

# UV Damage of the Hair

Klaudija Šebetić<sup>1</sup>, Ines Sjerobabski Masnec<sup>1</sup>, Vlatka Čavka<sup>1</sup>, Darko Biljan<sup>2</sup> and Ivan Krolo<sup>3</sup>

<sup>1</sup> Department of Dermatology and Venerology, University Hospital »Sestre milosrdnice«, Zagreb, Croatia

<sup>2</sup> Department of Dermatology and Venerology, University Hospital »Osijek«, Osijek, Croatia

<sup>3</sup> Department of Radiology, University Hospital »Sestre milosrdnice«, Zagreb, Croatia

## ABSTRACT

*Hair is a very important for our self-confidence as well as a very important part of appearance and self-concept. It reflects our personality and hair loss or hair damages are considered aesthetic imperfections and social handicap. Outward part of the hair is a »hair shaft« keratin fiber structure sensible to external effects whether they are mechanical, physical or chemical. Excessive sun exposition is the most frequent cause of hair shaft's structural impairment. Photochemical impairment of the hair includes degradation and loss of hair proteins as well as degradation of hair pigment. Hair protein degradation is induced by wavelengths of 254–400 nm. UVB radiation is responsible for hair protein loss and UVA radiation is responsible for color changes. Absorption of radiation in photosensitive amino acids of the hair and their photochemical degradation is producing free radicals. They have adverse impact on hair proteins, especially keratin. Melanin can partially immobilize free radicals and block their entrance in keratin matrix. It also absorbs and filters adverse UV radiations. Therefore melanin is important for direct and indirect protection of hair proteins. Protecting the cuticle is very important for keeping hair shaft's integrity. One can achieve that by avoiding noxious impacts or by implementation of hair care products with UV filters. Nowadays major studies and researches are conducted in order to create hair care products that prevent hair damage.*

**Key words:** hair, UV radiations, free radicals, hair care products

## Introduction

Hair has a great social significance for human beings. It is a very important for our self-confidence as well as a very important part of appearance and self-concept. It reflects our personality and hair loss or hair damages are considered esthetic imperfections and social handicap. Outward part of the hair is a »hair shaft« – keratin fiber structure sensible to external effects whether they are mechanical, physical or chemical. Photo ageing of the skin is nowadays very explored and researched domain by scientists and large pharmaceutical companies who are producing more and more advance-technology anti-age cosmetics. In recent times attention is directed also on photo ageing of the hair and major studies and researches are conducted in order to create hair care products that prevent hair damage.

## Hair Structure

Hair is composed of heavily melanized keratin fibers. Keratin is insoluble protein complex that forms 65% to 95% of hair fiber volume. It is consisted of amino acids bounded with all sorts of bounds (amid, disulfide, hydrogen, ionic and hydrophobic)<sup>1</sup>. Amid bounds are strongest and they can be broken only by impact of very strong acids and alkalis or by cutting. Once broken, they can never be restored. Central part of the hair (medulla) is surrounded with cortex – the greatest mass of the hair shaft. The melanin granules are located inside the cortex and constitute 3% of hair fiber volume. There are two types of melanin: eumelanin (dark-brown pigment) and pheomelanin (red pigment)<sup>1</sup>. Type, size, amount and distribution of melanin granules inside the cortex as well as thickness of hair shaft and content of air in hair shaft, es-

establish hair color. Cortex is surrounded with cuticle, protective layer of overlapping keratinized scales that constitute 10% of hair fiber volume. Cells of cortex and cuticle are bonded with structural lipids. Hair shaft is also consisted of other proteins (17%) and minerals (0.5%)<sup>2</sup>.

### Hair Damage Caused by Ultraviolet Radiation

All adverse external impacts that are causing degeneration of hair are called »weathering« by Rook and his associates. Excessive sun exposition is the most frequent cause of hair shaft's structural impairment. Dryness, reduced strength, rough surface texture, loss of color, decreased lustre, stiffness and brittleness of hair are caused by sun exposure<sup>3</sup>. UVB radiation maintains in cuticle area, while UVA radiation passes through cuticle and penetrates to cortex. Photochemical impairment of the hair includes degradation and loss of hair proteins as well as degradation of hair pigment. Hair protein degradation is induced by wavelengths of 254–400 nm<sup>2</sup>. UVB radiation is responsible for hair protein loss and UVA radiation is responsible for color changes<sup>2,3</sup>. Amino acids cystine, methionine, tryptophan, tyrosine and histidine are the most submissive to photochemical degradation. Ultraviolet radiation is causing oxidation of aforementioned amino acids as well as oxidation of the amid carbon of polypeptide chains<sup>4</sup>. These reactions are giving yellowish tone to the hair, which is called »photoyellowing«<sup>5</sup>. The amino acids of the cuticle are altered to a greater extent than those of the cortex because the outer layers of the fiber receive higher intensities of radiation<sup>5</sup>. This exposure can cause rupture and detachment of the external layers resulting in splitting of the ends. Portion of certain amino acids depends on the type of hair. Dark and black hair has more photosensitive amino acids (for example cystine) than fair hair<sup>2,5</sup>. Therefore dark and black hair has the biggest protein loss in the cuticle area. Increased exposition to sunlight also causes disappearance of lipids and cuticular layer, which contributes to hair changes. UVB radiation causes superficial micro structural changes of cuticle. Such damaged protective layer of hair shaft enables further degradation processes. Those impairments are even more expressed in conditions of very enhanced or decreased humidity. Melanin absorbs and filters adverse UV radiations (UVA and UVB) and subsequently dissipates this energy as heat<sup>2,5</sup>. Therefore it protects hair proteins. However absorption

