

ZINC AND ITS DERIVATIVES: THEIR APPLICATIONS IN COSMETIC

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Summary

Zinc is one of the most widespread cation present in human body and mainly in skeletal muscles, bones, teeth, hair, and skin (about 6% in stratum granulosum).

Zinc is involved in many metabolism processes and its deficiency results in different pathological conditions.

Zinc plays a major role in epidermis maturation and cutaneous integrity. For all these reasons Zinc salts find several applications in personal care.

Combining skin cleansing with skin care is one of the main goals of cosmetics. A new zinc salt, zinc coceth sulfate, is a surfactant provided with additional functional properties.

The work will illustrate the relationship between Zinc and skin and will quantify the total amount of residual Zinc in stratum corneum at different depths after cleansing with its aqueous solution. Functional properties of Zinc Coceth Sulfate will be demonstrated: underarm deodorant effect (sensorial and microbiological evaluation), dandruff control capacity (corneocytes count and dimension), and skin renewal (dansyl chloride method). Dermatological properties (skin/eye irritation and sensitization) will be also shown.

From all these data we will show that skin cleansing with Zinc Coceth sulfate involves some form of Zinc bond with stratum corneum in its outermost layers, providing so a base for its efficacy and safety.

Riassunto

Lo zinco è uno dei cationi più presenti nell'organismo umano, con le maggiori concentrazioni nei muscoli scheletrici, nelle ossa, nei denti, nei capelli e nella cute (circa il 6% nello strato granuloso). Lo zinco è coinvolto in molti processi metabolici e una sua carenza può originare diverse condizioni patologiche.

Lo zinco gioca un ruolo importante nel ciclo vitale dell'epidermide e nell'integrità cutanea. Per tutte queste ragioni i sali di zinco trovano diverse applicazioni nella cura della persona.

Il riuscire ad abbinare la detergenza della cute con la sua cura è uno dei principali obiettivi della cosmetica. Un nuovo sale di zinco, il cui nome INCI è Zinc Coceth Sulfate, è un tensioattivo con proprietà multifunzionali.

Il lavoro illustra la relazione esistente tra cute e zinco e quantifica lo zinco presente a differenti livelli dello strato corneo dopo l'utilizzo di soluzioni acquose di Zinc Coceth Sulfate. Descrive inoltre con l'ausilio di test le proprietà funzionali di Zinc Coceth Sulfate: effetto deodorante (valutazione sensoriale e microbiologica), controllo forfora (conta e valutazione dimensione dei corneociti), rinnovamento cellulare (metodo del dansil cloruro). Vengono altresì illustrate le proprietà dermatologiche (irritazione cutanea/oculare e sensibilizzazione).

Da tutti questi dati si evince che la detergenza con Zinc Coceth Sulfate implica una sorta di legame del catione zinco con la superficie dello strato corneo che permette di spiegarne l'efficacia e la tollerabilità.

INTRODUCTION

Divalent salts (usually Magnesium salts) of alkyl ether sulfates are known for their skin mildness. Zinc alkyl ether sulfates, obtained by a special synthesis and stabilized as regards hydrolysis, represent a new generation in the field of mild surfactants. They are provided with complex functional properties and a wide potential for special application in skin care. The reason for such functionality resides in the same aspect that originally seemed to hinder most cosmetic applications: the easy precipitation of Zinc salts from anionic surfactant solutions containing Zinc ions. This is also the key of its special activity in functional skin cleansing.

Zinc can influence the activity of 90 enzyme or protein complexes in our body. Following intestinal adsorption, it is rapidly transported to the skin (1). Zinc is important in the morphogenesis of the skin, for collagen synthesis and fibroblast proliferation and in repair processes. Its deficiency leads to specific dermatosis that responds promptly to oral or topical treatment (2). Such improvement does not seem to be related to an easy adsorption, but more probably to the activation of repair enzymes (3). Since when zinc oxide is recognised beneficial in wound healing, zinc became the source of common raw materials also in cosmetics. More recently, zinc oxide in micronized form has found extensive applications in sunscreens, as an effective UV-A filter. The wide use of zinc oxide and zinc carbonate (calamine) has an historical background in diaper rash baby cream, lenitive ointments and lotions astringent, mild antibacterial and soothing agent. Lenitive properties of insoluble Zinc compounds seem to be related to their slow release of Zinc ions and to their slightly alkaline pH. Probably Zinc inhibits the release of TCD4+ cell proliferation and stimulates IL-10 (an immunomodulation cytokine) production by

limphomonocytes (4), a process which is beneficial in the treatment of nickel allergies. Even if this property has been described also for soluble zinc salts, like Zinc Sulfate, toxicological precautions have induced the European legislator to limit the concentration of soluble zinc ions in cosmetics to 1%, while no limits exist for its insoluble derivatives (except zinc sulphophenolate and zinc pyritione). Occlusive patch with 25% zinc oxide are not irritant (5) while neither zinc nor its salts are reported to be significant allergens. In the treatment of oral mucosa, zinc showed a protective effect (6, 7).

