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"Global well-aging solution for scalp and hair: a natural up-cycled multi-functional ingredient"

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1. Introduction

Scalp and hair health plays a huge role in overall appearance and self-perception. The aging of hair and scalp is particularly visible, and the hair care industry has a substantial interest in delivering products that meet consumer expectations in this area. With age, scalp becomes dryer and less elastic, and less resistant to external stress as well as less protective of hair health. This leads to an increase of scalp oxidation, and to a decrease of hair health - affecting hair appearance as manifested in reduced shine, increased roughness and dryness, grey hair, and hair loss.

It is known that the condition of the hair fiber must be viewed as the result of a combination of pre-emergent and of post-emergent factors [1]. Sources of oxidative stress impacting the preemergent fiber include oxidative metabolism, smoking, UVR, inflammation from microbial, pollutant, or irritant origins, and oxidized scalp lipids. Sources of oxidative stress with impact on the post-emergent fiber include UVR enhanced by the presence of copper, and chemical insults from oxidizing hair colorants and pollutants [2]. It is thus important to develop cosmetic products aimed at the protection of both scalp and hair, especially aging hair whose resistance to the above insults is lessened.

Bioactive polyphenols are well known to protect against oxidative stress by directly scavenging ROS and/or inducing the activation of Nrf2 which in turn leads to an activation of various anti-oxidant enzymes. One of the main sources of polyphenols is forest trees, especially barks [3] due in part to its protective role, especially when growing in extreme climatic condition such as the Canadian winter season [4]. In Canada, large amounts of bark are produced as by-product of wood processing and are mainly burnt in large furnaces to supply at least a part of the forest industry's energy needs [5]. Therefore, this biomass residue most likely represents a rich source of potential cosmetic ingredients, especially to tackle hair aging. Here, we use the up-cycled bark of the white oak (*Quercus alba* L.), due to its valuable chemical composition, and

use in Native American traditional medicine for the treatment of sore, chapped skin and as a disinfectant [6].

The aim of the present study is to demonstrate the benefits of a sustainable white oak extract in protecting the scalp and hair from oxidative and UV stress, as well as limiting hair loss and white hair.

2. Materials and Methods

Materials

The white oak extract used in this work is an extract of the bark of the white oak (*Quercus alba* L.), a by-product of the forestry industry, produced using a proprietary hydro-alcoholic-based process, stabilized with non-palm certified glycerin. The ingredient is COSMOS-certified and standardized for procyanidin content to ensure batch-to-batch consistency, quality, and biological efficacy.

In vivo study

Tested formula:

5 ml of a serum containing 1% of White Oak extract or placebo (glycerin) has been applied on the entire scalp, with a massage to stimulate microcirculation and energize the scalp, then the hair is comb gently.

Scalp oxidation

2 groups of 10 volunteers, male and female from 42 to 65 years old, Caucasian, healthy, with general hair loss and gray hair (20-60%).

The serum is applied on scalp once a day for 45 days.

Malondialdehyde (lipid peroxidation product) analysis is performed on tape stripping samples at D0 and D45 for the 2 groups.

Hair condition

2 groups of 20 volunteers, male and female from 42 to 65 years old, Caucasian, healthy, with general hair loss and gray hair (20-60%).

The serum is applied on scalp once a day for 120 days.

Evaluation of hair density by TrichoScan® equipment: the number of hairs present in a unit of area was calculated from images of the scalp taken with the TrichoScan® microcamera on a surface of 0.592 cm^2. The area was shaved at D0.

Hair growth cycle phase study by cosmetic Trichogram: it consists of the extraction by traction of a determined number of hairs from the scalp, in order to know in which phase of the hair growth cycle they are in, anagen growth phase or telogen fall phase, as well as the initial and final appearance of the hair bulbs.

Hair falling counting after combing and wash test: the volunteers came to the visit without having washed their hair at least 48 hours before and without having combed their hair at least 24 hours before, to maintain the hairs which are near the end of telogen phase and avoid artificial reduction in the percentage of hairs in telogen phase. The technicians comb or wash each volunteer's hair according to a standard protocol. The hair falling out was collected for later counting.

Hair colour observation: The microcamera is a professional diagnostic piece of equipment consisting of a probe for exploring the scalp and the software for capturing and displaying images. The microcamera's function is to allow a direct, magnified view of a hair area to observe its state: number of white hair and/or number of not white hair.

Subjective assessment: Acceptability of the product will be measured additionally, by means of the subjective evaluation of the efficacy.

Statistical methods

Following normalization and variance homogenization tests, the data were submitted to an unpaired nonparametric Kolmogorov Smirnov test, a one-way ANOVA test, or a Two-way ANOVA test. The statistical significance threshold was set at $p<0.05$ (#$p<0.1$, *$p<0.05$, **$p<0.01$, ***$p<0.001$).

