JOJ Dermatology & Cosmetics
ISSN: 2689-4610

Juniper Publishers
key to the Researchers

Mini Review
Volume 5 Issue 4 -January 2024
DOI: 10.19080/JOJDC.2024.05.555670

JOJ Dermatol & Cosmet

Hair Invisible Damages

Alessandra Mari Goshiyama*, Marcos Roberto Rossan, Wagner Vidal Magalhães and Flávio Bueno de Camargo Junior

Chemyunion Ltda., Sorocaba, São Paulo, Brazil

Submission: December 18, 2023; **Published:** January 02, 2024

***Corresponding author:** Alessandra Mari Goshiyama, Chemyunion Ltda., Sorocaba, São Paulo, Brazil

Abstract

This mini-review article investigates environmentally damaging factors in hair and scalp, such as exposure to water with metal residues (hard and pool water), air pollution, and solar radiation (UVA/UVB). The extent of damage is closely tied to the frequency of exposure and the condition of the hair fibers, with bleached, dyed, and natural gray and blond hair being more vulnerable. Environmental damage manifests at nano, micro, and macrostructural levels, affecting hair characteristics like shine, strength, softness, and coloration. With a focus on water, air pollution, and solar radiation, this mini review explores the damage and emphasizes the need for detox hair products to avoid or mitigate these effects. Detox products aim to cleanse, eliminate impurities, and reduce the impact of pollutants, metals, and other harmful substances on hair and scalp health. The rising consumer concern for healthier hair underscores the relevance of detox action products in maintaining cleaner, stronger, and more vibrant hair.

Keywords: (Hair Fiber, Pollution, UVA/UVB; Environmental damages; Copper; hard water, metal)

Introduction

The increased quest for healthier hair underscores the importance of delving into potential sources of hair damage. Some of them are well known, such as mechanical damages like brushing and combing, and chemical processes like bleaching, perming, and straightening are acknowledged culprits in compromising the hair fibers health [1,2]. Besides those recognized sources of damage, a set of less apparent threats can be equally or more harmful to the hair fiber. Some of this damage goes unnoticed in our daily routine, and most can be correlated with the surroundings and the environment in which people usually live. The damage can range from nano to macrostructural, being nano when associated with protein and lipid loss, which can occur mainly due to exposure to solar radiation and can be intensified by the presence of other components, such as metals and pollutants in the hair fibers [2].

Mechanical properties and cuticle breakage changes can be observed when moving to microstructural damage. Once macrostructural damage is reached, a shine reduction and the appearance of split ends can be be observed [2], usually when the individual truly perceives and observes the damage. The occurrence of these damages often has not only one cause but an association of different factors. This mini-review article will focus on the damage caused by environmental processes such as exposure to water contaminated with metals (hard and pool water), atmospheric pollutants, and solar radiation (UVA/UVB). The extent of damage caused by these environmental processes is highly correlated with the frequency of exposure and the condition of the hair fibers; bleached, dyed, and gray hair are more affected [3].

The Effect of The Metals Present in the Water on Hair

Water is frequently used in hair care routines, such as washing to help remove sebum and impurities from the scalp and hair fiber. However, when considering water by itself, it is essential to note that depending on the location, the water may contain metal residues such as calcium, magnesium, copper, and iron [4]. The presence of these metals can affect and modify the behavior of hair stress and the performance of hair care products. The use of water with a level of metal ions can lead to changes in the hair fiber characteristics that may result in stiffness, difficulty in combing, reduced shine, increased volume, and mechanical properties modifications [1,2,6]. Some of these characteristic changes may be associated with the presence of metals such as copper (Cu) and iron (Fe) in the hair fiber, which can potentiate and accelerate oxidative damage caused by processes such as bleaching, dyeing, and UV radiation.

These metals are known to catalyze photochemical processes, especially the production of reactive oxygen species (ROS), which can interact with proteins, nucleic acids (DNA), lipids, and pigments present in hair fibers, potentially causing damage to these structures [4-6]. Naqvi and colleagues conducted a study that revealed an increase in protein loss among dyed hair strands lacking a chelating agent. This finding suggests that the presence of copper contributes to the elevated protein loss compared to the samples with chelating agent [7]. Another study by Marsh et al. reported a correlation in virgin hair with copper presence associated with protein loss [8]. The presence of copper ions ($Cu2^{+}$) in pool water, originating from chemicals such as algaecides used for algae control or from old metallic pipes used for water transport, can leave especially blond and white hair (natural or bleached) with a greenish color after prolonged exposure. This color change is due to the interaction of copper sulfate, a blue color substance, with the hair and the deposition of this metal [9-11].

