

Polluout® Detox

Description

Cosmetic hair care active with detoxification properties, able to restore and extend hair health and well-being from root to tip. With a synergistic association of polydentate polymeric chelating agent, sodium polyitaconate, an alpha-hydroxy acid-derived chelating agent, sodium citrate, and a biosurfactant *sapindus mukorossi* fruit extract, **Polluout® Detox** is designed to remove harmful particles and interferences from hair and scalp, such as calcium, magnesium, copper, and other pollutants, while improving shine, combability, and treatment effectiveness, as well as protecting the hair's DNA and revitalizing it from the source. It has natural origin content (NOC) equal to 100% (according to ISO 16128/2016 definitions).

INCI

Sodium Polyitaconate (and) Sodium Citrate (and) Sapindus Mukorossi Fruit Extract

Introduction

Driven by a growing demand for more natural and diversified products, the global hair care market is expected to reach USD 116.33 billion by 2024, with a CAGR of 3.35% between 2020 and 2025. Behind this remarkable growth is a new generation of consumers who are redefining their relationships with their hair and closely watching the skin care market.¹

As an evolution of hair care, scalp skinification embraces health from the root by increasing consumer conscience and education about hair follicles and their conditions. Data obtained from monitoring social media showed that people are more aware of the benefits of skin care when it comes to the scalp, focusing on hydration, relief, or detoxification as shown in **Figure 1**.^{2,3}

**Benefits mentioned in scalp care conversations on social media
(2020 - 2021)**

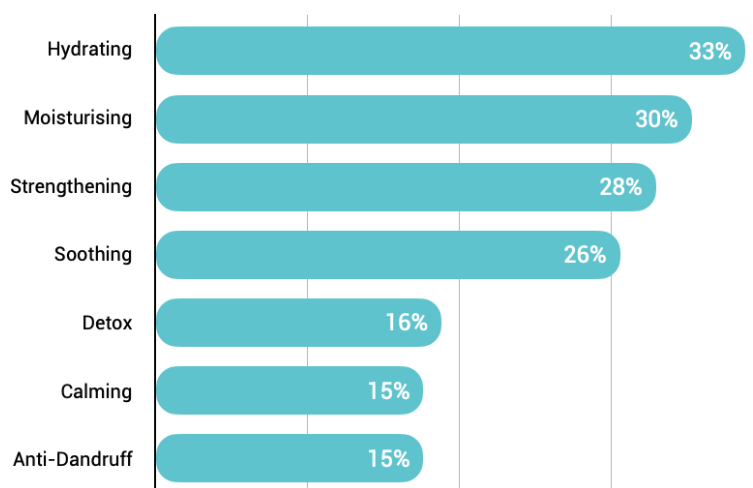


Figure 1: Sought-after benefits in scalp care

The perception that the scalp or hair reflects the quality of your health is recurrent, especially when there are more obvious signs such as breakage, opacity, or flaking. However, interaction with the environment can bring about several harmful interferences. For this reason, the term “detox” has been used for promoting the cleaning and recovery of the hair fiber and scalp, eliminating or reducing impurities that can silently damage hair, thus fostering health and well-being from root to tip.^{4,5}

Impurities that can affect the health of the hair and scalp include:

1. Copper and iron from old metal pipes in the water supply system;
2. Calcium and magnesium salts in high concentrations in hard water composition;
3. Copper present in algacides used in swimming pools;
4. Particulates containing metals and other chemical elements from air pollution.

Many of these sources, such as calcium, magnesium, copper, and iron, can affect the performance of cosmetic treatments, by reducing the deposition of conditioning agents and catalyzing the formation of free radicals, in addition to promoting damage to the keratin polypeptide chain and structural lipids of the hair fiber. These changes can reach molecular or nano-structural levels, implying silent changes in the structures of proteins and lipids. As a result, lipids and proteins are degraded and DNA is functionally changed, which is manifested by macrostructural or visible changes such as elevation, breakage and loss of cuticles, rough hair sensation, and reduced shine, which can lead to exposure of the cortex region, thus increasing the likelihood of split ends. The greater the damage to the protein structure, the lower the mechanical strength of the hair fiber, which may lead to breakage perceived as hair loss when brushing.^{6,7,8,9}

Additionally, copper ions (Cu²⁺) are adsorbed, being responsible for the greenish color of natural blonde or bleached hair, as well as white or gray hair. This greenish effect is activated when hair is exposed to UV radiation

or chemical treatments, where carboxylates or sulfonates can be created and complexed with this metal.^{6,7,8,9,10,11,12,13}

Maintaining the integrity of the scalp's barrier function is key to hair health. Air pollutants can affect the balance of this barrier, due to the potential influence of particulate matter (PM). Associated with an existing dysfunction, these particles can worsen this situation and inhibit the levels of proteins that are essential for cell differentiation and proliferation, such as FLG: Filaggrin, LOR: Loricrin, and KERS: keratins.^{14,15,16,17}

Particulate matter (PM) can induce both exogenous (exROS) and endogenous (ROS) reactive oxygen species (ROS), and the ROS-antioxidants imbalance results in oxidative stress. Reactive oxygen species (ROS) can also cause damage to the skin through lipid peroxidation and protein carbonylation, leading to irreversible cellular DNA damage. Such damage, along with mitochondrial dysfunction, can lead to apoptosis. At the same time, the PM can activate the expression of inflammatory cytokines that can trigger an inflammatory process. These three processes - barrier dysfunction, oxidation, and inflammation - are interconnected, as illustrated in **Figure 2**.^{14,15,16,17}

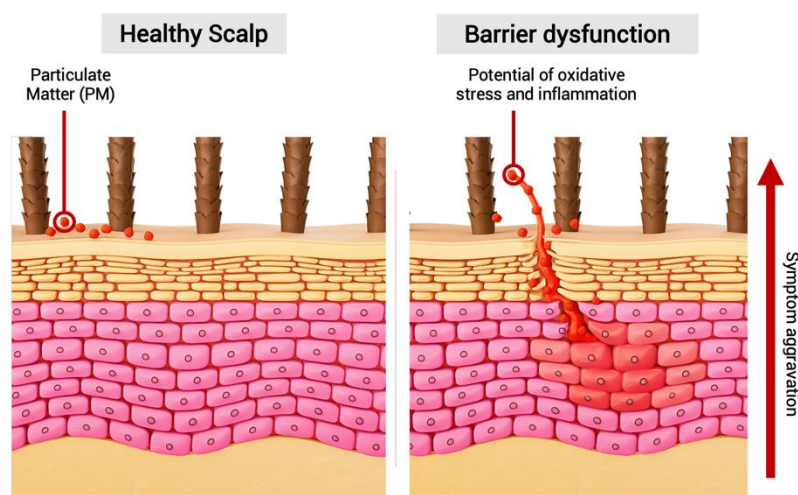


Figure 2: Influence of PM permeation on the integrity of the scalp barrier function.³⁹

Considering that hair and scalp can suffer from “invisible” interference and trigger visible changes, **Chemyunion** has developed **Polluout® Detox**, a cosmetic hair care active with detoxification properties to restore hair’s health and well-being from root to tip. With a synergistic association of polydentate polymeric chelating agent, sodium polyitaconate, an alpha-hydroxy acid-derived chelating agent, sodium citrate, and a biosurfactant *sapindus mukorossi* fruit extract, **Polluout® Detox** is designed to remove harmful particles and interferences from hair and scalp, such as calcium, magnesium, copper, and other pollutants, and improve shine, combability, and treatment effectiveness, as well as protecting the hair’s DNA and revitalizing it from the source.