Zinc coceth sulfate has the molecular structure reported in figure 1.

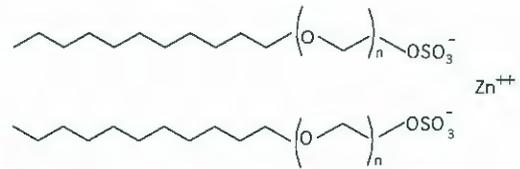


Fig. 1 ($n=3$, alkyl chain coconut based)

MATERIALS AND METHODS

Zinc coceth sulfate solution was provided by Zschimmer & Schwarz Italia, Tricerro.

Other surfactants solutions were provided by the same company. Reagents were analytical grade from Sigma Aldrich.

Solution for evaluation of zinc deposition were prepared at 12.5% a.m. (active matter) Zinc Coceth Sulfate (ZnCS) and respectively 12.5% a.m. SLES. 6 subjects were included in a first study while 4 subjects were included in the second one.

Stripped tapes were extracted by adding 3 ml of 37 % (w/w) HCl, left 5 hours then brought to 50 ml with water and analysed with ICP (Inductively Coupled Plasma Emission Spectroscopy): sample was atomised and exci-

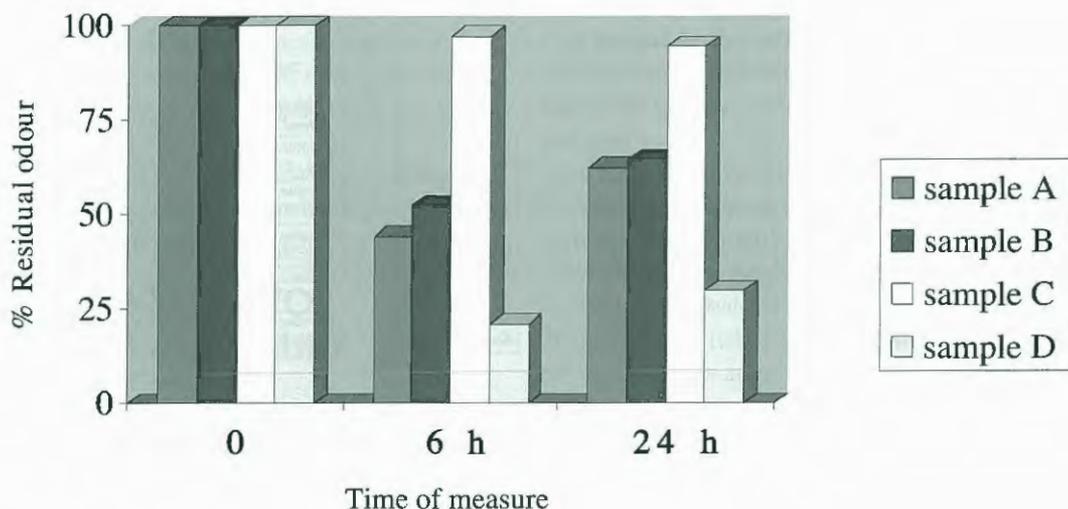


Fig. 4

Dandruff Control Capability

Dandruff is one of the most common and annoying scalp disease induced by disequilibrium of cutaneous homeostasis and worsened by hyperproliferation of saprophyte micro-organisms. Zinc Coceth Sulfate was proved to be able to control dandruff.

16 panellists, in 2 groups, used for two weeks 12% a.m. solutions of, respectively, Zinc Coceth sulfate alone and Sodium laureth sulfate with 0.75% Piroctone Olamine, a well known anti-dandruff agent. Before and after the treatment, the dandruff weight detached after hair brushing was measured. The two solutions gave non significant different results (9).

Table III

SAMPLE	Times	Odour Score			Percentage Decreasing Odour	
		Initial	6 h after last use	24 h after last use	at 6 h	at 24 h
A	Average score	5.4	2.5	3.1	55.7%	37.4%
B	Average score	4.8	1.9	2.8	47.4%	35.3%
C	Average score	3.8	3.7	3.6	2.6%	5.3%
D	Average score	5.0	1.2	1.7	79%	70%

MIC of Zinc Coceth Sulfate for *Pytyrosporom* Ovale and *Malassezia Furfur* was determined in a serial dilution test at pH 5.0. Table IV shows the obtained results.