A study conducted by Bhat and collaborators exposed bleached and natural white hair tresses to a solution mimicking the swimming pool environment a containing copper (algaecide); according to the damage in the hair tresses, the impact of the copper in the hair color was different, the bleached hair presented a darker green, as the natural white tresses a lighter green. In a case reported by Tomas and colleagues, a 20-year-old woman experienced greenish coloration in some parts of her hair after swimming in an outdoor community pool. Analytical tests revealed elevated copper levels, approximately 3 ppm, exceeding the recommended limit of 1.3 ppm determined by authorities of Catalunya (Spain). The woman had previously highlighted her hair, resulting in more damaged parts of the hair with potential cuticle damage, that when evaluated in a scanning electronic microscope (SEM), some fibers lacked a cuticle. It was hypothesized whether what was observed was due to a reaction of the excess of copper in the swimming pool with the components of the highlights coloring. According to the authors, the presentation of a strong green coloration only in some highlights supports this hypothesis [12,13].

Another case report by Schwartz and colleagues described a15-years-old teenage girl who experienced a dark green color in her hair after two months in a new house (Northern Virginia). High levels of copper were found at 2.57 ppm in the water from a bathroom sink, caused by copper pipes in the home plumbing system[11]. Water with the presence of calcium (Ca) and magnesium (Mg) in amounts exceeding 120 ppm can be classified as hard water, which can influence characteristics such as combability, softness, and stiffness of the hair fiber, as well as modification in the hair mechanical properties [14-16].

The type and state of the hair can influence the intensity of damage when exposed to hard water [14]. A study by Luqman and collaborators described that Ca and Mg usually stay mostly in the cuticle, the outermost layer of the hair fiber. Still, they wanted to evaluate the impact on the mechanical properties. This study showed a significant decrease in the tensile strength values of male hair types when exposed to hard water compared to the samples exposed to deionized water [15,17]. On the other hand, in another study conducted by Evans and collaborators with virgin and bleached medium brown hair tresses exposed to hard water, it was not possible to observe in a dry state a significant difference in break stress values, compared to the samples exposed to soft water. Additionally, it was possible to observe a significant increase in Young's modulus in hard water-treated bleached hair fibers compared to soft water-treated bleached hair fibers, which supports the increase in stiffness of hair exposed to metals [16].

In the same study in the wet state, the virgin hair treated with hard water presented a significant difference (19%) in the elastic modulus (young modulus) compared to the soft water treated hair. Similarly, break stress values were significantly higher (5%) in hard water-treated virgin hair than those of soft water-treated hair. According to the authors, this result indicates that the calcium and magnesium increased the hair resistance to extend and to break, collaborating with the Salt links (Coulombic interactions) by Feughelman in 1982 [16].. The study made by Godfrey et al. with different types of colored (dyed) hair from ten different countries (Brazil, China, Germany, Japan, Russia, Sweden, Turkey, United Kingdom and the United States) showed that the individuals that classified their hair as poor condition had significantly higher levels of copper (29ppm), calcium (5500ppm), and magnesium (390ppm) in their hair fibers, compared to those who classified the hair as good condition (Cu:27 ppm; Ca: 4375 ppm; Mg: 293ppm) [18].

Structural damage to the hair can be more often observed as a higher frequency of physical damage over time as the hair is washed, combed, or brushed, leading to increased cuticle breakage and the formation of split ends [18,19]. In addition, hard water can potentially alter the performance of cosmetic products. It can reduce the deposition of conditioning agents and the formation of foams (lather capability) and may change the response of the hair fiber in processes such as bleaching, permanent coloring, and straightening [1, 2, 5-7].

