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Beneficial Effects of a Sulfur-Containing Supplement on Hair and Nail Condition [1]

A prospective, double-blind study in middle-aged women

By Neelam Muizzuddin, PhD, and Rodney Benjamin

Abstract

Methylsulfonylmethane (MSM) is an organosulfur compound that has been shown to be beneficial for joint health, sports nutrition, and immune function, as well as exerting antiaging effects. It is gaining popularity as a nutritional supplement for support of the hair, skin, and nails. In this double-blind clinical study, 63 subjects ingested either 1 g or 3 g of MSM per day. Expert clinical grading and subject self-assessment were used to evaluate hair and nail condition over 4 months of use. MSM supplementation provided statistically significant improvements in the condition of the hair and nails as determined by expert grading and subject self-assessment. The higher concentration (3 g/day) of MSM delivered quicker and stronger benefits, as compared to the lower concentration (1 g/day). MSM appears to benefit hair and nail health, possibly by its action on keratin, which is a major building-block for the hair and nails.

Introduction

Hair is composed of 95% keratin, a fibrous, helicoidal protein that is a component of the skin and its appendages, including the hair and nails. It is synthesized by keratinocytes and is insoluble in water, which helps to protect the hair and contributes to its impermeability. The hair contains 18 amino acids, including proline, threonine, leucine, and arginine. Keratin is particularly rich in cysteine. Cysteine is a sulfurated amino acid that forms disulfide bonds between molecules and thus lends the structure strength and resistance. Aging and excessive exposure of hair to solar irradiation cause dryness, reduced strength, a rough surface texture, loss of color, decreased luster, stiffness, brittleness, and an overall dull, unhealthy appearance.[1-5]

Nails are composed of a protective protein called alpha-keratin, which imparts tough rigidity. Nails get their strength from 3 linked keratin layers, where oils and moisture cement and lubricate the nail plate. Functionality results from the nail shape, which mirrors that of the underlying bone. Hair and nails that maintain tight inter-corneocyte connections are generally not subject to desquamation. However, hair is shed through life-cycle programming, and nail corneocytes are eroded due to friction and physical activity.

The effect of the diet on aging skin has gained increasing attention over the past few decades[6] and studies on the effects of dietary supplements have confirmed that such supplementation can help to maintain and even improve skin, hair, and nail condition. In 2007, Jacquet et al[7] reported that a dietary supplement containing 100 mg shark cartilage, 1.6 mg vitamin B2, 6 mg vitamin B5, 2 mg vitamin B6, 0.15 mg vitamin B8, and 350 mg fish oil (omega-3 PUFA) had beneficial effects on the skin, hair, and nails and helped to reduce many signs of aging. Other studies have demonstrated that the oral intake of minerals like zinc (zinc monohydrate),[8-11] B vitamins,[10,12,13] and L-cystine[10] has beneficial effects on hair and nails, and 5-alpha-reductase inhibitors are useful for addressing hair loss.[14] While some of these studies demonstrated that oral supplementation can have a positive effect on hair and/or nails, others showed that a lack of nutrient intake has detrimental effects on the hair and nail conditions.

Methylsulfonylmethane (MSM) is naturally present in the environment. It is found in plants as well as the milk of both bovines and humans and may provide a source of sulfur for the essential amino acid methionine.[15] Sulfur-

containing amino acids influence the cellular redox state and the ability to detoxify free radicals, reactive oxygen species, and toxic substances, thus contributing substantially to the maintenance and integrity of cellular systems.[16] MSM sulfur can be assimilated into methionine and cysteine—both sulfur-containing amino acids—to provide a source of dietary fiber. MSM has been reported to affect the compartmentalization and metabolism of sulfur.[17] Animal studies with radioactive dimethylsulfone have indicated that over 80% of orally administered dimethylsulfone is metabolized in rat tissues, while over 10% is incorporated into the body including hair.[18] The distribution of radioactive sulfur in the rat suggests that dimethylsulfone is metabolized to yield sulfur-containing compounds in the body.[18]

> MSM may donate sulfur to keratin, which could help strengthen the bonds between keratin molecules in the hair and nails.