Composition:

Sodium polyitaconate

Sodium polyitaconate is a plant-based, biodegradable polymer, according to the chemical structure illustrated in **Figure 3**. Derived from itaconic acid, it is designed under the 12 precepts of green chemistry and synthesized through the reaction of radical polymerization in an aqueous system at mild temperatures.^{18,19}

Itaconic acid, a monomer used to build Sodium Polyitaconate, is listed by the United States Department of Energy (DOE) as one of 12 building blocks that can be transformed into a variety of high-value biobased chemicals, and has been intensely studied as a green monomer, alternative to acrylic acid, in polymers based on this monomer. It is produced on a large scale by fermenting biomass, such as corn or rice, and from lignocellulosic material. Biomass has great potential to sustainably produce various polymers and chemicals, replacing products of non-renewable fossil origin.^{20,21}

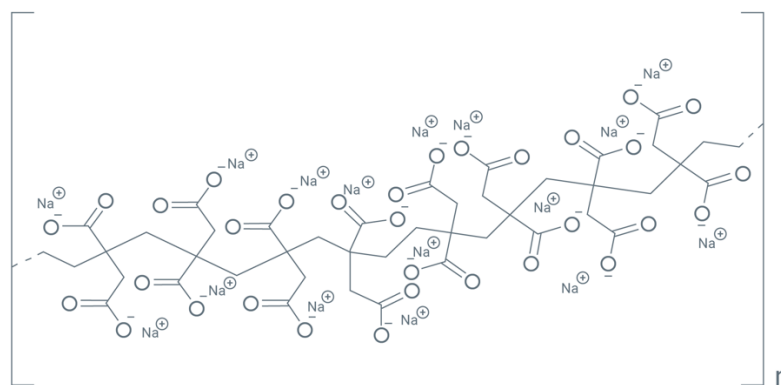


Figure 3: Sodium polyitaconate chemical structure.

Sodium citrate

Sodium citrate consists of the trisodium salt of citric acid, an alpha-hydroxy acid, which consists of a six-carbon tricarboxylic acid, obtainable from citrus fruit juices, but industrially produced mainly by fermentation processes using several types of microorganisms such as fungi, yeasts, and bacteria, according to the chemical structure illustrated in **Figure 4**.^{22,23,24}

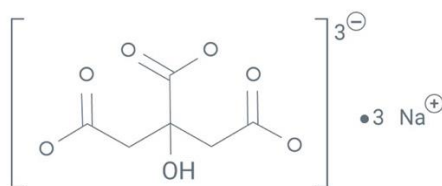


Figure 4: Sodium Citrate chemical structure.

Citric acid and its trisodium salts can act as pH adjusters, water softeners, buffers, and foam boosters by chelating ions responsible for water hardness, such as calcium and magnesium ions. These ions are prevented from reacting with anionic soaps and surfactants where they can form insoluble residues. This improves rinseability and reduces the potential for residual soap films to form on hair and skin.^{22,23,24}

***Sapindus mukorossi* fruit extract**

Sapindus mukorossi is an extremely valuable medicinal plant distributed throughout tropical and subtropical Asia, mainly found in northern India, China, and Japan. This tree can reach up to 12 to 20 meters, with a globose 1.8 meter wide crown. Its fruits are globose, fleshy drupes, about 1.8-2.5 cm in diameter, containing a seed, about 0.8-1.3 cm in diameter.

The fruit illustrated in **Figure 5** is valued for its high saponins content (around 10%) in the pericarp. In China and Japan, it has been used as a medicine for centuries. In Japan, its pericarp is called “enmei-hi,” which means “pericarp that prolongs life,” and in China “wu-huan-zi,” the “non-disease fruit.”²⁶⁻³⁶

Sapindus mukorossi extract is also rich in saponins, which act as natural surfactants. In low concentrations, these substances are adsorbed on the surface, altering the surface tension of a solution containing oil or dirt, thus making cleaning of the scalp and hair easier. This extract proved to be very efficient in the adsorption of chromium in a sample of contaminated water, as well as the removal of metals from contaminated soils, showing potential for the removal of contaminating metals from hard water, swimming pool water, and air pollution.²⁶⁻³⁶



Figure 5: *Sapindus mukorossi* fruits

Action mechanism:

Polluout® Detox causes a synergistic action between the ingredients, acting in three simultaneous steps to promote cleaning and recovery of the hair fiber and scalp, by eliminating or reducing impurities that can cause damage and providing health and well-being, from root to tip:

- 1- Chelation-induced complexation of metals on the surface of the hair fiber, as promoted by the polydentate polymer, sodium polyitaconate. In this capillary region, metals form complexes with the sulfonate groups arising from the breaking of the 18-MEA group thioester bond by oxidative processes,

such as discoloration or exposure to UV radiation. Oxidized metals are found in the cuticle in the form of sulfonate groups complexes. **Polluout® Detox** facilitates their removal and prevents cuticular oxidative damage as shown in **Figure 6**.

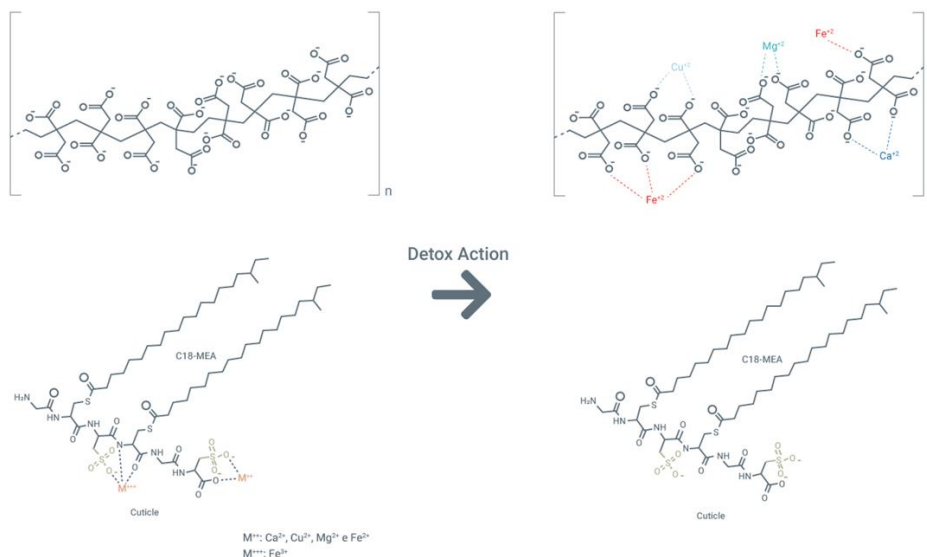


Figure 6: Ionic exchange and complexation of metals contained in the sulfonic groups of the cuticular region, by the sodium polyitaconate polymer.

- 2- The metals in the innermost part of the fiber form complexes with the amino, hydroxyl, and carboxylate groups of the keratin polypeptide chains. The sodium citrate in the composition of **Polluout® Detox** is a low molecular weight compound and can act on the innermost layers of the hair fiber, thus removing metals forming a complex with the carboxylate groups of citrate, and preventing oxidative damage in keratin, as illustrated in **Figure 7**.

