Delivery Technologies for Diversified Products II

CAMILLA ELENA DI BELLA

PhD Student
Department of Pharmacy
University "G.d'Annunzio" of Chieti and Pescara, Italy.

CONTROLLED RELEASE SOCIETY
CRS 2024 **Annual Meeting** AND **Exposition**
JULY 8-12, 2024 • BOLOGNA, ITALY

INTEGRATING
Delivery Science
ACROSS DISCIPLINES

Multi – method approach to study the impact of major stressors on hair health : development of targeted hair cosmetic products .

CONTROLLED RELEASE SOCIETY
CRS 2024
Annual Meeting AND Exposition
JULY 8–12, 2024 • BOLOGNA, ITALY

INTEGRATING **Delivery Science** ACROSS DISCIPLINES

TABLE OF CONTENTS

CONTROLLED RELEASE SOCIETY
CRS 2024 Annual Meeting AND Exposition
JULY 8-12, 2024 • BOLOGNA, ITALY

INTEGRATING **Delivery Science** ACROSS DISCIPLINES

INTRODUCTION

PHYSICAL FACTORS

Cuticle

Cortex cell

Cortex

Medulla
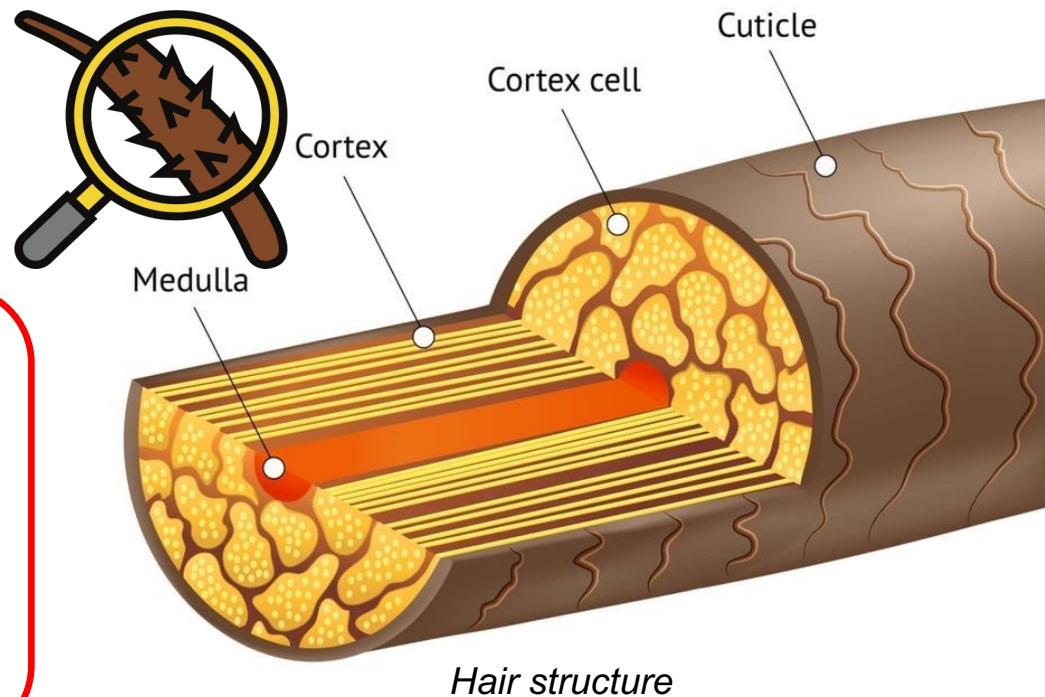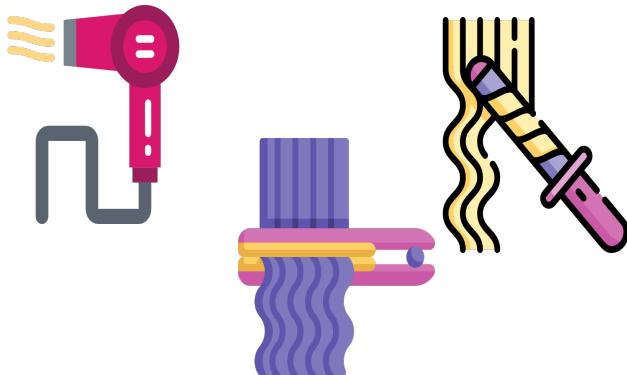
Hair structure