The Effect of Air Pollution on Hair

It is already known that exposure to pollutants is a risk factor for human health that can lead to increased oxidative stress, inflammation, allergies, and diseases [20-22]. Pollutants have a negative impact on the skin and hair, mainly enhancing the oxidation and degradation of proteins and lipids, especially when associated with UV radiation, contributing to the aging process in these areas [21-23]. Moreover, the impact of air pollution on hair is a growing concern, with natural phenomena like volcanoes and wildfires contributing to its sources. However, recent increases indicate that the significant production of pollutants stems from human activities, primarily fuel combustion (derived from petroleum and solids) and industrial processes. Air pollution comprises various pollutants, including polycyclic aromatic

How to cite this article: Alessandra Mari G, Marcos R R, Wagner Vidal M, Flávio Bueno de C J. Hair Invisible Damages. JOJ Dermatol & Cosmet. 2024; 5(4): 555670.DOI: 10.19080/JOJDC.2024.05.555670

hydrocarbons (PAHs), volatile organic compounds (VOCs), oxides, and particulate matter (PM) [21, 23-25].

Particulate matter (PM), a mixture of solid particles and droplets in the air, includes visible particles like dust, dirt, and soot. PMs are mainly classified into PM 2.5 and PM 10, where PM 2.5 consists of combustion particles, organic compounds, metals, etc. (size <2.5μm in diameter), and PM 10 includes dust, pollen, mold, etc. (size <10μm)) [3, 21, 23, 24]. These particles (PM) tend to adsorb various compounds with their elevated surface area, transporting transition metals and PAHs on their surface. The PM adhesion to the hair can vary according to hair length, weathering, grooming procedures, and aging [26]. The frequent contact of these harmful substances (PMs and PAHs) with hair fibers can lead to structural modifications, damage to cuticles and cortex, and increased hair surface hydrophilicity, contributing to dullness and roughness, potentially exacerbating under UV radiation [20, 23, 26]. In a study conducted by Galliano and collaborators, virgin Asian hair tresses were exposed to real-life severe (Air Quality Index - AQI – 100 -200 or above) aerial pollution conditions (Baoding, China) and showed that PMs may strongly adhere to the hair surface after 24h of exposure in one single hair (25 cm length).

A rough estimation of PMs was made through SEM images, determining around 10,000 PMs per hair fiber. Under the severe aerial pollution, the exposed hair tresses showed a rougher and duller surface. According to the authors, such observation may be due to the combination of the presence of tiny particulates and PMs (dispersion), along with UV and visible light exposure, and pollution-related oxidative gaseous compounds [26].. A study by QU and collaborators described that virgin Asian hair samples, when exposed to cigarette smoke, significantly decreased contact angle values. After six cycles of exposure (6h), the hair stresses had an 85% reduction in the contact angle value compared to the initial values. The decrease in the contact angle values indicates an increase in hydrophilicity that leaves the hair more permeable to substances. The increase of hydrophilicity characteristic can be correlated with the loss of the 18-MEA (18-methyl eicosanoic acid), an essential lipid presents in the hair surface that air pollution compounds, such as ammoniac compounds, can damage [23]. Additionally, the same group observed a decrease of 90% in tryptophan, an amino acid indicator for measuring protein degradation in hair, caused by exposure to cigarette smoke [23]. As hair readily interacts with the environment, it can absorb water vapor, facilitating the penetration of contaminants in the air. The porous state of hair fibers influences this process – the more porous (damage), the greater the water absorption and, consequently, the transport of pollutants. Besides the impact on hair fibers, pollution exposure can also affect skin health, causing irritation, redness, allergies (atopic dermatitis and psoriasis), and possible exfoliation of the outer scalp layers. Pollutants can disrupt the skin barrier function, making it more permeable to external agents and consequently increasing susceptibility to irritation [22, 27].

Moreover, the presence of particulate matter can negatively influence hair growth by increasing the inflammatory process (production of cytokines) and promoting the formation of reactive oxygen species (ROS) [28]. This can elevate oxidative processes in the follicular region, leading to the apoptotic death of some cell types, such as follicular keratinocytes and can also impact melanocyte function, accelerating the appearance of gray hair [29].

The Effect of Solar Radiation on Hair Fibers and Scalp

Frequent exposure to solar radiation can result in damage to hair fibers, leading to increased roughness, porosity, fragility, and stiffness while diminishing shine and tensile strength and impacting the natural and/or artificial coloration of the hair [2, 5, 30-32]. Within the solar spectrum, we will focus on the effects of UVA/UVB radiation. UVB radiation primarily affects the cuticular region of the hair fiber, while UVA radiation can penetrate the cortex [31]. The former is associated with protein degradation due to the absorption of radiation by chromophores, organic functional groups that absorb in the ultraviolet or visible region [33], present in this region, such as amino acids (tyrosine and tryptophan) and disulfide bonds [34,35] UVA radiation is related to hair fiber depigmentation due to photo-oxidative reactions resulting from forming reactive oxygen species (ROS) [34, 35]. ROS formation occurs through the interaction of UVA radiation with photosensitive structures in the hair [36].