When administered orally, MSM is rapidly absorbed, well-distributed, and efficiently excreted from the body.[19,20] In humans, a daily dosage of 3 g of MSM results in a significant increase in blood MSM after just 2 weeks of treatment, with a continued rise in blood MSM after 4 weeks of treatment.[21] Plasma concentration of MSM is directly correlated with MSM intake; there is no difference in this response between men and women.[22] The peak concentration is reached within the initial 4 weeks of supplementation, and plasma levels do not increase further during subsequent treatment.[22]

MSM is Generally Recognized As Safe (GRAS). It is well-tolerated by most individuals at dosages of up to 4 g daily, with few known and mild side effects.[23] It has been reported to be nontoxic.[19,24]

An increase in levels of glutathione (GSH), superoxide dismutase (SOD), and catalase (CAT) from MSM intake supports the natural antioxidant pathways of the body.[25] MSM reduces levels of homocysteine, which damages collagen crosslinking.[26] While it has also been hypothesized to enhance the production of keratin, a major building block of hair and nails, the literature contains little information on the efficacy of MSM in this area.

Therefore, a prospective clinical study was designed to examine the effect of oral administration of MSM on the condition of the hair and nails. In addition, this study sought to identify the best dose for optimum efficacy.

Material and Methods

The study was conducted at a third-party clinical testing facility (International Research Services Inc. (IRSI), Port Chester, NY) according to IRSI research policies and standard operating procedures, as well as US and international standards of good clinical practice (US Food and Drug Administration and International Conference on Harmonization [ICH] guidelines). The study was approved by the Allendale Institutional Review Board (IRB), and informed consent was obtained from each participant prior to enrollment.

A total of 63 subjects completed the study. The subjects were recruited from the Westchester, NY, area using the subject database of IRSI. The subjects were all females between 35 and 59 years of age with Fitzpatrick Skin Type I-IV. They were healthy with no acute or chronic disease or medical condition, including dermatological problems, that could put them at risk in the opinion of the Principal Investigator or compromise study outcomes. Subjects who regularly used nutritional supplementation (within the previous 2 weeks) were excluded. The subjects were not participating in any other clinical studies involving the face. Subjects with a history of allergic reactions, skin sensitization, and/or known allergies to cosmetic ingredients, toiletries, sunscreens, etc., were also excluded, as were those who were immunocompromised, on hormone replacement therapy, or on oral contraception for less than 3 months before the screening visit. Pregnant and lactating women were excluded. Employees of the testing lab or other testing firms/laboratories, cosmetic or raw goods manufacturers, or suppliers were excluded.

The regular use of facial products and color-cosmetics for at least 2 weeks prior to study enrollment was allowed during the study period. In contrast, the use of other systemic or topical medications and treatments was prohibited during the study.

The panel was divided into 2 groups. Group A (n=31) received a daily dose of 3 g of OptiMSM® 1,000 mg vegetarian capsules containing 100% MSM in a hydroxypropyl methylcellulose shell (Bergstrom Nutrition, Vancouver, WA) and Group B (n=32) consumed 1 g a day of the same product. The subjects were instructed to take the capsules in the morning with or without food for 4 months and to refrain from using any hair or nail treatment products and from receiving manicures for the course of the study.

Expert visual grading of hair shine, volume, overall health and split ends was conducted at baseline and at weeks 4, 8, 12, and 16. This grading scale was created and validated internally by IRSI and used a 1-10 cm scale where 1 was none and 10 was extreme for each parameter. At each time point, the subjects also assessed the same parameters via a questionnaire that asked the participants to indicate their level of agreement with a statement regarding the results on a 5-point scale.

Nails were also visually graded by trained experts using a 1-10 cm scale, where 1 was none and 10 was extreme for nail shine and overall appearance at baseline and at weeks 2, 4, and 8. At each time point, the subjects also assessed the condition of their nails via a questionnaire.