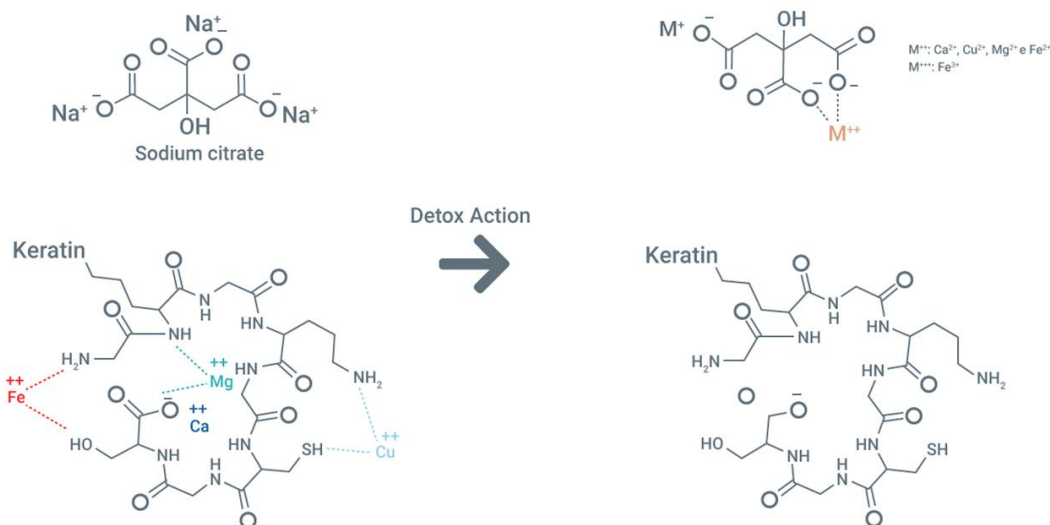


Figure 7: Ionic exchange and complexation of metals contained in keratin protein structure by the alpha hydroxy acids derivative (sodium citrate)

- 3- *Sapindus mukorossi* extract is part of the composition of **Polluout® Detox** and contains a complex mixture of saponins that act as emulsifiers, having a hydrophilic part represented by glycosides, rich in hydroxyls, and a hydrophobic part represented by triterpene structures. This structure promotes cleaning of the scalp and hair of excess oil and particulate material deposited through emulsification, where surfactant molecules are adsorbed at the sebum-water or particulate material-water interface, reducing solid-liquid or liquid-liquid interface tension, which emulsifies sebum or particulate matter that is removed from the substrate (hair fiber or scalp surface), as illustrated in **Figure 8**.³⁷

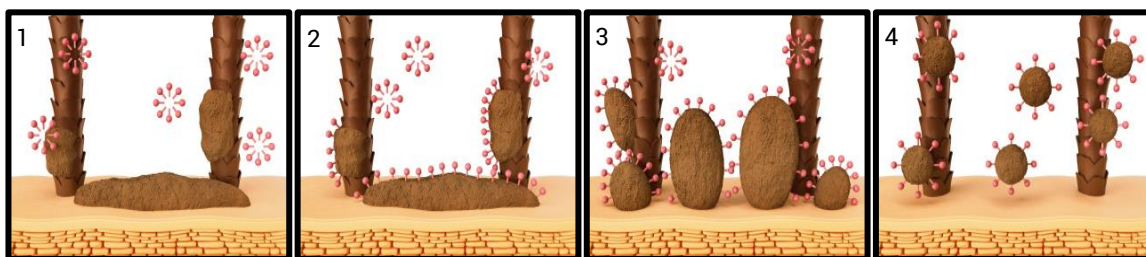


Figure 8: Mechanism for cleaning particulate matter and excessive oiliness of the scalp and hair fiber.

- (1) Particulate or oily material adhered to the surface of the hair or scalp. (2) Surfactant adsorption on the surface of the material. (3) Emulsification of oil or particulate matter. (4) Oily or particulate material removed from the surface of the hair fiber or scalp

Benefits

Considering the chelating action and the high cleaning efficiency **Polluout® Detox** offers:

- Removal of the greenish effect on the hair from exposure to pool water;
- Maintenance of the hair's natural shine;
- Better efficiency in the deposition of oxidative dyes;
- Improves the efficiency of hair treatments;
- Stronger and more resistant hair;
- Improved hair cleanliness, removing pollution particles;
- Scalp soothing action.

Tests

In order to assess the performance of **Polluout® Detox**, **Chemyunion** carried out the following tests:

1. Treatment of hair strands:

For the following tests, hair strands were subjected to standardized washing and drying followed by a chemical bleaching process three times.

2. Evaluation of the effectiveness in removing Calcium (Ca⁺²), Magnesium (Mg⁺²), and Copper (Cu⁺²) ions from hair fibers

The hair strands were standardized for the tests as follows:

- 2.1. Exposure of treated hair strands to calcium (Ca - Calcium Chloride Dihydrate 120 ppm), magnesium (Mg - Magnesium Sulfate 40 ppm), or copper (copper sulfate 10 ppm) solution for 7 hours, followed by rinsing with running water (1 minute) and blow-drying (medium temperature).
- 2.2. Submission of hair strands in a 2% aqueous solution for 10 minutes, followed by rinsing and blow-drying five times according to your treatment group:
 - 2.2.1. Placebo (purified water – MiliQ)
 - 2.2.2. **Polluout® Detox**
 - 2.2.3. Benchmark (Acrylic Acid/Acrylamidomethyl Propane Sulfonic Acid Copolymer)

2.3. EDS evaluation by SEM

The elemental composition of the hair fibers was measured using energy dispersive X-ray spectroscopy (EDS), coupled to a Scanning Electron Microscope (SEM). To carry out the analysis, the fibers (12 per group) were coated with gold (Au) to eliminate electronic charging. For each fiber, an accelerating tension

spectrum was obtained and the mass percentage (wt%) of Ca, Mg, and Cu was quantified. The mass percentage (wt%) results are shown in **Figures 9, 10, and 11**.