Melanins (eumelanin and pheomelanin) play a role as a natural photoprotector to reduce the effects of ROS on the keratinized matrix. However, they oxidize, changing hair color [30]. Artificial pigments may also undergo oxidation, resulting in a change in color for dyed hair. ROS action in the cortex region can cause damage to the matrix and weaken the hair due to the oxidation of lipids and Amino acids [36]. The impacts of solar radiation, especially UVA/UVB, on hair fibers, can be intensified with the presence of metals and pollutants in the hair fibers and scalp, leading to an increased formation of ROS, as described earlier, causing the oxidation of hair fiber structures [1, 5-7, 27]. In Marsh's study, chemically untreated hair samples with different levels of copper were evaluated whether the presence of this metal would lead to increased protein damage when exposed to UV radiation. The findings indicated an increase in protein loss derived from increased copper level and UV exposure time [8]. Considering the broad and harmful impact of metals and pollutants on the condition of the hair, enhanced by exposure to radiation and other sources of oxidative stress, protection strategies against these agents have been developed for hair care. In this context, solutions capable of chelating metals or preventing the adhesion

How to cite this article: Alessandra Mari G, Marcos R R, Wagner Vidal M, Flávio Bueno de C J. Hair Invisible Damages. JOJ Dermatol & Cosmet. 2024; 5(4): 555670.DOI: 10.19080/JOJDC.2024.05.555670

of harmful substances to the hair, popularly called detoxifying (detox) products, have emerged as useful allies in personal care.

Detox Hair Products

With the search for ways to reduce those harmful effects, the term detox has emerged, which can be related to the word detoxification from the Cambridge dictionary, meaning the process of removing harmful or toxic chemicals ("DETOXIFICATION definition | Cambridge English Dictionary",). This term has been widely used and applied mainly to health and well-being. Nowadays, numerous products, diets, and even treatments with this appeal are significantly present in the personal care market. Evaluating products in the Hair Care market with the detox claim, most are associated with removing substances such as pollutants, metals, fats, and cosmetic residues, aiming to reduce harmful effects on hair fibers and the scalp that can be caused by contact with different substances. Thus, for the development of assets with this objective, it is crucial to understand the primary sources of exposure and their possible effects on the structure of the hair fiber.

Hair products claiming detoxification primarily aim to prevent or reduce the environmental impacts as previously described, thereby promoting the health and well-being of both hair and the scalp. They achieve this by promoting cleanliness, elimination, or reduction of impurities and dirt, thereby decreasing the interaction of these substances with hair fibers and the scalp. One of the critical mechanisms of products with this claim is the removal of particles and dirt, typically accomplished using surfactants. Surfactants are cleaning agents whose primary function is to reduce the adhesion forces (interfacial tension) between impurities/particles and hair fibers, facilitating their removal from hair strands and the scalp [38]. Another mechanism is removing metals from hair strands and the scalp to reduce the potential for photo-oxidative damage caused by transition metals such as iron and copper. This mechanism is achieved using ingredients with chelating properties, binding compounds containing two or more electron-donating functional groups capable of forming structures with medications.

The formulation aims to reduce or eliminate the presence or accumulation of these metals, thereby inhibiting their catalysis to form free radicals. Some detox products also feature antioxidant actives such as green tea extracts, ginger, and vitamins C and E, which aid in reducing ROS. It is crucial for the antioxidant active to reach the cortex region for efficacy, and encapsulation with lipophilic systems (liposomes) can assist in the penetration of these actives into the hair structure. Products are also designed to reduce the contact and interaction of pollutants/metals with hair fibers and the scalp. They achieve this using hydrophobic film-forming actives that protect the hair, facilitating its removal when washed after exposure along with deposited pollutants/substances, presenting a synergistic action with detox products.

The growing concern for the health of hair and the scalp has increased consumer demand for softer, shinier, more resilient hair with minimal frizz and no split ends [39]. Thus, detox action products become significant allies in maintaining cleaner, stronger, and healthier hair.