Statistical Analysis

Visual assessments were analyzed with descriptive statistics; paired t-test (monadic). Statistical significance was set at $P<0.05$, and a statistical trend was set at $P<0.01$.

Results

Hair

Figure 1 shows the effects of oral administration of MSM on hair condition. With respect to the visual grading of hair condition (Fig. 1 A-I), there was a statistically significant improvement in hair shine with use of the product. The high dose of 3 g/day clearly improved hair shine soon after the study began (12% improvement vs baseline within 4 weeks; $P<0.05$), and this trend persisted over the course of the study, with highly significant results after 12 weeks (22.9% improvement; $P<0.001$) and 16 weeks (29.7% improvement; $P<0.001$). The lower dose of 1 g/day also improved hair shine versus baseline—significantly ($P<0.05$) after 8 weeks and highly significantly after 16 weeks ($P<0.001$). In the subject self-assessment of hair condition (Fig. 1 A-II), most subjects agreed that supplementation with MSM improved hair shine. Only 1 of the subjects in Group A disagreed after 4 weeks and 16 weeks. Only 2 of the subjects in Group B disagreed after 4 weeks and 16 weeks.

While visual grading of split ends did not show a change with treatment, most subjects noticed some improvement with use (Fig. 1 B-II). In Group A, only 4 subjects disagreed after 4 weeks and 1 disagreed after 16 weeks. In Group B, 4 subjects disagreed after 4 weeks and 2 disagreed after 16 weeks.

Both doses of MSM appeared to significantly increase hair volume after 8 weeks of use ($P<0.001$) (Fig. 1 C-I) and hair volume continued to improve over the course of the study. The high dose (3 g/day) tended to be much more effective than the lower dose (1 g/day). Most subjects agreed that the product improved their hair volume (Fig. 1 C-II).

As shown in Fig. 1 D-I, there appeared to be some improvement in the overall healthy appearance of hair; however, contrary to previous trends, the lower dose tended to be more effective than the higher dose. As with the other parameters, most of the subjects agreed that treatment resulted in an overall healthier appearance (Fig. 1D-II).