CHEMICAL FACTORS

ENVIRONMENTAL FACTORS
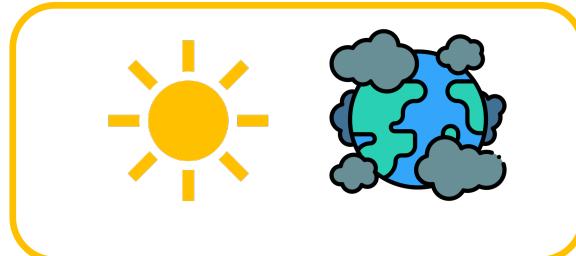
AIM OF THE STUDY

Hair stressors
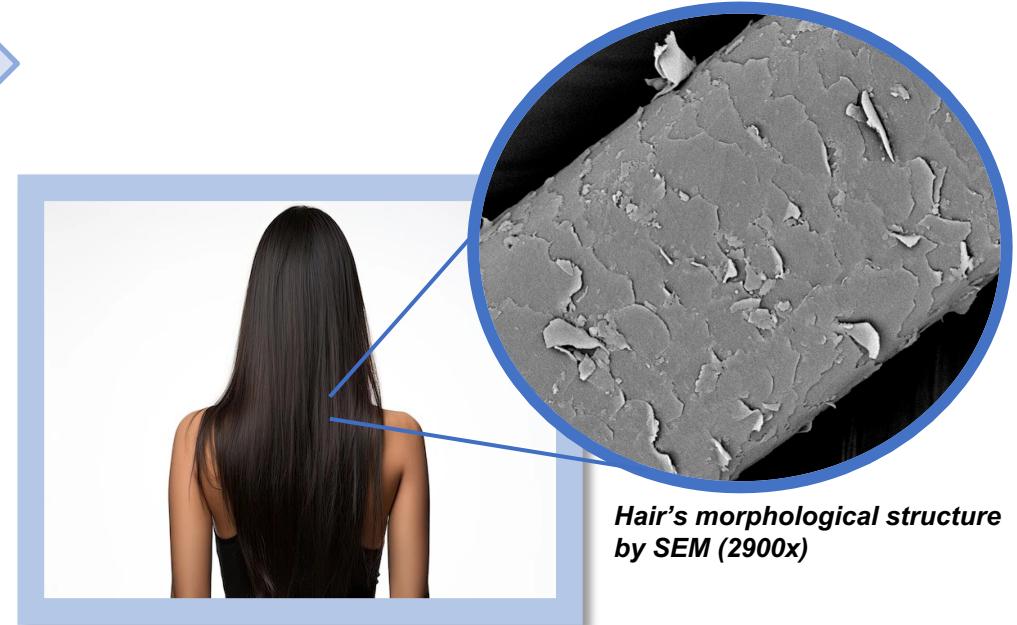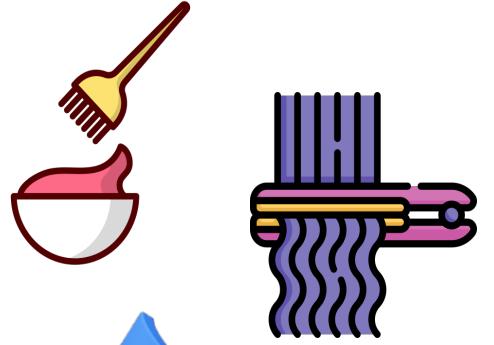
Hair's morphological structure by SEM (2900x)

Formulation of Cosmetic Hair Products

Shampoo   Biphasic oil   Hair lotion

Hair mask

✓ Cosmetic Efficacy Tests

CHARACTERIZATION

Optical Microscopy   FT-IR   SEM   RAMAN   TGA
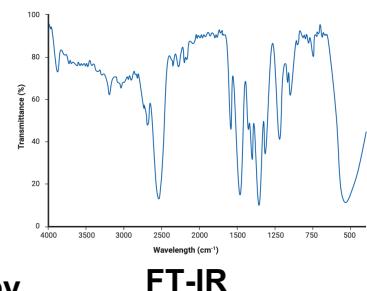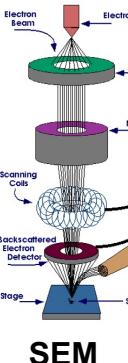
METHOD
- Motic PA53 BIO Standard Microscope with MoticamS6 Camera
- 100x magnification