3. Results

Scalp oxidation

One of the consequences of uncontrolled oxidative stress is tissues injury caused by oxidative damage. Free radicals or reactive oxygen species (ROS) can attack lipids, which provoke lipid peroxidation in membranes. Medium or high levels of lipid peroxidation rates can induce cellular apoptosis or necrosis programmed cell death. Malondialdehyde (MDA) level is commonly known as a marker of oxidative stress and the oxidant status in scalp.

The aim of the study is the analysis of malondialdehyde (MDA) as a product of lipid peroxidation, in human scalp cells obtained in strip tapes from two different groups. The evaluation consists in the analysis of malondialdehyde (MDA) as a product of lipid peroxidation, in human scalp cells using a commercial fluorometric kit.

Compared to D0, malondialdehyde (MDA), as a product of lipid peroxidation, significantly decreased on D45 after White Oak treatment on the scalp by 56%, unlike placebo treatment.

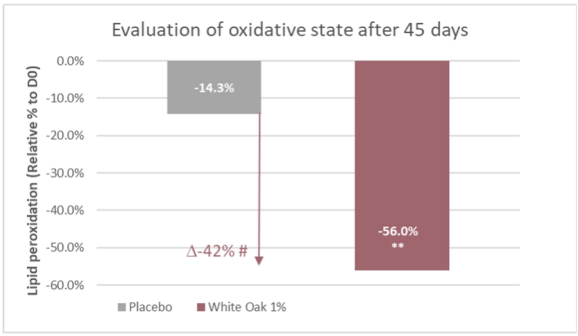

Figure 1. Lipid peroxidation of the scalp after using the serum for 45 days. % of reduction relative to D0.

- ***Evaluation of hair density by TrichoScan® equipment***

The hair density, indicated in number of hairs per cm^2, is measured at each time point, on a shaved area.

If it is higher at the end of the experiment, it indicates the capacity of the product to generate new hairs.

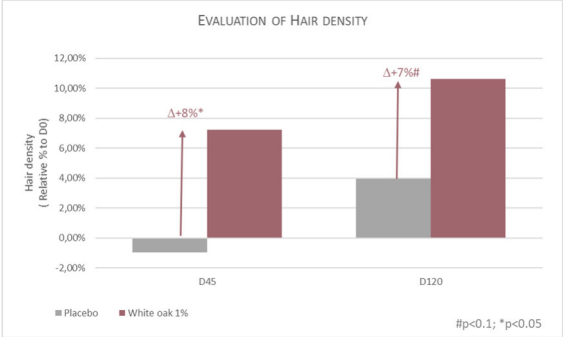

Figure 2. Hair density measurement by TrichoScan® on a shaved area after 45 and 120 days of treatment. % of increase relative to D0.

For volunteers applying White Oak treatment, the hair density is higher after 45 and 120 days compared to placebo.

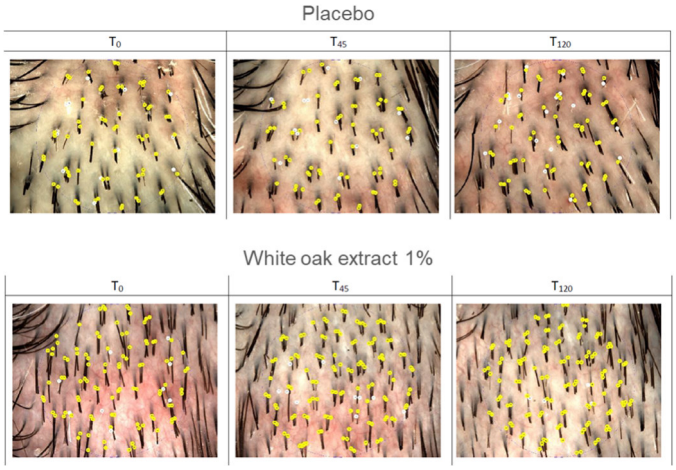

Figure 3. Picture of shaved area after hair renewal at D45 and D120.

- ***Cosmetic Trichogram***

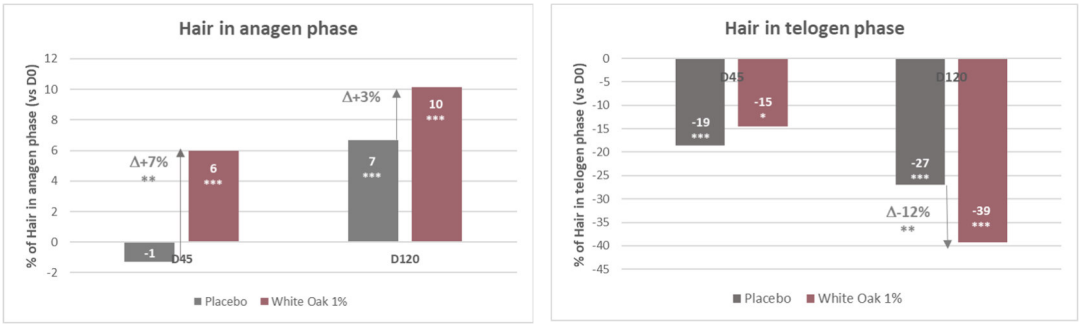

Figure 4. Number of hairs in anagen or telogen phase at D45 and D120. % of increase or decrease relative to D0.