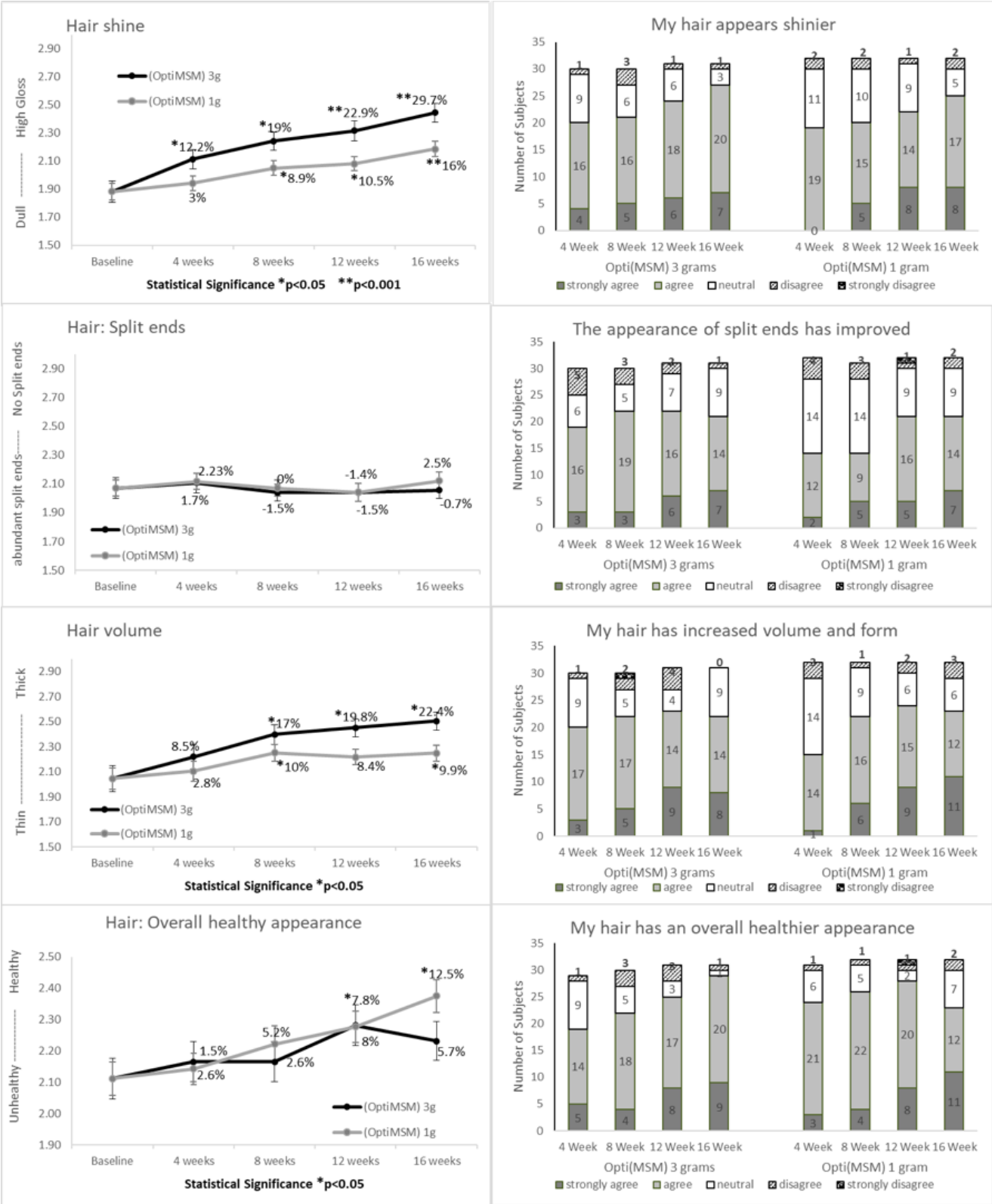

Figure 1. A-I, B-I, C-I, D-I: Hair improvement as assessed by expert visual grading. A-II, B-II, C-II, D-II: Results of subject self-assessment.

Nails

Figure 2 shows assessments of nail condition after treatment with MSM. As observed in Fig. 2 A-I, there was a significant improvement in nail shine within 2 weeks of treatment with MSM at both 1 g/day ($P<0.05$) and 3 g/day ($P<0.001$). While the higher dose was more effective than the lower dose, nail shine continued to improve over the course of the study for both concentrations. Most of the subjects agreed that nail shine improved with treatment (Fig. 2 A-II), and this beneficial effect was evident sooner with the higher dose.

For both doses, there was a significant improvement in overall nail appearance within 2 weeks of supplementation ($P<0.05$) and appearance continued to improve for 8 weeks ($P<0.001$) (Fig. 2 B-I). Furthermore, most subjects agreed that their nails appeared to be healthier (Fig. 2 B-II) and stronger (Fig. 2 B-III) with supplementation.