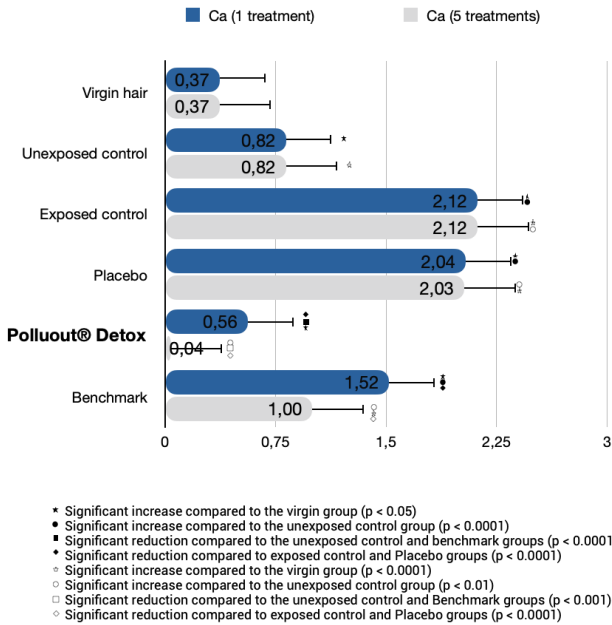


Figure 9: Results of mass percentage (wt%) of calcium

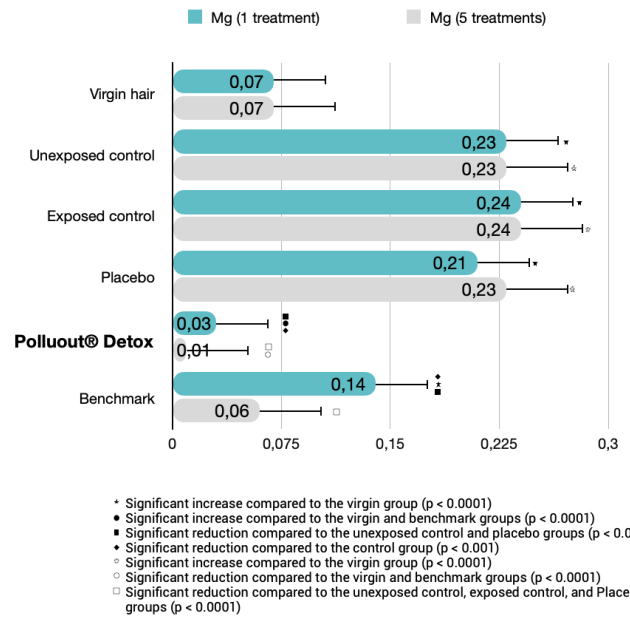


Figure 10: Results of mass percentage (wt%) of magnesium

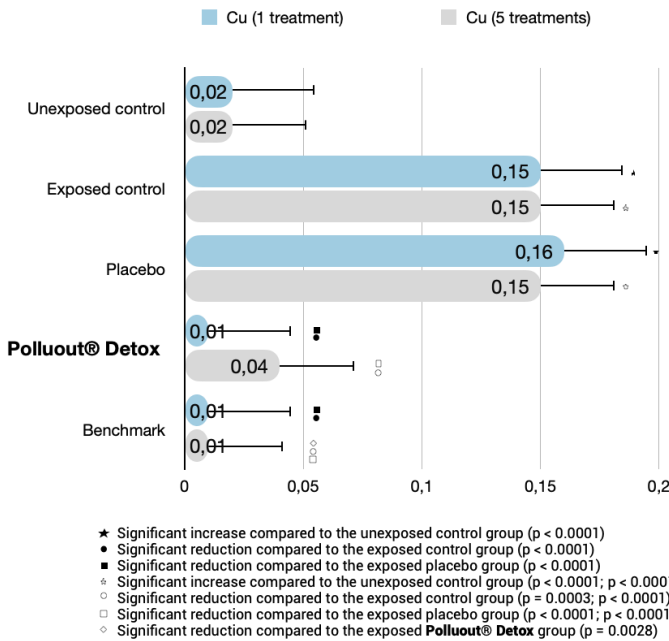
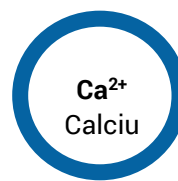


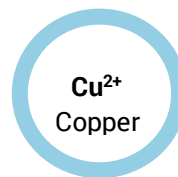
Figure 11: Results of mass percentage (wt%) of copper



Reduction of up to **98.11%** of calcium when compared to the exposed control group.



Reduction of up to **95.83%** of magnesium when compared to the exposed control group.



Reduction of up to **93.3%** of copper when compared to the exposed control group.

Figures 9, 10, and 11 show that **Polluout® Detox** was effective in reducing calcium, magnesium, and copper after one and five treatments when compared to placebo.

3. Evaluation of the effectiveness in removing Calcium (Ca²⁺) and Magnesium (Mg²⁺) ions from hair fibers in shampoo treatment

To conduct the tests, standardized hair strands were treated as follows:

- 3.1. After exposure to the hard water test solution (Calcium and Magnesium) used in test 2, hair strands were rinsed with running water (1 minute) and blow-dried (medium temperature).
- 3.2. Afterwards, the hair strands were treated with a standardized amount of shampoo formulation for 2 minutes according to their treatment group:
 - 3.2.1. Placebo (Shampoo),
 - 3.2.2. **Polluout® Detox 2%**
 - 3.2.3. Benchmark (Placebo + Benchmark 2% -Acrylic Acid/Acrylamidomethyl Propane Sulfonic Acid Copolymer)
- 3.3. Later, the hair was rinsed for 1 minute and blow-dried at medium temperature.
- 3.4. **EDS evaluation by SEM** according to item 2.3 and results shown in **figure 12**

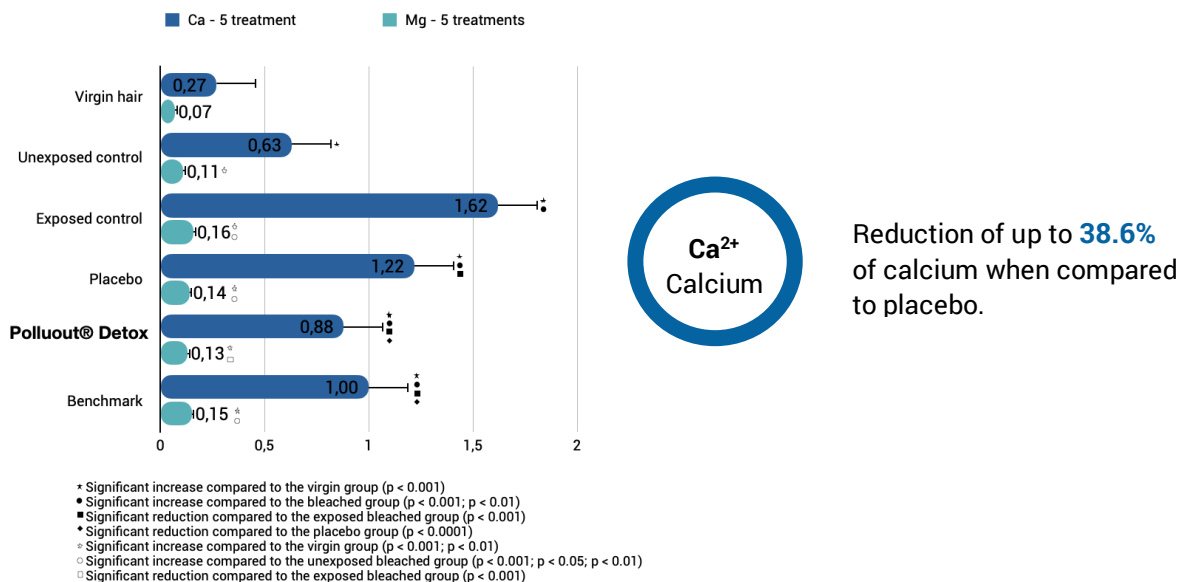


Figure 12: Results of mass percentage (wt%) of calcium and magnesium

Figure 12 shows that **Polluout® Detox** was effective in reducing calcium by up to 38.6% when compared to placebo.

4. Evaluation of the effectiveness in removing copper ions from hair fibers in shampoo treatment

After the hair strands were bleached, as described in topic 1, they were exposed to a copper sulfate (CuSO_4) solution at 10 ppm for 6 hours. After the soaking time, the hair strands were blow-dried at medium temperature.

