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RESEARCH ARTICLE

Resveratrol, Blueberry, Cranberry and Raspberry Exhibit Protection Effect to Photodamaged Hair

Julia de Souza Gomes[1], Marina Silva Rita[1], João Marcos da Cunha Altomare[1], Nadia Rezende Barbosa Raposo[2], Marcos Antônio Fernandes Brandão[2] and Hudson Caetano Polonini[1,3]*

[1]*Faculdade de Ciências Médicas e da Saúde de Juiz de Fora (Suprema), Juiz de Fora, Brazil*

[2]*Núcleo de Pesquisa e Inovação em Ciências da Saúde (NUPICS), Universidade Federal de Juiz de Fora (UFJF), Juiz de Fora, Brazil*

[3]*Ortofarma Laboratório de Controle de Qualidade, Matias Barbosa, Brazil*

***Corresponding author:** *Hudson Caetano Polonini, Faculdade de Ciências Médicas e da Saúde de Juiz de Fora, Alameda Salvaterra, n. 200, Bairro Salvaterra, CEP 36.033-003, Juiz de Fora MG, Brazil, Tel: +55-32-2101-5000*

Abstract

When hair is exposed to the sun there may occur protein degradation, which alters its physical appearance. Thus, beneficial hair adjuvants with addition of natural sunscreens are sought for cosmetics development. In this study, we developed hair conditioning products containing blueberry, raspberry, cranberry and resveratrol in different proportions, incorporated into TrichoCond®. *In vitro* photoprotection capacities of the products and cystine content of the hair samples after treatments were determined. Two conditioners out of the seven tested presented a significative sun protection. Three samples of treated hair presented suitable results in maintenance of the cystine content in the hair fiber after sun exposure. Hair conditioning products developed using resveratrol (alone or in combination) showed better hair fiber protection against solar radiation. The materials used showed increased photoprotection when used in combination, suggesting a synergic effect among them.

Keywords

Sunscreens, Blueberry, Raspberry, Cranberry, Resveratrol

Introduction

Hair fibers are prone to suffer external aggressions over their life cycle, such as rain, pollution and ultraviolet (UV) radiation from the sun. This last is also considered one of the main factors that leads to hair aging, as it damages the lipids in the hair fiber and oxidizes its pigments. Additionally, when hair is exposed to the sun, the structural integrity of its fibers may undergo changes caused by protein degradation, which can be seen to the naked eye as dryness and decreased brightness and color [1-3].

It is noteworthy that the natural, intrinsic hair protection, i.e., the presence of pigments such as melanin, is not sufficient for photoprotection [4]. In this sense, external adjuvants to hair protection are sought, possibly added to shampoos of conditioners. Additionally, photoprotective adjuvants from natural sources are among the current trends, because of their alleged lower aggression to the environment [5,6].

Traditionally, natural UV products contain a significative number of polyphenols, once they are known to possess remarkable antioxidant activity and capacity to absorb UV radiations [5,7,8]. These molecules are also expected to protect the hair fibers against the oxidation of their proteins and lipids [2].

Based on the arguments presented, this study focused on four natural substances with possible photoprotective action to hair fibers: *Vaccinium myrtillus L.* (blueberry), *Vaccinium macrocarpon* Aiton (*cranberry), Rubus idaeus L.* (raspberry) and *Polygonum cuspidatum* (Japanese Knotweed), once all of them contain a high constitution of phenolic compounds. Using these substances alone or combination, the objective was to develop a hair conditioner that would be able to protect the hair fiber against solar radiation and maintain its proteins intact.

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Table 1: Formulation and sun protection results for the conditioners developed.

Formulation	Ingredients						SPF	UVAPF	λc (nm)	Ratio UVA/UVB
	Blueberry	*Cranberry*	*Raspberry*	Resveratrol	Glicerin	TrichoCond™				
F1	-	-	-	-	5%	95 mL	-	-	-	-
F2	-	-	15%	-	5%	80 mL	-	-	-	-
F3	-	15%	-	-	5%	80 mL	-	-	-	-
F4	15%	-	-	-	5%	80 mL	-	-	-	-
F5	10%	10%	10%	-	5%	65 mL	-	-	-	-
F6	-	-	-	15%	5%	80 mL	10	2	348	0.380
F7	5%	5%	15%	5%	5%	65 mL	14	2	348	0.346

Results expressed as the average of 27 determinations (3 plates x 9 readings each).

SPF: Sun Protection Factor; UVAPF: UVA Protection Factor; λc: Critical Wavelength.

Table 2: Cystine quantification on hair treated and exposed to solar radiation.

Treatment	Amount of cystine (%)†
F1	5.2 (± 0.11)
F2	< 0.7
F3	< 0.7
F4	< 0.7
F5	< 0.7
F6	18.9 (± 4.55)
F7	28.7 (± 7.23)
Positive Control	< 0.7
Negative Control	< 0.7

Results expressed as mean ± standard deviation; Positive Control: Treatment sample with 20% w/w aqueous sodium lauryl sulfate solution; Negative Control: Hair sample without danger type of treatment; †0.7% corresponds to the limit of quantification of cystine in the analytical solution corrected for dilutions made of the hair.

