

3
2
Vol. 50 No. 6

DISPLAY

November/December 1999

JOURNAL OF COSMETIC SCIENCE

The Official Journal of the Society of Cosmetic Chemists

SCC

Contents

	Page
ORIGINAL PAPERS	
Effect of coconut oil on prevention of hair damage. Part I <i>Aarti S. Rele and R. B. Mohile</i>	327
DNA damage, repair, and tanning acceleration <i>A. A. Vink, P. T. M. Van den Berg, and L. Roza</i>	341
Rheological properties of aerosol foams containing aqueous cationic polymer and anionic surfactant <i>Yoshifumi Yamagata</i>	351
REVIEW PAPER	
Structural characteristics and permeability properties of the human nail: A review <i>Gouri V. Gupchup and Joel L. Zatz</i>	363
INDEXES	
Author index to Volume 50	387
Subject index to Volume 50	391

CHEMISTRY

UNIVERSITY OF WASHINGTON

III 1 2 2000

Journal of Cosmetic Science

The Official Journal of the Society of Cosmetic Chemists

(ISSN 0037-9832)

VOLUME 50 • NUMBER 6

NOVEMBER/DECEMBER 1999

Published by the Society of Cosmetic Chemists

Editor: Joel Zatz, Ph.D., Rutgers University, College of Pharmacy, 160 Frelinghuysen Road, Piscataway, NJ 08854-8020

Associate Editor: Linda Rhein, Ph.D., Smithkline Beecham Consumer, 1500 Littleton Road, Parsippany, NJ 07054

Production: SCC, 120 Wall Street, Suite 2400, New York, NY 10005-4088

Editorial Advisory Board: Daniel Brannan, Ph.D., Abilene Christian University, Abilene, TX 79699

Genji Imokawa, Ph.D., Kao Corporation, 2606 Akabane, Ichikai-machi, Haga, Tochigi, 321-34 Japan

Janusz Jachowicz, Ph.D., ISP, 1361 Alps Road, Wayne, NJ 07470

Kenneth Klein, Cosmetech Labs, Inc., 39 Plymouth Street St 4, Fairfield, NJ 07004-1681

T. Joseph Lin, Ph.D., TJL Associates, 628 Enchanted Way, Pacific Palisades, CA 90272

Robert Lochhead, Ph.D., University of Southern Mississippi, 159 Pompano Road, Hattiesburg, MS 39402

Martin Rieger, Ph.D., 304 Mountain Way, Morris Plains, NJ 07950

R. Randall Wickett, Ph.D., University of Cincinnati, 3223 Eden Avenue, Cincinnati, OH 45267

Executive Director: Theresa Cesario, 120 Wall Street, Suite 2400, New York, NY 10005-4088

President: Karl F. Popp, R.Ph., A.C. Sriefel Research Institute, Route 145, Oak Hill, NY 12460, (518) 239-6901, Fax: (518) 239-8402

Vice President: Joseph P. Pavlichko, Amerchol Corporation, 136 Talmadge Road, Edison, NJ 08818, (732) 248-6070, Fax: (732) 287-4186

Vice President-Elect: Michael Smith, Cosmair, Inc., 189 Terminal Avenue, Clark, NJ 07066, (732) 499-2386, Fax: (732) 499-2929

Secretary: Mort Westman, Westman Associates, Inc., 8 Ivy Lane, Oak Brook, IL 60523, (630) 850-7543, Fax: (630) 850-8786

Treasurer: John Wagner, Jr., Schering-Plough HealthCare, 3030 Jackson Avenue, Memphis, TN 38151, (901) 320-2060, Fax: (901) 320-5132

Subscription: JOURNAL OF COSMETIC SCIENCE, the Official Journal of the Society of Cosmetic Chemists is published six times per year with January/February, March/April, May/June, July/August, September/October, November/December issues. Yearly subscription price is \$200.00.

© Copyright 1999 by the Society of Cosmetic Chemists. Permission is granted to readers and nonprofit libraries acting for them for fair use of the material contained in this Journal. Permission is further granted to quote from this Journal in scientific works with the customary acknowledgment of the source. Consent from EACH OF THE ORIGINAL AUTHORS along with notification to the Society of Cosmetic Chemists is required to reprint a figure, table or other excerpt. The republication, systematic or multiple reproduction of any material in this Journal (including abstracts) is permitted under written license from the Society of Cosmetic Chemists. The Society of Cosmetic Chemists may also require that permission must be obtained from EACH OF THE AUTHORS. Address inquiries to the Editor.

JOURNAL OF COSMETIC SCIENCE, the Official Journal of the Society of Cosmetic Chemists is a registered trademark of the Society of Cosmetic Chemists.

POSTMASTER, MEMBERS AND SUBSCRIBERS: Send address changes to The Society of Cosmetic Chemists, 120 Wall Street, Suite 2400, New York, N.Y. 10005-4088.