4.1 Afterwards, the hair strands were treated with a standardized amount of shampoo formulation for 2 minutes according to their treatment group:

- 4.1.1. Placebo (Shampoo)
- 4.1.2. **Polluout® Detox 2%**
- 4.1.3. Benchmark (Placebo + Benchmark 2% -Acrylic Acid/Acrylamidomethyl Propane Sulfonic Acid Copolymer)

4.2. ICP-OES (Inductively Coupled Plasma Optical Emission Spectroscopy) Evaluation

The copper content of hair fibers was determined by the inductively coupled plasma optical emission spectrometry (ICP-OES) method. In this method, the sample is submitted to acid digestion and then introduced into the ICP-OES equipment for the quantification of metals. The ICP-OES technique is based on the measurement of the electromagnetic radiation emitted by atoms or ions excited by the argon plasma in the visible and ultraviolet spectrum regions (160-800 nm). The sample in aqueous solution goes through a nebulization process before being submitted to vaporization, atomization, ionization, and excitation in the plasma source and thus provide the emission spectra. Each element emits radiation at a specific wavelength, enabling to determine the identity of the elements present in the sample, and the intensity of the emitted radiation is used in its quantification. Results are shown in **Figure 13**.

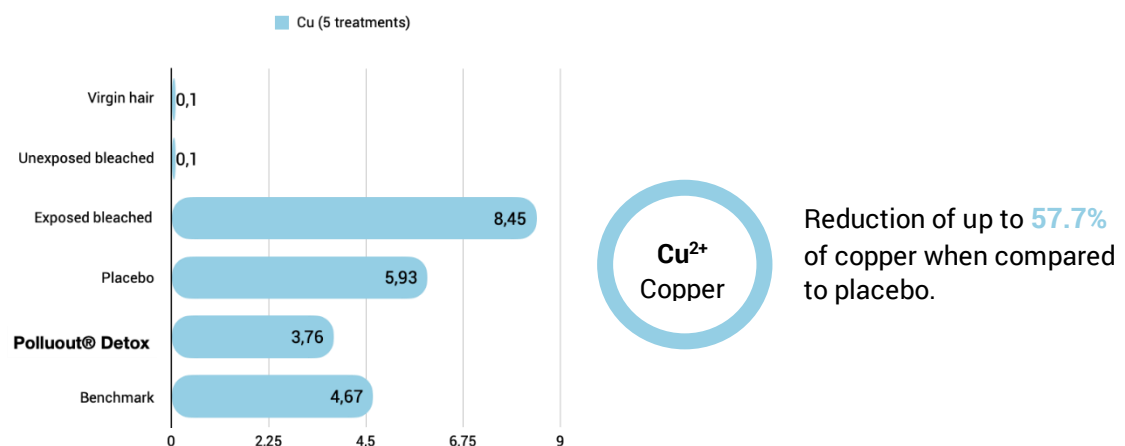
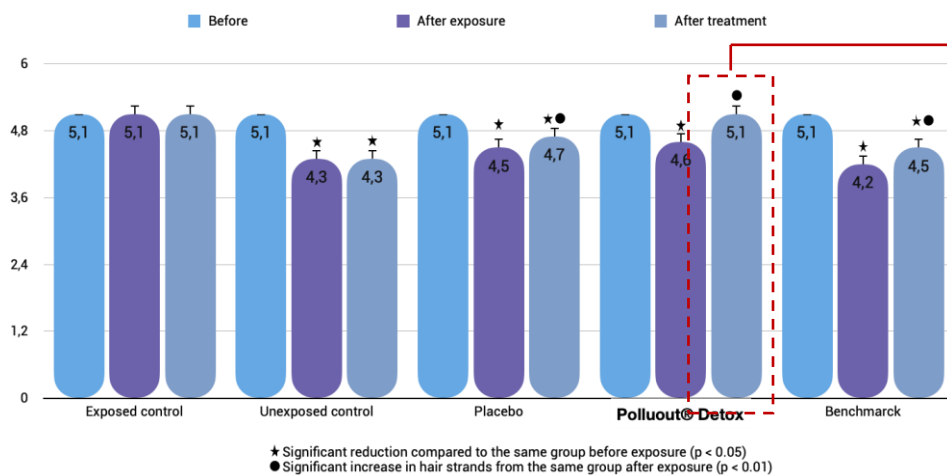


Figure 13: Copper results in ppm

Figure 13 shows that **Polluout® Detox** was effective in reducing copper by up to 57.7% when compared to placebo.

5. Evaluation of hair strands shine maintenance when exposed to hard water (Ca⁺² and Mg⁺²)

After treating the hair strands and exposing them to a hard water solution (with calcium and magnesium content), the SAMBA Hair System equipment (Bossa Nova Technologies, USA) was used to evaluate shine. The equipment successively captures two images in different states of polarization, which allows to decompose the images of hair strands into a specular image and a diffuse image. For this study, the results obtained by the Reich-Robbins formula were used and are shown in **Figure 14**:



Polluout® Detox restores **100% of the hair's natural shine**, reversing the negative effects of hard water

Figure 14: Reich-Robbins unit shine results on hair strands before and after exposure to calcium and magnesium solutions.

Figure 14 shows that hair exposed to hard water (with calcium and magnesium) has a significant reduction in shine unit values and that **Polluout® Detox** returns hair shine to its initial values, reversing 100% of the interferences caused by calcium and magnesium.

6. Evaluation of the green coloration removal in hair fibers exposed to Cu⁺² ions in shampoo treatment

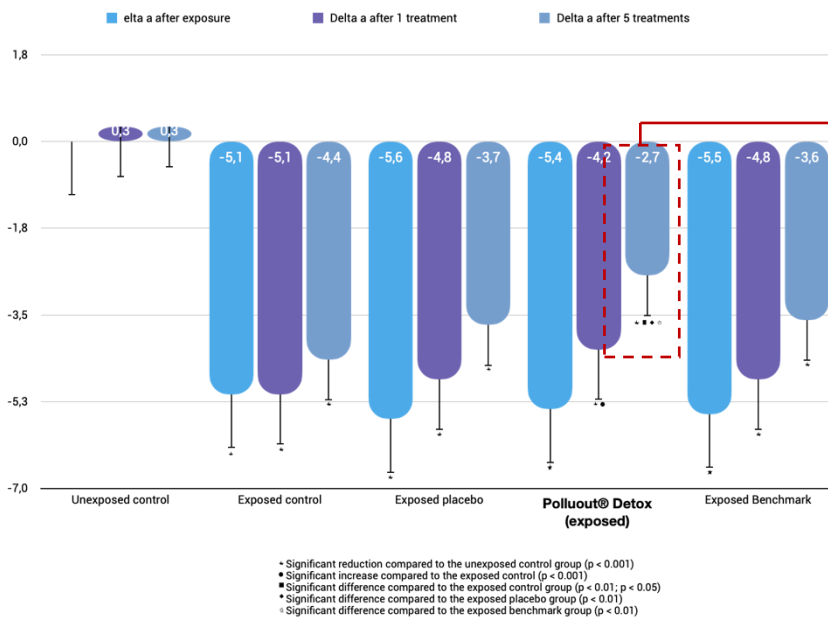
After treating the hair strands, they were exposed to a copper sulfate solution (10 ppm) for 35 hours and blow-dried at medium temperature.