After 45 days of treatment with White Oak, there was a significant increase in the number of hairs in the anagen growth phase compared to D0 and the placebo. After 120 days of treatment a significant decrease in the number of hairs in the telogen loss phase was observed for White Oak treatment, compared to D0 and placebo.

The resulting anagen / telogen ratio, at both time points, is higher for White Oak than for placebo (Fig.5).

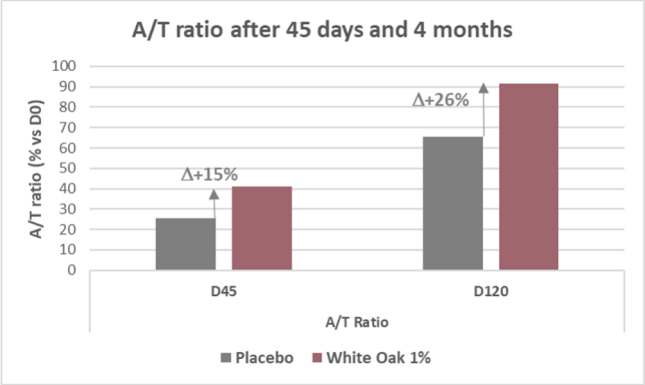

Figure 5. Anagen / Telogen ratio at D45 and D120. % of increase relative to D0.

White Oak extract regulates the hair growth cycle for limited hair loss and improved growth.

- ***Combing and wash test***

Between day 45 and day 120, summer began, with very high temperature recorded in Spain, where the clinical study was taking place. We know that in summer, hair loss increases.

Thanks to treatment with 1% White oak extract, hair loss during the summer period (between D45 and D120) was limited compared to the placebo.

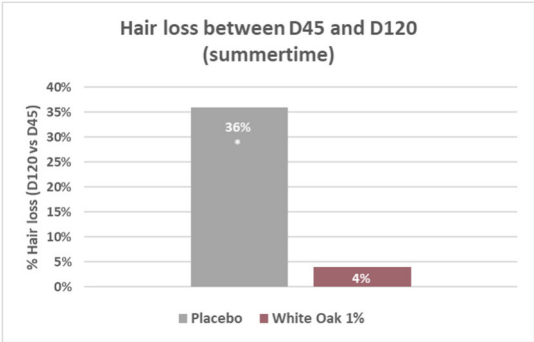

Figure 6. Hair loss during hot period (%D120 versus D45)

White Oak treatment slowed down hair loss during the summer period.

- ***Hair colour observation: white hair proportion***

In the second part of the clinical study, between 45 and 120 days, the percentage of white hair for the White Oak treatment was lower (difference of 13%) compared to placebo, which means that White Oak reduces the appearance of white hair.

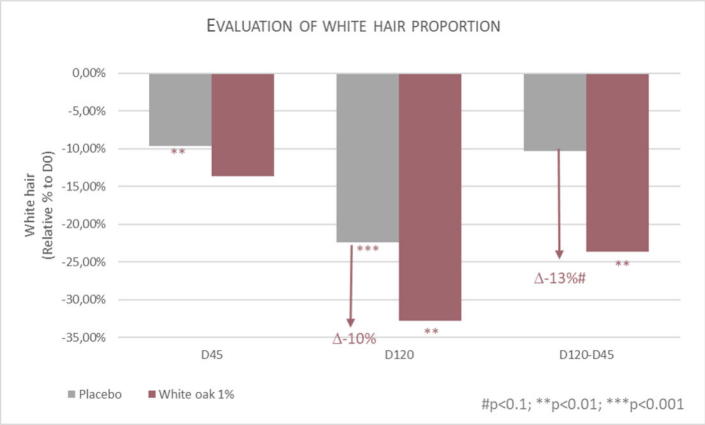

Figure 7. White hair proportion on the shaved area. % of decreased after 45 and 120 days compared to D0, and after 120 days compared to 45.