Responsibility for Statements Published: The Society of Cosmetic Chemists, the Committee on Publications and the Board of Directors assume no responsibility for statements or opinions advanced by contributors to this Journal.

Missing numbers will not be supplied if claims are received more than 60 days after the date of the issue, or if loss was due to failure to give notice of change of address. The JCS cannot accept responsibility for foreign delivery when its records indicate shipment was made.

Editors and Publishers: Abstracts or digests of articles not exceeding 400 words may be published, duly credited to the author and JOURNAL OF COSMETIC SCIENCE, the Official Journal of the Society of Cosmetic Chemists.

Authors: When using illustrations or quotations taken from copyrighted publications, authors must get written permission from the copyright holder to reproduce the same.

Page Charges: The authors of a manuscript will no longer be assessed a page charge for printed manuscripts. The author will still be responsible for the cost incurred for the printing of color photographs. Any material set into type but ordered deleted from the publication at the page proof stage must also be paid for by the author. These charges will be invoiced to the senior author at the time of publication.

MANUSCRIPTS: Manuscripts should be prepared in accordance with "Information for Authors," copies of which are available from 120 Wall Street, Suite 2400, New York, NY 10005-4088, (212) 668-1500, Fax: (212) 668-1504

Periodicals postage paid at New York, New York and additional mailing offices.

Publication office: 120 Wall Street, Suite 2400, New York, NY 10005-4088
(212) 668-1500, Fax: (212) 668-1504

Structural characteristics and permeability properties of the human nail: A review

GOURI V. GUPCHUP and JOEL L. ZATZ, *College of Pharmacy, Rutgers University, 160 Frelinghuysen Road, Piscataway, NJ 08854.*

Accepted for publication October 15, 1999.

Synopsis

The human nail forms a resistant barrier to the topical penetration of actives. Thus, treatment of nail disorders, such as fungal infections, remains a challenge because of the difficulty encountered in achieving therapeutic concentrations of drugs at the site of infection. The nail is primarily composed of a highly cross-linked keratin network that contains several disulfide linkages. This unique structure results in a highly effective permeability barrier. Nail penetration has been reported to be affected by molecular size and hydrophilicity; smaller, water-soluble molecules are found to preferentially permeate the nail. Permeation of undissociated drugs is favored in certain instances. Also, some studies indicate that the nature of the vehicle can influence drug penetration. Recent research has focused on improvement of penetration of topically applied actives into and through the nail. Studies have shown that compounds containing sulfhydryl groups in conjunction with keratolytic agents can significantly enhance drug penetration, relative to a control formulation (without enhancer). Such sulfhydryl compounds are thought to reduce the disulfide linkages in the nail keratin matrix. Thus, although some success has been achieved in enhancing penetration of drugs through the nail, further research is required to achieve successful topical products for treatment of nail infections.

INTRODUCTION

The human nail acts as a protective covering to the delicate terminal phalanges of the fingers and toes and helps in grasping small objects. Changes in the appearance of the nail result from a variety of conditions such as fungal, bacterial, and viral infections or dermatological disorders (1–3). Various cosmetic procedures such as application of artificial acrylic nails, use of nail hardeners, and manicures can also result in nail disorders (4).

Fungal infections of the nail, called onychomycosis (OM), are some of the most commonly encountered dermatological disorders, typically manifested as localized infections of the nail or nail bed. OM has widespread incidence and is thought to account for 40% of all nail disorders. It is estimated that 4.9–12.3 million people are affected with OM in the United States. The incidence of OM increases with age, and toenails are infected about seven times more frequently than fingernails. Mycotic nail infections are caused by dermatophytes, yeasts, and nondermatophyte molds, although dermatophytes are be-

discoloration of the nail, brittleness, pitting, splitting, hypertrophy, or even complete separation of the nail from its bed (onycholysis) (6). Thus, nail diseases may result in unaesthetic changes in nail appearance. Hence, these disorders require treatments that will eradicate the infection and allow the nails to return to a cosmetically acceptable state.

Current treatment modalities for OM include surgery and oral antifungals. While surgical nail removal (avulsion) is invasive and painful, high doses of oral medication can lead to systemic side effects. These adverse effects combined with treatment times extending to several months, and frequent incidences of relapses observed with oral antifungals, often lead to patient noncompliance and interruption of therapy. Thus, topical therapy is the most desirable, but it has met with limited success to date. The primary reason for the resistance of the nail to topical therapy is the extremely low permeability of the nail plate and thus the inability of actives to reach the site of infection (7). This review will outline the structure, chemical composition, and physical properties of the nail, and will also describe studies used to investigate and improve permeation of actives through the human nail.