OBJECTIVE
- ✓ Evaluation of hair's surface morphological differences between untreated natural hair and hair subjected to stress treatments.
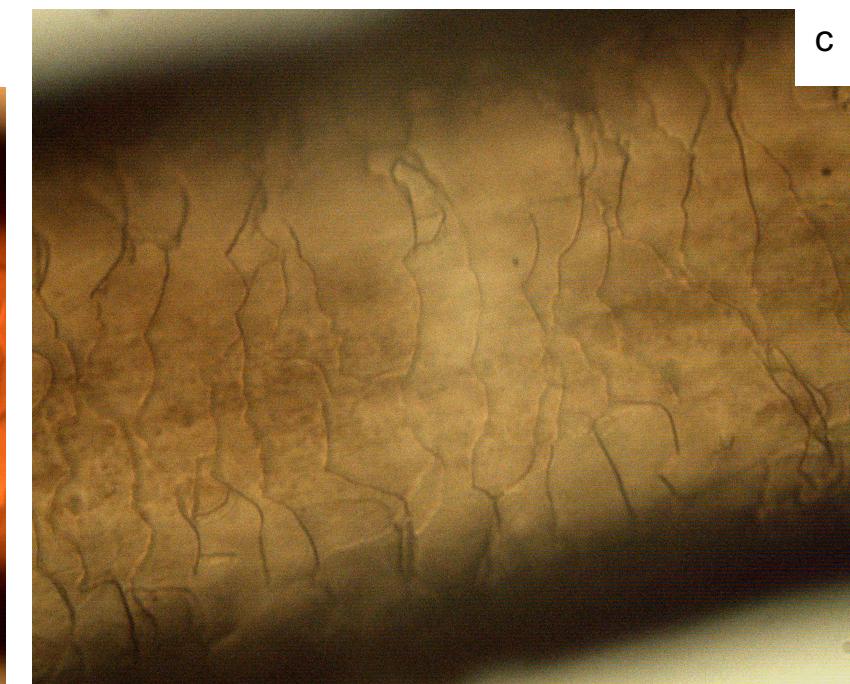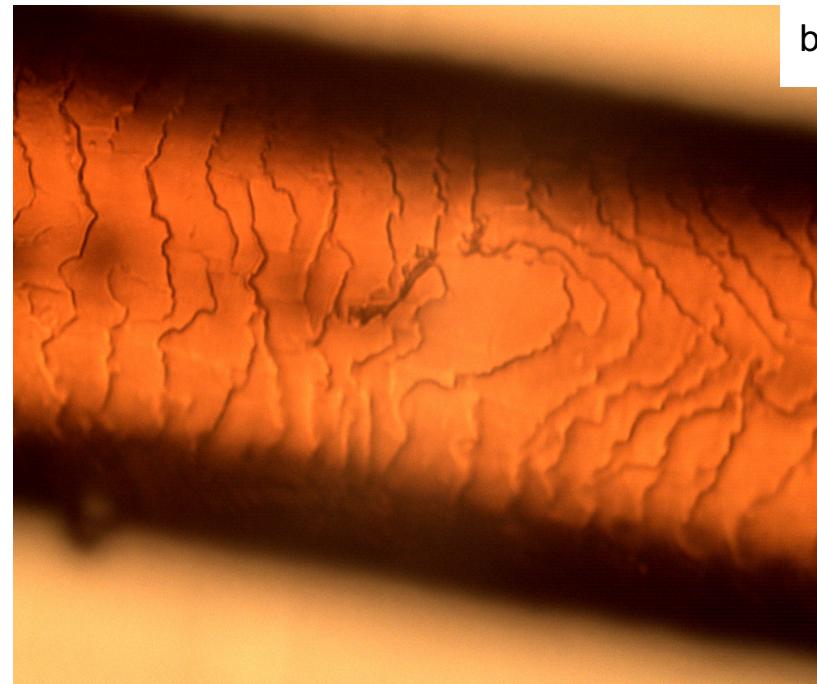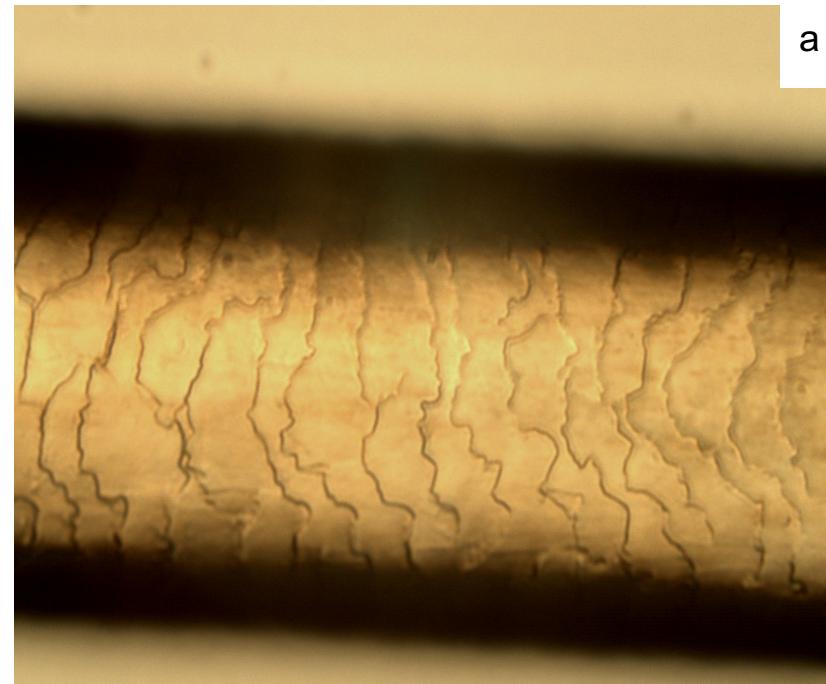
Fig.1 Hair's morphological structure observed under Optical Microscopy at 100x magnification: (**a**) Natural untreated hair (control); (**b**) Hair treated with permanent coloring product; (**c**) Straightened hair with hair flat iron.