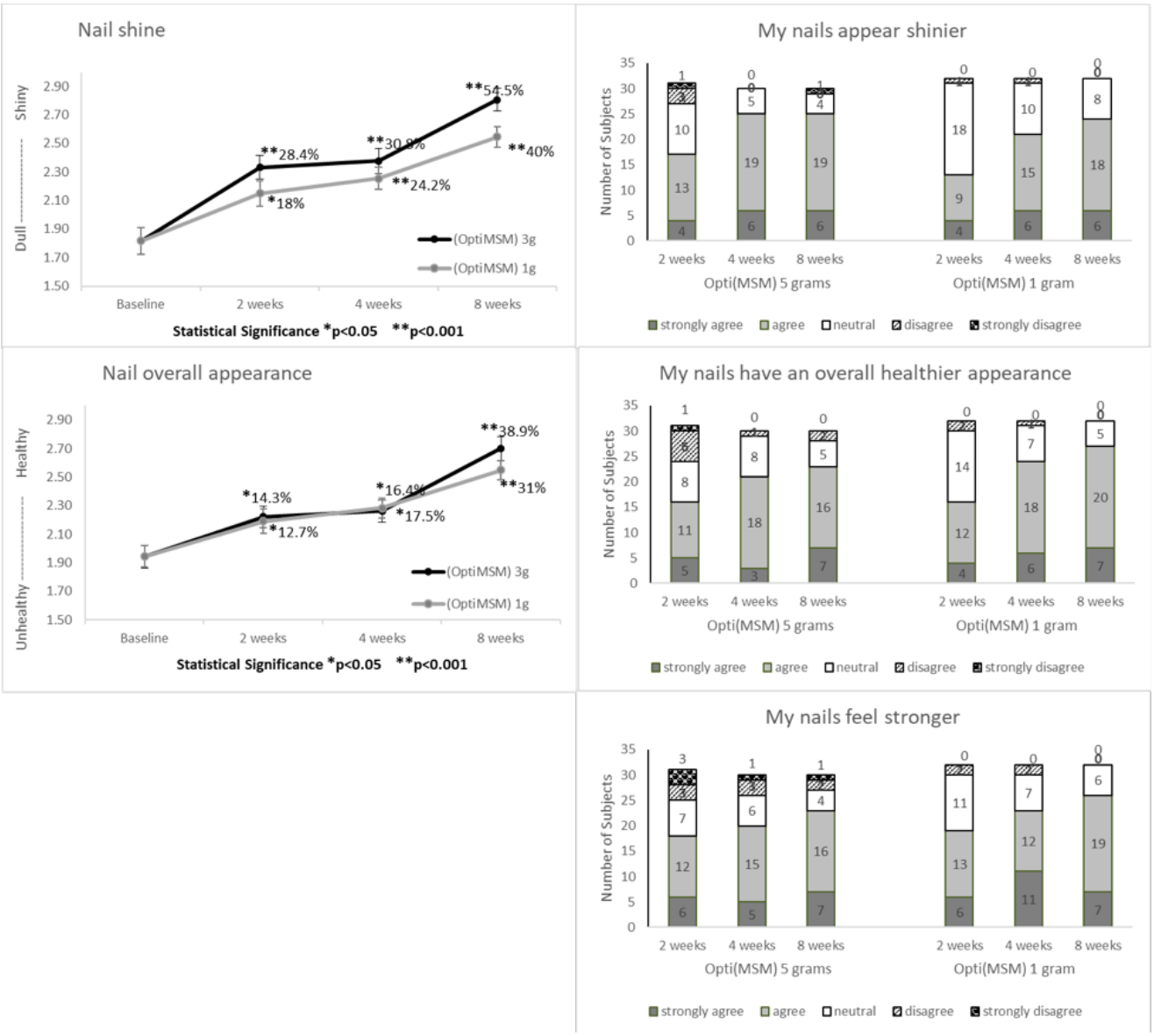

Figure 2. A-I, B-I: Nail improvement as assessed by expert visual grading. A-II, B-II, B-III: Results of subject self-assessment.

Discussion

Although myriad instruments are available to measure the condition of hair and nails, the ultimate satisfaction of the consumer depends on palpable changes as perceived through visual observation and subject self-perception. In this study, participant self-assessment questionnaires indicated overall satisfaction with hair and nail health. Consistent with previous findings for the skin,[27] MSM improved the condition of the hair and nails in

a dose-related manner. Measurable improvements with 2 assessment tools suggest that MSM supplementation is beneficial for hair and nail health in this study demographic. The most noticeable effects were the improvements in hair shine and volume and nail shine. Expert grading revealed a statistically significant improvement in these parameters for both the 3 g/day and 1 g/day doses. Similarly, the subjects themselves reported predominantly positive responses.

MSM is a popular dietary supplement that is used for various reasons, including the maintenance of normal keratin levels in the hair, skin, and nails.[28] Keratin provides intra- and intermolecular hydrogen bonds and large amounts of the sulfur-containing amino acid cysteine required for the disulfide bridges. Extensive disulfide bonding contributes to the insolubility of keratins and thermally stable crosslinking that imparts significant strength and rigidity to hair and nail structures. Human hair is approximately 14% cysteine. The amount of cysteine disulfide keratin determines the strength of the bonds to make hard cells like nails, or softer to make flexible tissue like hair and skin. The more flexible and elastic keratin of human hair has fewer interchain disulfide bridges than that in mammalian fingernails. Supplementation with MSM can provide a good source of sulfur to strengthen these bonds.