6.1 Afterwards, the hair strands were treated with a standardized amount of shampoo a formulation for 2 minutes according to their treatment group:

- 6.1.1. Placebo (Shampoo),
- 6.1.2. **Polluout® Detox 2%**
- 6.1.3. Benchmark (Placebo + Benchmark 2% -Acrylic Acid/Acrylamidomethyl Propane Sulfonic Acid Copolymer)

6.2. Colorimetry evaluation

Measurements were performed using the colorimeter equipment (Gardner) in different regions of the hair strands (10 readings per hair strands), before, after exposure to the CuSO₄ solution, and after washing (1 and 5 treatments). During the analyses, the L* a* b* parameters were measured (CIELab system) and the color changes of the hair strands were evaluated by calculating the Δa* parameter. The Δa* parameter determines the variation in color from red (+60) to green (-60) as shown in **Figure 15**. Images were captured on hair strands after 5 treatments, as represented by **Figures 16**.



Polluout® Detox reduces the green color of hair by **up to 200%** when compared to initial exposure after 5 treatments. **Effective since first use.**

Figure 15: Colorimetry results (Delta a) after exposure in the CuSO₄ solution, and after 1 and 5 shampoo treatments.

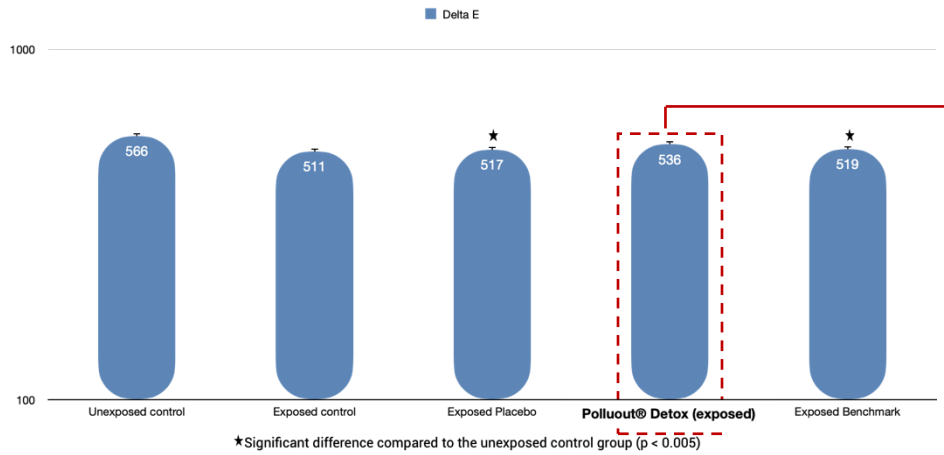


Figure 16: Colorimetry results (Delta a) after exposure in the CuSO_4 solution, and after 5 shampoo treatments.

Figures 15 and 16 show that, when exposed to pool water containing copper sulphate the green coloration of the hair strands increase significantly, mainly in blond hair. Treatment with **Polluout® Detox** showed a reduction of up to 200% in Delta a (green color) when compared to first exposure, in addition to reducing 28.6% in the first treatment and having a performance superior to 33.3% when compared to the benchmark.

7. Evaluation of color of hair exposed to Cu^{+2} ions and hard water (Ca^{+2} and Mg^{+2})

After treatment of the hair strands and exposure to the test solutions of hard water and copper sulfate for 7 hours, the hair strands were dried, treated again with shampoo following the parameters of topic 6, and dyed red (6.66). After dyeing, the colorimetry method used in topic 6 was selected, where greater delta E values indicate that the hair strands had greater total color variation, evidencing a greater dyeing effect, as shown in **Figure 17**. Example of evaluated hair strands are shown in **Figure 18**.



Polluout® Detox reduces the interference of hard water and copper sulphate **in color**, promoting better color deposition and uniformity.

Figure 17: Results of Dta E parameter values after staining



Figure 18: Image of the hair strands after dyeing

Figures 17 and 18 show that hair strands treated with **Polluout® Detox** showed a similar coloration to the control group without exposure. This indicates that **Polluout® Detox** assisted in removing residues that may interfere with the deposition of dyes and tone uniformity.

8. Evaluation of hair after exposure to Ca^{+2} , Mg^{+2} , and Cu^{+2} ions + pollution (charcoal)

After treatment and exposure to the test solutions of hard water and copper sulfate, the hair strands were exposed to graphite powder in the pollution chamber for 10 minutes. Then, two types of evaluations were performed:

8.1. Assessment of the cuticle surface through scanning electron microscopy (SEM)

After exposure, surface evaluation was performed through Scanning Electron Microscope (SEM), using 10±2 fibers per group, capturing 3 images per fiber (close to the root, middle, and tips), with 1100 times magnification. Example of images obtained from the SEM are shown in **Figure 19**:

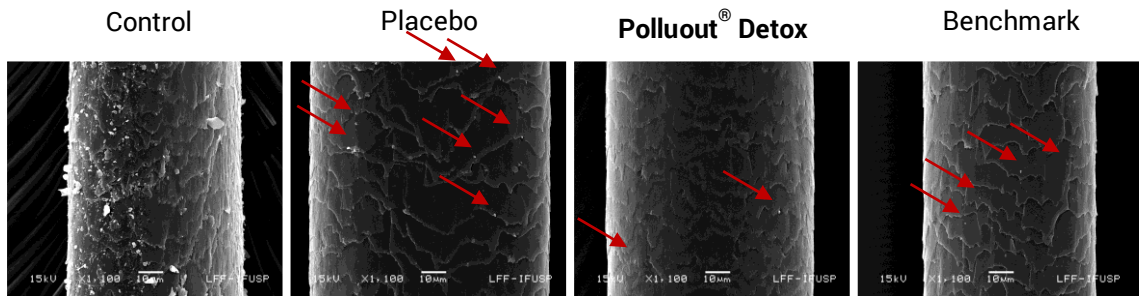
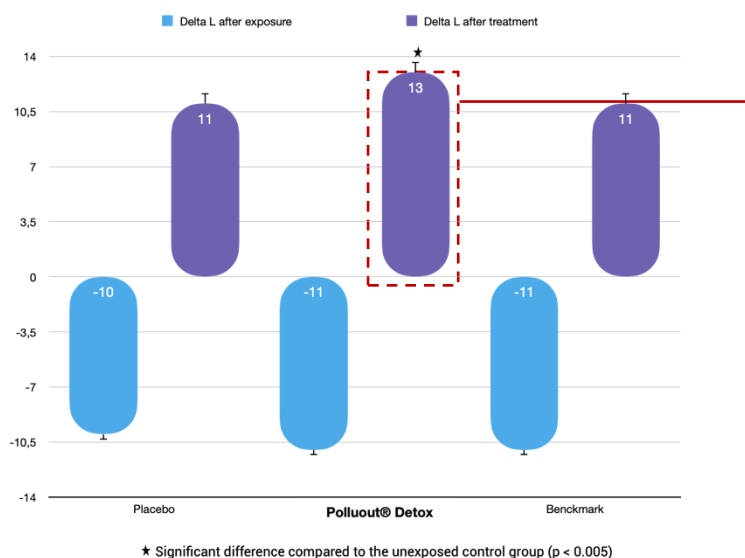


Figure 19: Cuticle surface through scanning electron microscopy (SEM)

The images show that **Polluout® Detox** presented a smaller number of particles when compared to the other tested groups, indicating better effectiveness in the removal of health-interfering particles.