STRUCTURAL CHARACTERISTICS OF THE HUMAN NAIL

STRUCTURE AND ANATOMY OF THE NAIL

The nail, shown schematically in Figure 1, consists essentially of the hard, flat, and roughly rectangular nail plate, which is closely connected to the nail bed. The nail bed appears pink in color due to its extensive vascular network, and can be seen due to the translucency of the nail plate. The nail wall surrounds the nail proximally, while the groove-shaped nail fold encloses the nail laterally. The nail root lies 3–5 mm deep within the nail fold and is invisible. The nail plate emerges from the matrix, the distal end of which appears as the whitish crescent-shaped lunula. The eponychium is formed from the epidermis of the proximal nail wall. The stratum corneum of the eponychium forms the cuticle. Below the cuticle lies the matrix. The skin under the free edge of the nail is called the hyponychium (8–9).

The matrix. The matrix is mainly responsible for the formation of the nail plate. During nail plate formation, the basal cells of the matrix flatten, and fragmentation of cell nuclei and condensation of cytoplasm occur to form flat, keratinous cells whose cell borders, in contrast to hair, are retained. The lower cell layers of the matrix contain melanocytes, and this may cause varying degrees of pigmentation of the human nail plate, depending on race (8–9).

The nail bed. The nail bed extends from the lunula to the hyponychium. It does not contribute much to the formation of the nail plate; however, keratin production in the nail bed occurs synchronously with extension of the nail plate. The nail bed acts mainly as a holder and slide for the nail plate (8–9).

The nail plate. The nail plate consists of dead, cornified, adherent cells without nuclei, but with prominent cell borders. The nail plate is 0.5–1.0 mm thick, made of α -keratin, and consists of three layers: the dorsal and intermediate nail, formed from the matrix; and the ventral nail, formed from the nail bed (Figure 1). The dorsal nail is a few cell layers thick and contains hard keratin, while the intermediate nail contains softer keratin

(A)

(B)

(C)

Figure 1. Schematic of the nail plate.

discoloration of the nail, brittleness, pitting, splitting, hypertrophy, or even complete separation of the nail from its bed (onycholysis) (6). Thus, nail diseases may result in unaesthetic changes in nail appearance. Hence, these disorders require treatments that will eradicate the infection and allow the nails to return to a cosmetically acceptable state.

Current treatment modalities for OM include surgery and oral antifungals. While surgical nail removal (avulsion) is invasive and painful, high doses of oral medication can lead to systemic side effects. These adverse effects combined with treatment times extending to several months, and frequent incidences of relapses observed with oral antifungals, often lead to patient noncompliance and interruption of therapy. Thus, topical therapy is the most desirable, but it has met with limited success to date. The primary reason for the resistance of the nail to topical therapy is the extremely low permeability of the nail plate and thus the inability of actives to reach the site of infection (7). This review will outline the structure, chemical composition, and physical properties of the nail, and will also describe studies used to investigate and improve permeation of actives through the human nail.

STRUCTURAL CHARACTERISTICS OF THE HUMAN NAIL

STRUCTURE AND ANATOMY OF THE NAIL

The nail, shown schematically in Figure 1, consists essentially of the hard, flat, and roughly rectangular nail plate, which is closely connected to the nail bed. The nail bed appears pink in color due to its extensive vascular network, and can be seen due to the translucency of the nail plate. The nail wall surrounds the nail proximally, while the groove-shaped nail fold encloses the nail laterally. The nail root lies 3–5 mm deep within the nail fold and is invisible. The nail plate emerges from the matrix, the distal end of which appears as the whitish crescent-shaped lunula. The eponychium is formed from the epidermis of the proximal nail wall. The stratum corneum of the eponychium forms the cuticle. Below the cuticle lies the matrix. The skin under the free edge of the nail is called the hyponychium (8–9).

The matrix. The matrix is mainly responsible for the formation of the nail plate. During nail plate formation, the basal cells of the matrix flatten, and fragmentation of cell nuclei and condensation of cytoplasm occur to form flat, keratinous cells whose cell borders, in contrast to hair, are retained. The lower cell layers of the matrix contain melanocytes, and this may cause varying degrees of pigmentation of the human nail plate, depending on race (8–9).

The nail bed. The nail bed extends from the lunula to the hyponychium. It does not contribute much to the formation of the nail plate; however, keratin production in the nail bed occurs synchronously with extension of the nail plate. The nail bed acts mainly as a holder and slide for the nail plate (8–9).

The nail plate. The nail plate consists of dead, cornified, adherent cells without nuclei, but with prominent cell borders. The nail plate is 0.5–1.0 mm thick, made of α -keratin, and consists of three layers: the dorsal and intermediate nail, formed from the matrix; and the ventral nail, formed from the nail bed (Figure 1). The dorsal nail is a few cell layers thick and contains hard keratin, while the intermediate nail contains softer keratin

(A)

(B)

(C)

Figure 1. Schematic of the nail plate.

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.