Conclusion

As the quest for healthier hair intensifies, understanding and addressing environmental sources of damage becomes essential. This mini-review article highlights the often-unnoticed threats posed by exposure to water with metal residues (hard and pool water), air pollution, and solar radiation, emphasizing their impact on hair fibers, especially combined. The complexities of damage, ranging from nano to macrostructural levels, underscore the need for preventive measures, as most of the studies describe the increase of reactive oxygen species formation that can potentialize the oxidative process in the hair fiber and scalp. Detox hair products emerge as pivotal allies, employing surfactants, chelating agents, and antioxidants to cleanse, eliminate impurities, protect, and reduce oxidative damage. With the consumer demand for softer, shinier, and resistant hair on the rise, more studies are necessary to evaluate the efficacy of the products with detox actions that play a crucial role in maintaining hair health in an increasingly urbanized world.

References

1. Robbins CR (2012) Chemical and physical behavior of human hair (5th edn). Springer. Clermont, FL, USA.
2. Marsh J, Gray J, Tosti A (2015) Healthy hair. Healthy Hair pp. 1-136.
3. De Vecchi R, da Silveira Carvalho Ripper J, Roy D, Breton L, Germano Marciano, et al. (2019) Using wearable devices for assessing the impacts of hair exposome in Brazil. Nature Sci Rep 9(1): 13357.
4. Marsh J, Gray J, Tosti A (2015) Understanding Hair Damage. Healthy Hair pp. 45-70.
5. Groves PR (2017) Photodegradation of Hair Proteins: Mechanistic Insights and the Role of Transition Metals. Doctos Philosophy Thesis, University of York, New York.
6. McMichael AJ, Hordinsky MK (2018) Hair and scalp disorders: medical, surgical, and cosmetic treatments. CRC Press. Boca raton, FL, USA pp 326.
7. Naqvi KR, Marsh JM, Godfrey S, Davis MG, Flagler MJ, et al. (2013) The role of chelants in controlling Cu (II)-induced radical chemistry in oxidative hair colouring products. Int J Cosmet Sci 35(1): 41-49.
8. Marsh JM, Iveson R, Flagler MJ, Davis MG, Newland AB, et al. (2014) Role of copper in photochemical damage to hair. Int J Cosmetic Sci 36(1): 32-38.
9. Melnik BC, Plewig G, Daldrup T, Borchard F, Pfeiffer B, et al. (1986) Green hair: guidelines for diagnosis and therapy. J Ame Acad Derma 15(5): 1065-1068.
10. Nordlund JJ, Hartley C, Fister J (1977) On the Cause of Green Hair. Arch Derma 113(12): 1700-1700.
11. Schwartz RH, Yasin SK, Yoo JK (2014) A Teenage Girl with Green Hair. Pediatric Derma 31(4): 497-499.

How to cite this article: Alessandra Mari G, Marcos R R, Wagner Vidal M, Flávio Bueno de C J. Hair Invisible Damages. JOJ Dermatol & Cosmet. 2024; 5(4): 555670.DOI: 10.19080/JOJDC.2024.05.555670