8.2. Colorimetry evaluation

The colorimetry method used in topic 6 was the same chosen for this evaluation, where the color values of the hair strands were evaluated by calculating the ΔL^* parameter. The L^* parameter determines the brightness variation from black (0) to white (100). The higher the value, the lighter the color of the hair strands. The colorimetry results are described after exposure and then after treatment with shampoo as performed in topic 6 and shown in **Figure 20**.



Polluout® Detox reduced carbon particles from hair by **18.2%**, evidencing its efficiency in **cleaning particulate matter** from pollution.

Figure 20: Results of delta L*, after exposure in the particle chamber and after treatment of hair strands with shampoo

Through the colorimetry results of the ΔL^* parameter after the treatments, **Polluout® Detox** was shown to deliver a significantly superior performance in 18.2% when compared to the Placebo and Benchmark groups, in the maintenance of the coloration, and, therefore, in removing particles of carbon (graphite powder) from the surface of the hair.

9. Evaluation of hair fiber strength after exposure to Cu^{+2} + UVA/B radiation.

After treating the hair strands, a coloring procedure was performed followed by washing and rinsing thoroughly with running water (2 minutes). Two tests were carried out to evaluate the performance of **Polluout® Detox** on the strength of the hair fibers, in which they were submitted to 12 cycles of exposure to copper sulfate solution (CuSO_4), treatment with shampoo and exposure to UVA/UVB radiation.

9.1. Evaluation of strength in water (breaking stress)

For breaking stress evaluation, the cross-sectional area of the hair fibers was measured using the FDAS-770 equipment (Dia-Stron Ltd., UK). After the measurement, the fibers were subjected to the tensile strength test using the MTT-686 - Automated Miniature Tensile Tester (Dia-Stron Ltd., UK) equipment, in water (Mili-Q®). 50 ± 5 samples of hair fibers, randomly selected from each hair strand, were used. The test was carried out in a room with temperature ($23 \pm 2^\circ\text{C}$) and relative humidity ($50 \pm 5\%$) control. The results of the strength values are shown in **Figure 21**. And this test was carried out to simulate the cumulative effect of exposure to swimming pool water and solar radiation (UVA/UVB).

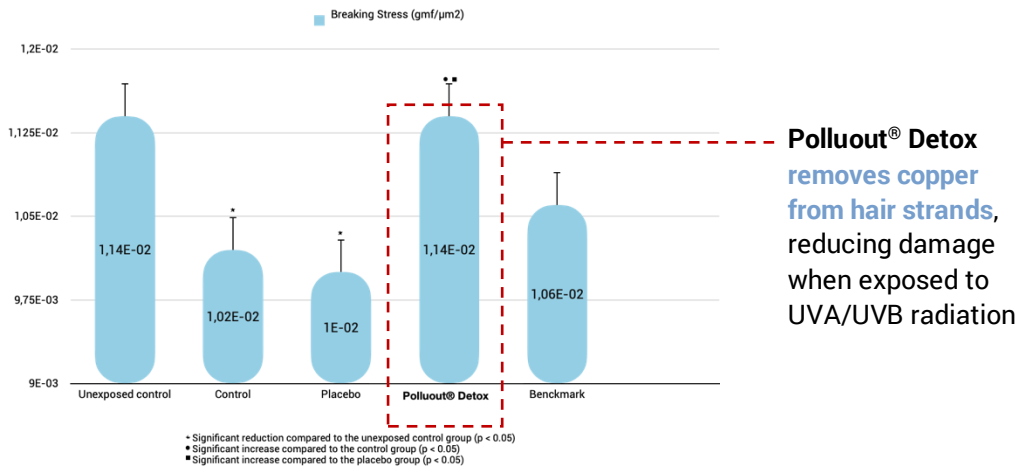


Figure 21: Results of breaking stress in simulation of the cumulative effect of exposure to swimming pool water and solar radiation (UVA/UVB).

Polluout® Detox increases strength and reduces the cumulative effects of UVA/UVB radiation on hair exposed to copper, when compared to the control and placebo groups. Additionally, it removes copper from hair strands, reducing damage when exposed to UVA/UVB radiation.

9.2. Tensile strength evaluation against brushing

To evaluate the tensile strength hair fibers when brushing, the BLPA 300 – Automatic brushing (Bioluz – Equipamentos e Serviços Ltda.) was used, and the number of hairs in the tray located under the brushes was quantified at every 1000 cycles at 66.7 rpm, until 10000 cycles. Results were illustrated in **Figure 22**.

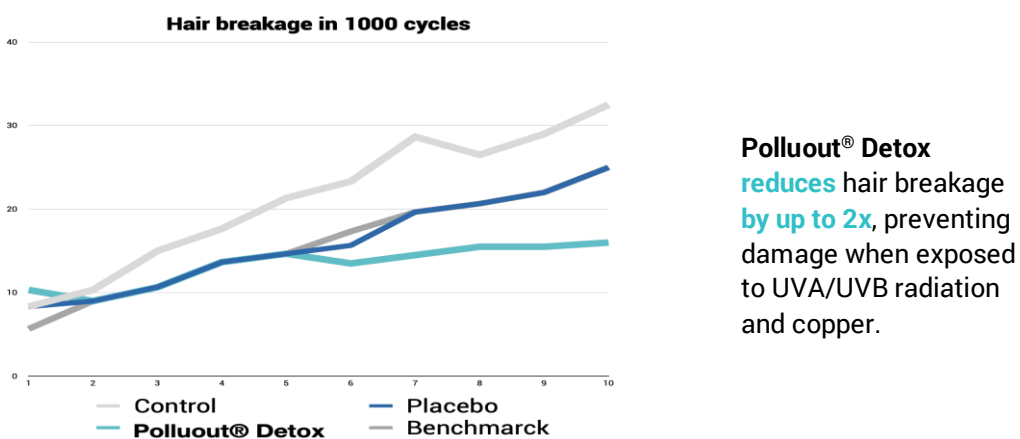


Figure 22: Results of tensile strength when brushing hair strands

Polluout® Detox showed lower quantities of broken hair after 5000 cycles, when compared to the control, placebo, and benchmark groups. This indicates that treatment with **Polluout® Detox** can reduce hair breakage by up to 2x and protect hair strands from damage when exposed to copper and UVA/UVB radiation.

10. Evaluation of DNA fragmentation - Comet Assay Method

The Comet Assay is used to quantify DNA damage. This damage results in alterations in the DNA nitrogenous base sequence and unlike mutations, lesions detected by the assay are subject to correction. The test consists of cell lysis, DNA exposure, and electrophoresis. Under this test, DNA fragments (produced by the breakage caused by the xenobiotic agent) are subjected to electrophoresis, after staining they “migrate” to form a comet tail. In other words, the smaller the comet tail formation, the better the protective action of the test product. Results are shown in **Figures 23 and 24**.