Nails can be a barometer of overall health and aging. Like hair, nails undergo changes over time due to disease, internal processes in the body as it ages, nutritional deficiencies, or external factors like long-term exposure to chemicals or ultraviolet light. The growth of nails is known to slow with age. In addition, nails become dull and brittle, and/or yellowed and opaque. Lengthwise ridges may develop, which further compromise the integrity of the nails.

The nail is a specialized skin appendage. It grows approximately 2 to 3 mm per month and achieves complete replacement in 6 to 9 months. Most of the nail plate is made of keratin and contains both “hard” keratin (hair-type) and “soft” keratin (epithelial-type). In addition to these keratins, intermediate filament-associated proteins that are high in sulfur or tyrosine/glycine moieties and the protein trichohyalin are also expressed throughout the nail unit.[29]

Hair-type keratin constitutes 80% to 90% of the nail plate and epithelial-type keratin comprises most of the remaining 10% to 20%. Its overall sulfur content is approximately 10% by weight. The disulfide bonds of cysteine in the matrix proteins are known to greatly contribute to nail hardness by holding the keratin fibers together, thereby contributing to the nail plate tensile strength. Contrary to popular belief, calcium does not contribute to nail hardness and makes up only 0.2% of the nail plate by weight.[30] Although the major contribution to nail-plate hardness is unclear, it is likely due to both the high concentration of sulfur matrix protein and the current hydration state.

Numerous options are available for the treatment of brittle nails, including buffing and moisturizing, application of essential fatty acids, and ingestion of vitamin C, pyridoxine, iron, vitamin D, calcium, amino acids, and gelatin.[13] A nutritional supplement that has been extensively investigated and recently shown promise is biotin, or vitamin H.[31] The present results suggest that MSM could also be a good source of nutrition for nail health.

Conclusion

Under the conditions of this study, oral supplementation with MSM led to significant improvements in the appearance and condition of hair and nails as evaluated by expert grading and participant self-assessment. The higher concentration (3 g/day) of MSM seemed to deliver quicker and stronger benefits compared to the lower concentration (1 g/day). Although the exact mechanism of action is not well understood, it has been hypothesized that MSM may donate sulfur to keratin, which could help strengthen the bonds between keratin molecules in the hair and nails.

Conflict of Interest

Rodney Benjamin received funds from the study sponsor (Bergstrom Nutrition) outside the submitted work. In addition, Benjamin has patents (U.S. Patent 8,217,085 and its foreign counterparts, U.S. Patent 8,546,373, and U.S. Patent 8,841,100 and its foreign counterparts) licensed to Biogenic Innovations. Neelam Muizzuddin received funds from Bergstrom Nutrition for helping to draft this manuscript.

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About the Authors

Neelam Muizzuddin, PhD, operates a consulting company that offers skin clinical research designing, testing, data mining, and training, as well as preparing manuscripts for publication. Muizzuddin has worked in the cosmetic industry for over 3 decades as a clinical research scientist. She has extensive expertise in managing GCP-compliant clinical studies pertaining to safety and efficacy of topical materials and is proficient in using skin bioengineering instrumentations for skin Muizzuddin Neelam is a serious student of the skin microbiome. She has several publications as book chapters, patents, and papers in peer-reviewed journals. She is president of Skin Clinical Research Consultants, LLC, and adjunct professor at SUNY Stony Brook.

Rodney Benjamin has worked extensively with MSM since April 1997. He is currently director of research, development and client technical services for Bergstrom Nutrition. He holds degrees in both chemistry and business administration and is the inventor of numerous methylsulfonylmethane patents. He is considered a subject matter expert on methylsulfonylmethane. He has delivered several interviews and technical presentations both domestically and internationally.

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