Methods

Hair products

Seven different hair conditioners were evaluated using TrichoCond™ (Fagron, Brazil) as a cosmetic base and the following raw materials: Blueberry dried extract (Florien, Brazil), cranberry dried extract (Viafarma, Brazil), concentrated ketones extracted from raspberry (Viafarma, Brazil) and trans-resveratrol extracted from Japanese Knotweed (Viafarma, Brazil). The composition of the products is described in Table 1.

Photoprotection assay

Samples were weighed (32.5 mg) on polymethylmethacrylate plates (n = 3). The plates were then protected from exposure to light in a darkroom at room temperature (≈ 20 °C) for 15 minutes, and thereafter were measured at 290 nm to 450 nm at 1 nm intervals at 9 different sites of each plate, using a transmittance analyzer (UV2000S, Labsphere, USA). For UVAPF (UVA Protection Factor), the plates were inserted into UVA irradiation source (Atlas Suntest, Germany) and then exposed to a calculated UV dose. After that, new measurements of transmission of the sunscreen samples were carried out to acquire the second UV spectrum and then the final UVAPF, UVA/UVB ratio and critical wavelength (λc) were calculated. A detailed protocol and a theoretical framework can be found in Polonini and colleagues (2013) [9]. All results were expressed as an average of 27 determinations (3 plates, 9 readings each, at different sites).

Cystine content analysis

To estimate maintenance of protein content, samples of natural hair (untreated, with lights and dyed) were separated into wicks of approximately 1 g, which were then cut and identified in S1 (near root), S2 (medium) and S3 (tip) and stored in plastic bags at room temperature until analysis.

These hair samples were submitted to treatments with the formulations F1-F7. Positive Control was treated with 20% w/v aqueous sodium lauryl sulfate solution to simulate hair damage. Negative Control was represented by hair in which no treatment was performed.

To simulate the exposure of hair to the photolytic action of sunlight, the hair samples were exposed to a sunlight dose of 2.35 J/cm^2 (Atlas Suntest, Germany). Subsequently the hair was hydrolyzed in acidic solution (30% hydrochloric acid, v/v) for 9 hours at 115 °C. Thereafter, a liquid phase was filtered and neutralized with 18% ammonium hydroxide (v/v) to a pH value of 4.8 (cystine isoelectric point). This sample was incubated for 20 hours at ambient temperature for precipitate formation, which was redispersed with 6% (v/v) hydrochloric acid, followed by decolorization for 30 minutes at 80 °C using 4% activated carbon solution (m/v). The solution was filtered again and the obtained filtrate was hair hydrolyzate. Cystine can reduce Fe^{3+} to Fe^{2+} and can react with phenanthroline to form a stable colored ternary complex, which has a maximum absorption value at 510 nm. Therefore the cystine content of the hair hydrolyzate was colorimetrically determined.

Results and Discussion

From the seven conditioners developed, only two presented significative photoprotective parameters (F6 and F7), but the results were limited to UVB region (Table 1). Although the importance of UVA radiation in promotion of hair color change [10], tests were continued, so to evaluate the effects of the products on protein protection.

Quantification of cystine evaluates indirectly the decomposition of the hair fiber, once it is constituted of 65-95% of proteins. Cystine is an amino acid found mostly in the hair outermost layer and is present in about 12% of the hair proteins, especially keratin. It is considered a stable compound; however, in contact with UV radiations it can undergo denaturation, which affects the mechanical properties of the hair [11-13].

Hair samples treated with F1, F6 and F7 presented significative preservation of cystine samples (Table 2), suggesting a possible effect on stabilization of proteins structure in the hair, even with low UVA protection. In fact, samples with no treatment or washed only with sodium lauryl sulphate (used to simulate hair damage) showed cystine content under the limit of quantification of the method. This is accordance with Scanavez, et al. [14], who wrote that surfactants used for hair washes can interfere with the physical structure of the hair fiber, because they act on the extractable substances of the cortex and the cuticle.

The findings are in accordance with previous reports from literature. For instance, Bucci, et al. [15], found out that 16% (m/v) blueberry ethanolic extract liposomes resulted in effective skin protection against UV radiation. Other studies, such as those described by Araújo, et al. [16] and Polonini, et al. [9], have shown that resveratrol has a potential photoprotective action on skin when added to cosmetic base lotion, which increases when associated with other plant species. This meets our results once the SPF of the conditioner containing resveratrol in association with other vegetable derivatives presented higher SPF than the conditioner containing only this substance.

Araújo, et al. [16] also reported photoprotective activity for cosmetic-based skin containing raspberry ketones (20%, w/v). In addition, when associated with resveratrol (20%, w/v), the protective action against UVA and UVB radiation was noteworthy, which also agrees with the present data.

To sum up, the results show that is possible to create conditioners that could act protecting the hair from UV radiations, maintaining the hair proteins structure. However, a better SPF and UVAPF should be obtained for a better placement of the product in the market. To sum up, two conditioners showed suitable SPF, but low UVA protection. Despite of this, the products compounded with TrichoCond® exhibited a capacity to protect the hair proteins. This suggests that the substances, specially resveratrol, can be used for hair products claiming hair protection from the sun.

Sources of Support

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Statement

All authors contributed equally to this article.

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