SEM
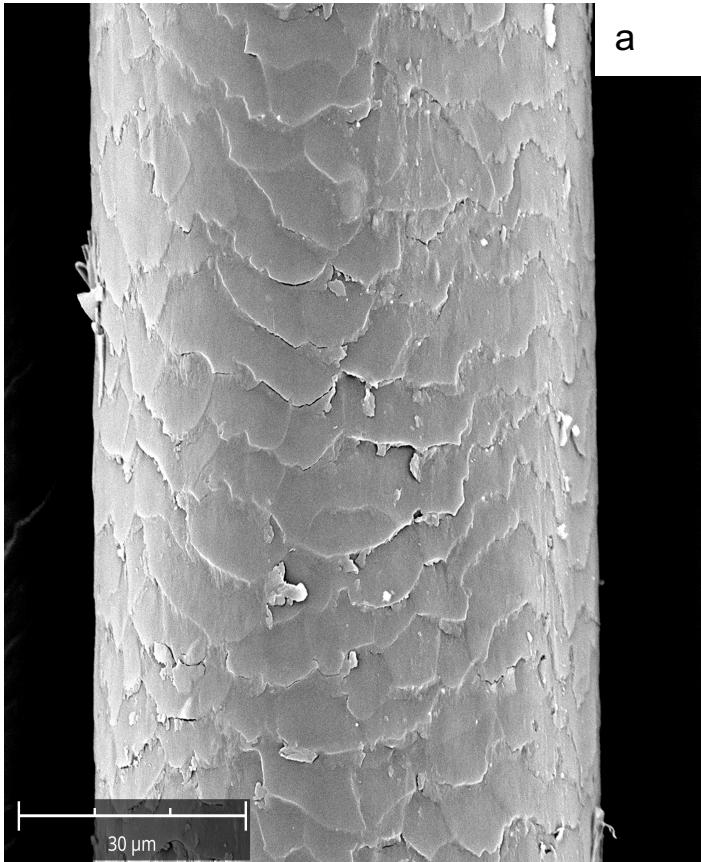
METHOD
- FEI Quanta 600F Scanning Electron Microscope
- 15Kv Voltage
- 2900x magnification
- Gold coating
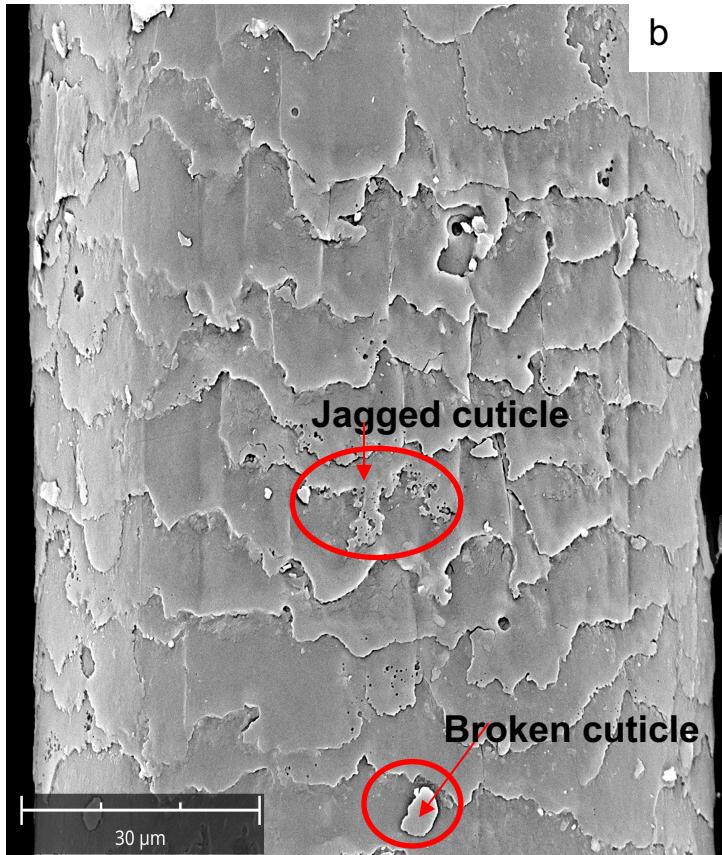
OBJECTIVE
- ✓ Evaluation of cuticle morphological differences found between natural untreated hair and hair subjected to stress procedures.