of radiation in photosensitive amino acids of the hair and their photochemical degradation is producing free radicals. They have adverse impact on hair proteins, especially keratin. Melanin can partially immobilize free radicals and block their entrance in keratin matrix<sup>2</sup>. Therefore melanin is important for direct and indirect protection of hair proteins. In described processes of photo protection melanin fades. Opinions about photo stability of feomelanin and eumelanin (resistance of dark and fair hair towards UV radiation) are divided<sup>6</sup>. Some authors are considering dark hair to be more resistant to photo degradation regarding to larger photo stability of eumelanin. On the other side there are opinions of less degradable pheomelanin. Anyway it seems that resistance of dark and fair hair to photo oxidation is not related to type of melanin but with its quantity. In fact, hair with more pigmented granules shows less protein loss during exposition of UV radiation<sup>7,8</sup>.

### Hair Care

Protecting the cuticle is very important for keeping hair shaft's integrity. One can achieve that by avoiding noxious impacts or by implementation of hair care products with UV filters<sup>9</sup>. Physical and chemical filters achieve protection from UVA and UVB radiation<sup>10</sup>. Physical filters are surface protectors that are reflecting ultraviolet rays of all wavelengths<sup>10,11</sup>. Most common physical protectors are titanium dioxide and zinc oxide. Chemical filters are preventing penetration by absorbing UV rays<sup>12</sup>. The best filter with wide spectrum is benzophenone<sup>13</sup>. UVB photo filters, such as octyl methoxy cinnamate, absorb less than 25% of the total UV irradiation at concentrations as high as 30 mg/g hair<sup>14</sup>. UVA absorbers were found to be more effective, with benzophenone-3 and benzophenone-4 absorbing about 40% of UV at the same concentration<sup>7,13,14</sup>. The UV filters represent a first defense line aimed to reduce the amount of UV radiation that reaches the hair structure<sup>14,15</sup>. Antioxidants constitute a second defense line by reducing the amount of free radicals generated inside the hair<sup>16</sup>. UVB filters are more efficient than UVA filters to avoid the free radical production in hair<sup>16</sup>. Antioxidants have to penetrate into the hair structure and must interact with the melanin polymer to be efficient<sup>16</sup>. The encapsulation in suitable carrier systems (for example liposomes) enhances the penetration capacity of actives into the hair and protects the antioxidants against oxidation<sup>16</sup>.

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K. Šebetić

*Department of Dermatovenerology, University Hospital »Sestre milosrdnice«, Vinogradska cesta 29, 10000 Zagreb, Croatia  
e-mail: klaudija.sebetic@email.t-com.hr*

## **OŠTEĆENJE KOSE UV ZRAKAMA**

### **S A Ž E T A K**

Kosa je vrlo važna za naše samopouzdanje, te je vrlo važan dio našeg izgleda i samopoimanja. Ona je odraz naše osobnosti, te se njezino oštećenje ili gubitak smatraju estetskim manama kao i socijalnim hendikepom. Vlas je građena od keratinskih vlakana osjetljivih na čimbenike iz okoline (mehaničke, fizičke ili kemijske). Pretjerano izlaganje kose suncu je najčešći uzrok oštećenja strukture stabljike vlasi. Fotokemijsko oštećenje vlasi uzrokuje degeneraciju i gubitak proteina i pigmenta vlasi. Degradaciju proteina uzrokuju valne duljine u spektru između 254 do 400 nm. UVB zračenje uzrokuje gubitak proteina vlasi, a UVA zračenje promjene boje. Apsorpcija zračenja uzrokuje fotokemijsku degradaciju aminokiselina koje su sastavni dio keratina, što dovodi do stvaranja slobodnih radikala. Oni imaju štetan učinak na proteine kose, posebno keratin. Melanin djelomično imobilizira slobodne radikale i sprečava njihovo prodiranje u matriks keratina. Melanin također i apsorbira u određenoj mjeri štetna zračenja, te je stoga odgovoran za izravnu i neizravnu zaštitu proteina kose. Za očuvanje integriteta vlasi važno je sačuvati kutikulu. To se može postići prvenstveno izbjegavanjem štetnih utjecaja i primjenom sredstava za njegu kose koje sadrže UV filtre. Danas se provode brojna istraživanja i studije da bi se stvorili što bolji pripravci za njegu kose koji će spriječiti njezina oštećenja.