- ***Self-assessment***

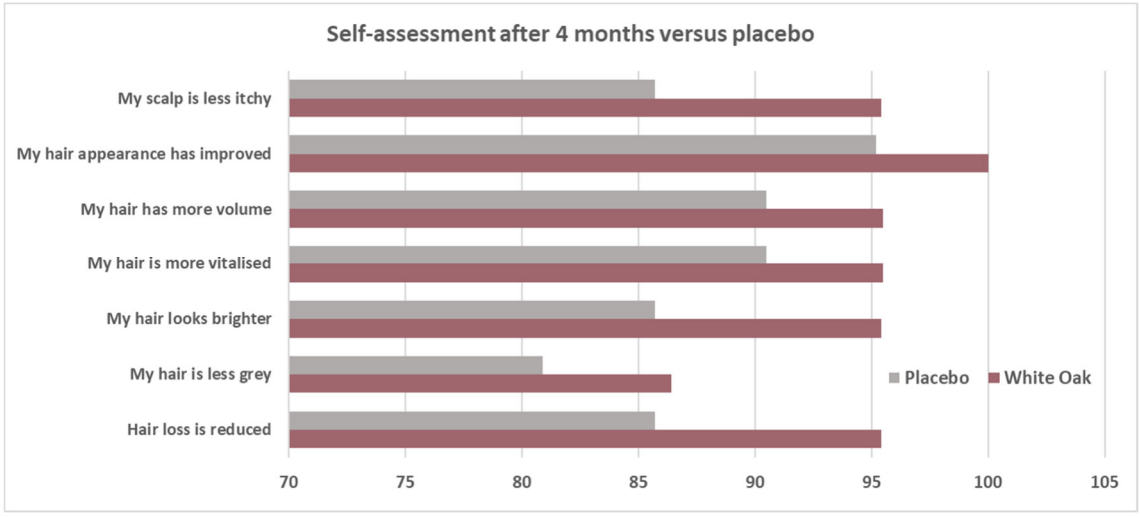

Figure 8. Self-assessment results after 4 months for volunteers applying White Oak treatment or placebo. % of positive responses (slightly agree, agree and strongly agree).

After 4 months, volunteers who received the White Oak treatment experienced greater improvement in the whole condition of the hair and scalp compared to the placebo, demonstrating a holistic anti-aging effect.

4. Discussion

Aging represents an inevitable biological process involving multiple factors that manifest visibly on all cutaneous appendages, particularly the hair. The hair follicle, a unique structure, undergoes various modifications over time. While skin aging and alopecia are extensively documented in dermatological literature, hair aging has not received comparable attention. Like skin, hair aging comprises two components: intrinsic aging, encompassing natural physiological changes related to time progression, and extrinsic aging, associated with environmental exposures and physicochemical stress induced by daily grooming practices [11]. Ultraviolet radiation exposure can accelerate extrinsic aging, resulting in dull and pale coloration, loss of

natural shine, alterations in surface texture, and increased hair dryness. Furthermore, gray hair exhibits enhanced sensitivity to weathering, greater fiber reactivity to reducing and oxidizing agents, and increased vulnerability to ultraviolet radiation [12].

Previous studies have demonstrated the significant efficacy of White Oak extract against oxidative stress, inflammation, and apoptosis *in vitro*. Evidence indicates that with advancing age, the scalp becomes less resistant to UV radiation and oxidative stress, with a strong correlation established between oxidation, graying, and hair loss. By acting on the scalp and pre-emerging fiber, White Oak extract protects the post-emerging fiber, thereby preserving its health and appearance. Additionally, our investigations have demonstrated this extract's capacity to act directly on hair, enhancing shine and strength while exerting a reparative effect on damaged hair from three distinct ethnicities following a single application of a rinse-off product containing 1% White Oak extract compared to vehicle. These mechanical properties of oak bark had not been previously demonstrated.

In vivo investigations presented herein substantiate the efficacy of White Oak extract in mitigating scalp oxidation, while further demonstrating significant **decrease** in hair **loss** and enhanced follicular growth. These findings were corroborated by favorable subjective assessments from study participants regarding the comprehensive health status of their hair. These observations complete the characterization of this holistic ingredient, targeting each component of physiological aging in both scalp and hair. By reinforcing natural protective mechanisms, this ingredient contributes to decelerating the aging process and maintaining hair health.

5. Conclusion

Thanks to its unique composition, the W.O. extract significantly reduced scalp oxidation, optimized the hair growth cycle by increasing hair in the anagen phase and reducing hair in the telogen phase, resulting in the reduction of hair loss and improvement of hair growth. Hair density increased significantly compared to D0, showing significant improvement versus placebo, while white hair proportion and summer hair loss decreased. After 4 months, volunteers reported superior results with the W.O. extract compared to placebo in reducing itchiness, improving hair appearance and volume, achieving more vitalized and brighter hair, reducing grey hair, and decreasing hair loss.

These *in vivo* results, along with previous research on hair fibers and the scalp, validate the broad efficacy of White Oak extract in counteracting age-related effects on scalp and hair health and overall appearance. While multiple ingredients are often needed and added together in the same formula, this solution delivers multifunctional benefits in only one single product.

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