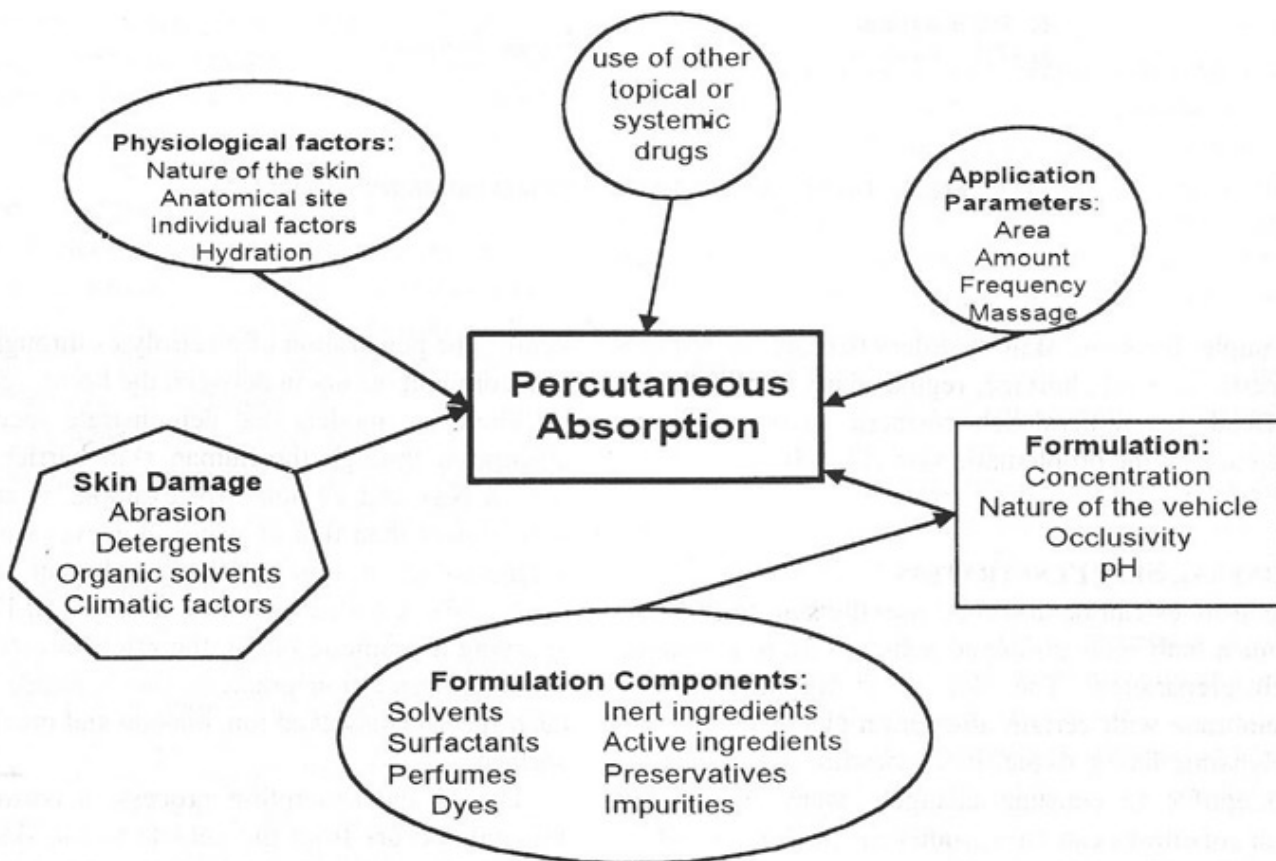


Fig. 4. Schematic representation of the multiple factors involved in the percutaneous absorption of a cosmetic ingredient (10).

#### References

1. Muller A. Introduction to Natural Bases: Towards 100% Active Cosmetics. Incosmetics Conference Proceedings, 1996:43-64.
2. Harvey HW. The Chemistry and Fertility of Seawaters. Cambridge, UK: Cambridge University Press, 1955.
3. Voss W, Ma'or Z. A skin smoothness effect of Dead Sea minerals. A comparative laser profilometric evaluation of skin surface (Unpublished data).
4. Beyth M. Recent evolution and present stage of the Dead Sea. In: Nissenbaum A, cd. Hypersaline Brines and Evap-oric Environments. Amsterdam: Elsevier, 1980:155-166.
5. Dyrssen D, Wedborg M. Equilibrium calculations of the speciation of the elements in sea water. In: Goldberg ED, ed. The Sea, vol. 5, New York: John Wiley & Sons, 1974.
6. Vengosh A, Stannsky A, Metlout A, Fink M, Ertich S. Saltinization of the coastal plain of Israel. Hydrological Service Report. 1991:20.
7. Rosen MJ. Dispersion and aggregation of solids in liquid media by surfactants. In: Surfactants and Interfacial Phenomena, 2nd ed. New York: John Wiley, 1989:337-362.
8. Shaw DJ. Introduction to Colloid and Surface Chemistry. London: Butterworth, 1966.
9. Even-Paz Z, Sham" J. The Dead Sea and psoriasis. Historical and geographic background. *Int J Dermatol* 1989;28:1-9.
10. Marty JP, Wepierre J. Percutaneous absorption of cosmetics: Implications in safely and efficacy. In Baran R,
11. Maibach HI, eds. *Cosmetic Dermatology*. London: Martin DunitzLtd.. 1994:61-76.

12. Shani J, Milner Y, Politi Y, Katzir I, Chromsky O, Brener S. Inhibition of psoriatic skin cell proliferation in tissue culture, by selected Dead Sea salts. *Pharmacol Commun* 1995;7:21-27.
13. Shani J, Sharon R, Koren R, Even-Paz Z. Effect of Dead Sea brine and its main salts on cell growth in culture. *Pharmacology* 1987;35:339-347.
14. Shani J, Sulliman A, Katzir I, Brener S. Penetration of selected Dead Sea minerals through a healthy rabbit skin, from a sustained-release transparent varnish, as a prospective treatment for psoriasis. *J Eur Acad Dermatol Venereol* 1995;4:267-272.
15. Wester RC, Maibach HI. Percutaneous absorption and cosmetics. In: Baran R, Maibach HI, eds. *Cosmetic Dermatology*. London; Martin Dunitz Ltd., 1994:55-60. Jacobi OK. Composition of the skin's natural moisturizing factor (NMF). *J Soc Cos Chem* 1967;18:149-152. Schaefer H, Zesch A, Stiitten G. Penetration of electrolytes. In: *Skin Permeability*. Berlin/Heidelberg/New York: Springer-Verlag, 1982:766-770.
16. Maibach HI. Percutaneous absorption: Science and mud. *Cosmetics and Toiletries*, 1994;109:33. Wester RC,
17. Maibach HI. Percutaneous absorption in diseased skin. In: *Topical Corticosteroids*. Basel; Karger. 1992:128-141.