12. Bhat GR, Lukenbach ER, Kennedy RR, Parreira RM (1979) The green hair problem: A preliminary investigation. J Soc Cosmet Chem 30(2): 1-8.
13. Tomas X, Nogueras M, Bartolome A, Ferrando J (2022) Pseudo green hair. Int J Trichol 14(2): 65.
14. Evans AO (2011) Investigation of the Interaction between Water Hardness Metals and Human Hair. ProQuest Dissertations and Theses.
15. Luqman MW, Ali R, Khan Z, Ramzan MH, Hanan F, et al. (2016) Effect of topical application of hard water in weakening of hair in men. JPMA J Pak Med Assoc 66(9): 1132-1136.
16. Evans AO, Marsh JM, Wickett RR (2011) The structural implications of water hardness metal uptake by human hair. Int J Cosmet Sci 33(5): 477-482.
17. Luqman M, Ramzan M, Javaid U, Ali R, Shoaib M, et al. (2018) To evaluate and compare changes in baseline strength of hairs after treating them with deionized water and hard water and its role in hair breakage. Int J Trichol 10(3): 113.
18. Godfrey S, Staite W, Bowtell P, Marsh J (2013) Metals in female scalp hair globally and its impact on perceived hair health. Int J Cosmet Sci 35(3): 264-271.
19. Marsh JM, Davis MG, Lucas RL, Reilman R, Styczynski PB, et al. (2015) Preserving fibre health: Reducing oxidative stress throughout the life of hair fibre. Int J Cosmet Sci 37(Suppl 2): 16-24.
20. Naudin G, Bastien P, Mezzache S, Trehu E, Bourokba N, et al. (2019) Human pollution exposure correlates with accelerated ultrastructural degradation of hair fibers. Proc Natl Acad Sci USA 116(37): 1840-18415.
21. Rembiesa J, Ruzgas T, Engblom J, Holefors A (2018) The impact of pollution on skin and proper efficacy testing for anti-pollution claims. Cosmet 5(1): 4-13.
22. Drakaki E, Dessinioti C, Antoniou CV (2014) Air pollution and the skin. Front Environ Sci 2(5): 11: 1-6.
23. Qu X, Niu L, Kroon B, Foltis L (2018) Pollution damage and protection of Asian hair. Cosmetics 5(1): 1-9.
24. Richard F, Creusot T, Catoire S, Egles C, Ficheux H (2019) Mechanisms of pollutant-induced toxicity in skin and detoxification: Anti-pollution strategies and perspectives for cosmetic products. Anna Pharma Fr 77(6): 446-459.
25. Kim KH, Kabir E, Kabir S (2015) A review on the human health impact of airborne particulate matter. Environ Int 74: 136-143.
26. Galliano A, Ye C, Su F, Wang C, Wang Y, et al. (2017) Particulate matter adheres to human hair exposed to severe aerial pollution: consequences for certain hair surface properties. Int J Cosmet Sci 39(6): 610-616.
27. Dijkhoff IM, Drasle, B, Karakocak BB, Petri-Fink A, Valacchi G, et al. (2020). Impact of airborne particulate matter on skin: A systematic review from epidemiology to in vitro studies. Particle and Fibre Toxicol 17(1): 35.
28. Jun MS, Kwack M H, Kim MK, Kim JC, Sung YK (2020). Particulate matters induce apoptosis in human hair follicular keratinocytes. Ann Dermatol 32(5): 388-394.
29. Trüeb RM (2006) Pharmacologic interventions in aging hair. Clinical Inteiventions in Aging, 1(2): 121-129.
30. Santos Nogueira AC, Joekes I (2004) Hair color changes and protein damage caused by ultraviolet radiation. J Photochem Photobiol B 74(2-3): 109-117.
31. Šebetic K, Masnec IS, Èavka V, Biljan D, Krolo,I (2008). UV damage of the Hair. Collegium Antropologicum 32(2): 163-165.
32. Daiio, MF, Baby AR, Velasco M VR (2015) Effects of solar radiation on hair and photoprotection. J Photochem Photobiol B (153): 240-246.
33. Ferreira VR (2022) Cyomophoes - Chemistry.
34. Kirschenbaum L (2000) Oxygen radicals from photo irradiated human hair: an ESR and fluorescence study Journal of cosmetic (51): 169-182.
35. Locke B, Jachowicz J (2005) Fading of artificial hair color and its prevention by photofilters. Journal of Cosmetic Science, 56(6): 407-425.
36. Fernández E, Martínez-Teipel B, Armengol R, Barba C, Coderch L (2012) Efficacy of antioxidants in human hair. J Photochem Photobiol B 117(9): 146-156.
37. Cambridge University D (n.d.) Detoxification definition | Cambridge English Dictionary.
38. Maria Fernanda Reis Gavazzoni Dias (2015) Hair cosmetics: An overview. Int J Trichology 7(1): 2-15.
39. Maish JM, Davis, MG, Flaglei MJ, Sun Y, Chaudhary I, Mamak M, et al. (2015) Advanced hair damage model from ultra-violet riadiation in the presence of copper. Int J Cosmet Sci 37(5): 532-541.

DOI: 10.19080/JOJDC.2024.05.555670

How to cite this article: Alessandra Mari G, Marcos R R, Wagner Vidal M, Flávio Bueno de C J. Hair Invisible Damages. JOJ Dermatol & Cosmet. 2024; 5(4): 555670.DOI: 10.19080/JOJDC.2024.05.555670