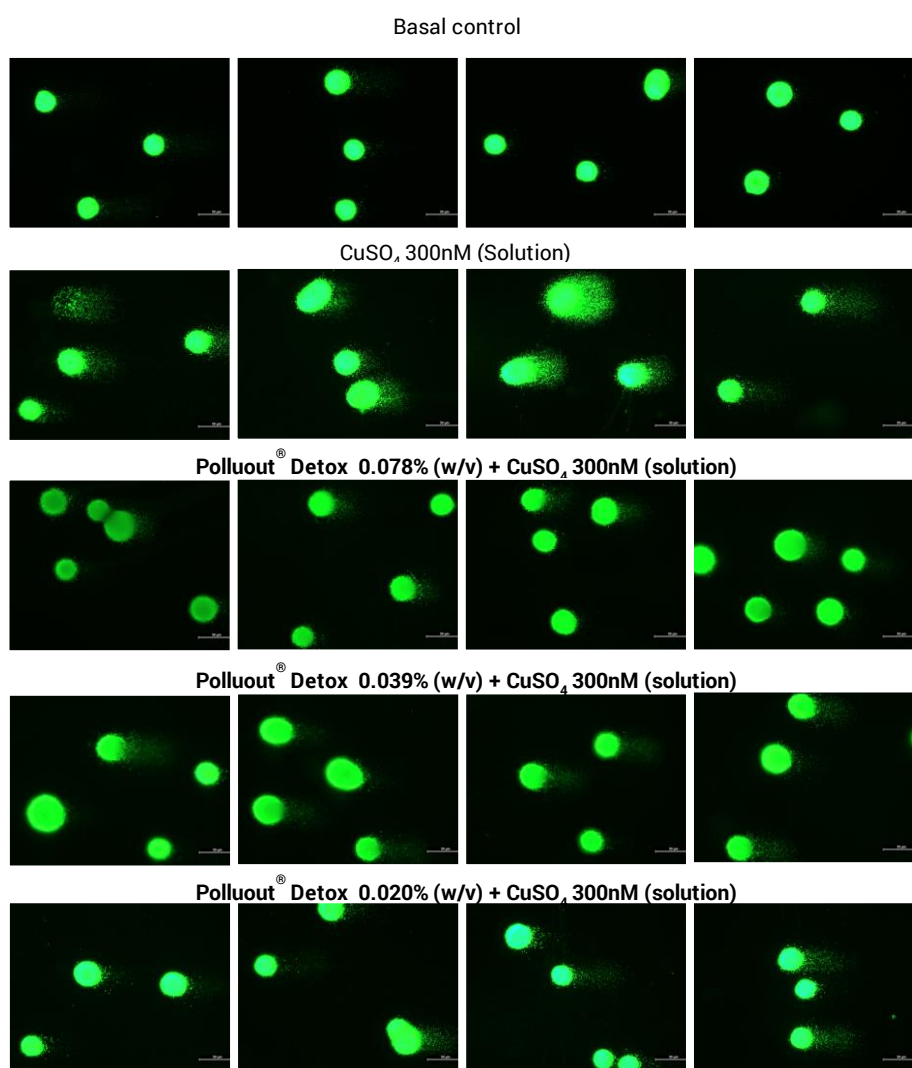
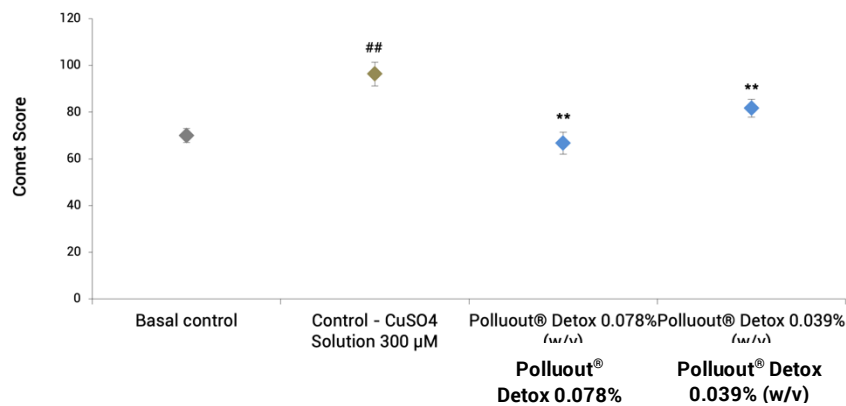


Figure 23. Comet assay evaluation of DNA protection potential in human keratinocytes after exposure to CuSO₄ solution (300 μM) and Polluout[®] Detox



Significant difference compared to the basal control group (p < 0.01)
 ** Significant difference compared to the CuSO₄ control group (p < 0.01)

Figure 24. Comet assay evaluation of DNA protection potential in human keratinocytes after exposure to CuSO₄ solution (300 µM) and **Polluout® Detox**

Polluout® Detox showed potential to significantly reduce DNA fragmentation in cultured human keratinocytes under exposure to copper sulfate solution (CuSO₄, 300 nM), showing its protective effect against damage to the scalp when exposed to copper ions.

11. Evaluation of the soothing effect through the IL-6 mediator

Maintaining the integrity of the scalp’s barrier function is key for hair health, and external interferences, such as copper sulfate, can affect its homeostasis and trigger irritating or inflammatory processes. In order to evaluate the **Polluout® Detox**’s soothing effect, studies were carried out to quantify the inflammatory mediator IL-6 through 24-hour incubation of human keratinocytes with copper sulfate solution and non-cytotoxic concentrations of **Polluout® Detox**, the results of which are described in **Figure 25**.

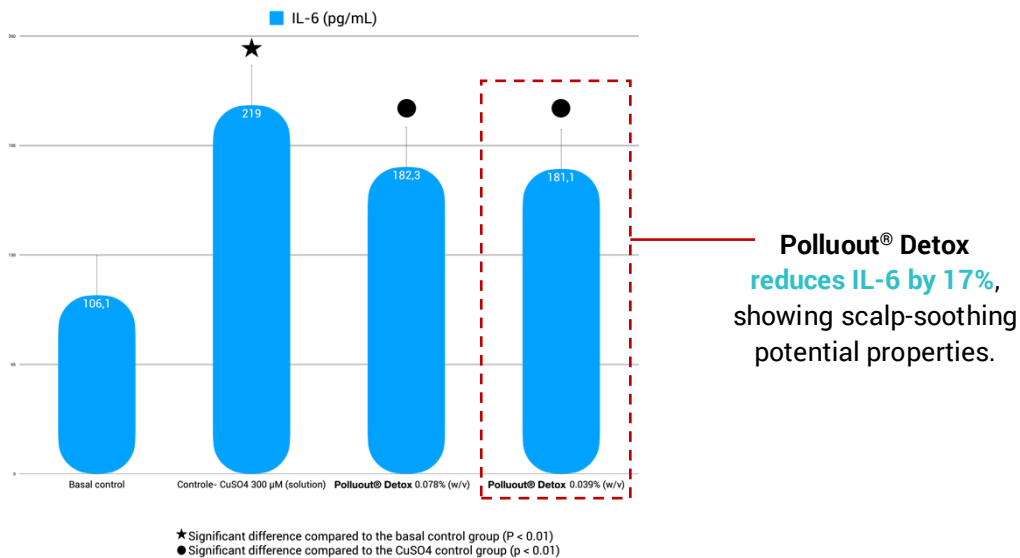


Figure 25: Effect of IL-6 synthesis in human keratinocytes after exposure to copper sulfate solution

Polluout® Detox showed potential for a significant reduction of IL-6 by 17% when compared to human keratinocytes exposed to a copper sulfate solution, evidencing scalp-soothing properties when exposed to the copper element.

Application

Compatible with shampoos, aqueous solutions, and anionic or non-ionic emulsions.

Stability and Compatibility

Stable and compatible with anionic and non-ionic bases. Water-soluble and oil-insoluble ingredient.

Concentration of Use

Indicated the use of 2%

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