Table IV

MIC in %	Microorganism
20	<i>Pytyrosporom ovale</i>
12.5	<i>Malassezia Furfur</i>

Cell Turn Over

Experimentally, alpha hydroxy acids effects on cutaneous renewal are measured by the speed of disappearance of a spot (visible under UV lamp) obtained by treating the skin with a solution of dansyl chloride. The comparison between the fluorescence intensity of the skin in the normally washed site (control area) and in skin treated

with 48% Zinc Coceth Sulfate (25% sol.) in presence of 2% alpha-hydroxy acids shows a 28% increase of cell turn-over ($p=0,001$) (10). When the same trial is carried out with the simple aqueous 48% solution of Zinc Coceth Sulfate, a 23% increase over the standard takes place ($p=0,001$) (10).

No significant differences are shown between the two solutions.

Dermal Innocuity

Zinc Coceth Sulfate was tested with the following methods in order to prove it is safe for skin.

Zein Test: Zein, a practically water insoluble cereal protein, when blended with surfactants undergoes a solvation process. A relationship between the irritation potential of a surfactant and the amount of Zein dissolved in water is frequently demonstrated (11).

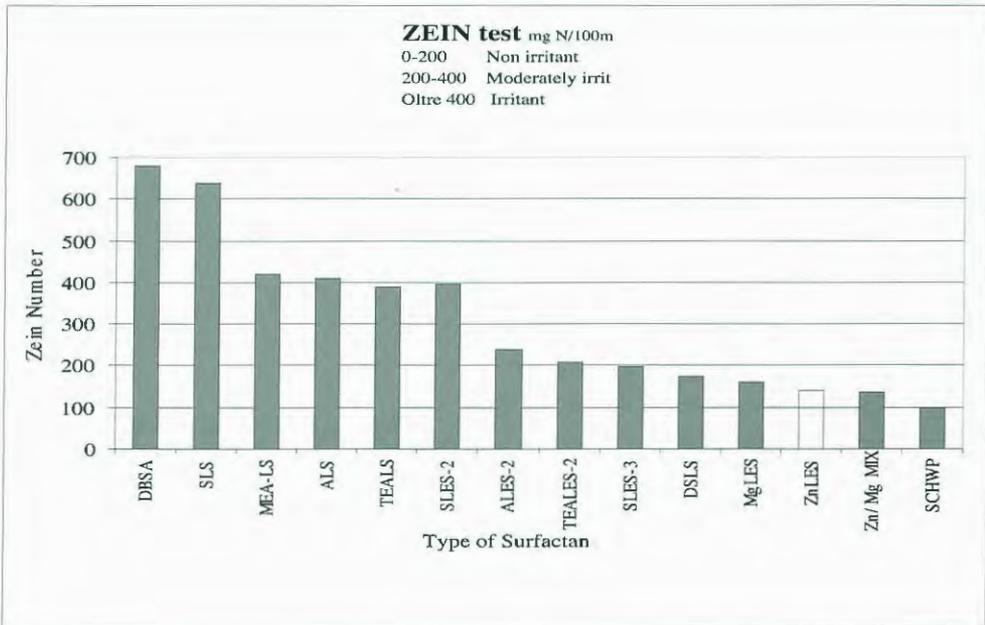


Fig. 5

Table V

DBSA	Dodecylbenzen Sulphonic Ac.	TEALES-2	TEA Laureth-2 Sulfate
SLS	Sodium Lauryl Sulfate	SLES-3	Sodium Laureth-3 Sulfate
MEA-LS	MEA Lauryl Sulfate	DSLS	Disodium Lauryl Sulphosuccinate
ALS	Ammonium Lauryl Sulfate	MgLES	Magnesium Laureth-2 Sulfate
TEALS	TEA Lauryl Sulfate	ZnLES	Zinc Coceth Sulfate
SLES-2	Sodium Laureth-2 Sulfate	Zn/Mg MIX	1/1 Zn Coceth Sulfate/Magnesium Laureth-2 Sulfate
ALES-2	Ammonium Laureth-2 Sulfate	SCHWP	Sodium Cocoyl Hydrol. Wheat Protein

Shelanski and Shelanski Test: Zinc Coceth Sulfate is void of any irritant and sensitising potential. Severe in-vivo trials have demonstrated this quality: as an example, the Shelanski-Shelanski test, carried out on 25 volunteers aged 18 to 70; with 5% a.m. solutions applied in 7 mm Finn Chambers. Treatment was repeated for four weeks, by applying a patch a week. Finally, a revealing patch evidences the possible outcome of sensitisation. Preliminary patches are maintained on the skin for 48 hours. Treated skin site is examined after 15', 1 h and 24 h from patch removal. The revealing patch is identically examined. Evaluation scores are given to the evidenced oedema and erythema, on the basis of their intensity (12).

CONCLUSIONS

The age of functional skin cleansing is still amazing: after various structures of mild surfactants, the use of "colloidal deposition" cations, opened by this new Zinc surfactant, offers elegant and complex formulation potential, allowing interesting blends and tailor-made cutaneous effects for sensitive skin and for restitution cleansing at low pH.

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