a

b

c

Jagged cuticle

Broken cuticle

Lifting cuticle

30 µm   30 µm   30 µm
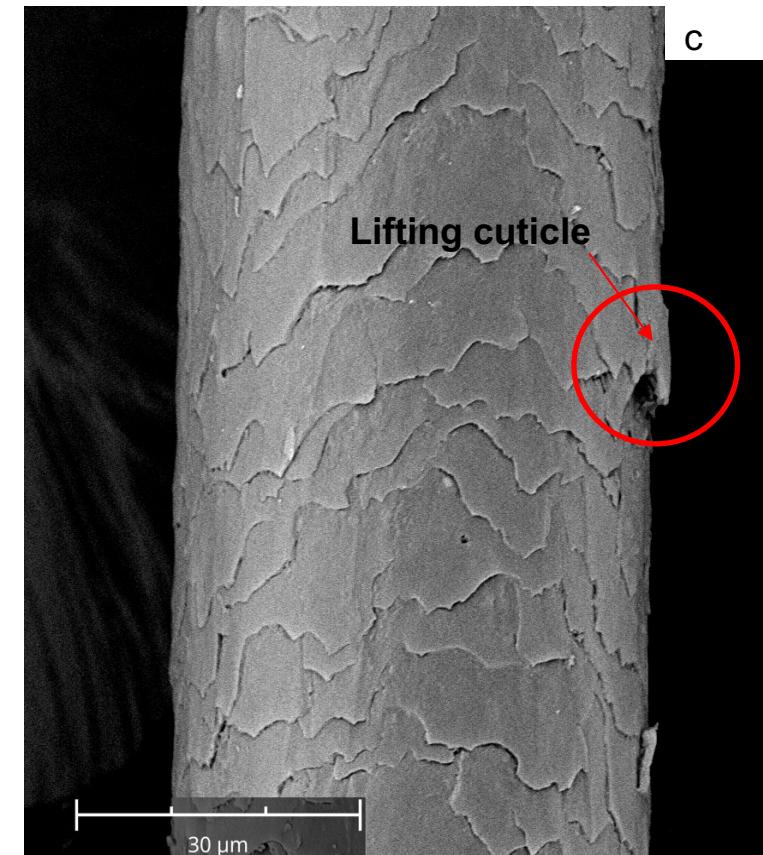
Fig.2 Scanning Electron Microscopy (SEM) of hair samples: SEM images at 2900x magnification of (**a**) untreated hair (**b**) hair treated with permanent coloring product (**c**) Straightened hair with hair flat iron.

METHOD
- Shimadzu IRAffinity-1S FTIR Spectrophotometer
- Transmission sample analysis
- Number of scans: 45
- Spectral range: 4000-400 cm^{-1}

OBJECTIVE
- ✓ Assessment of the molecular structure of untreated natural hair and hair exposed to stressors.
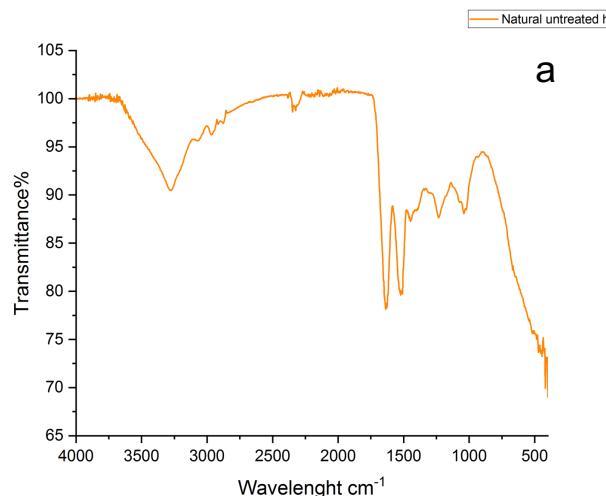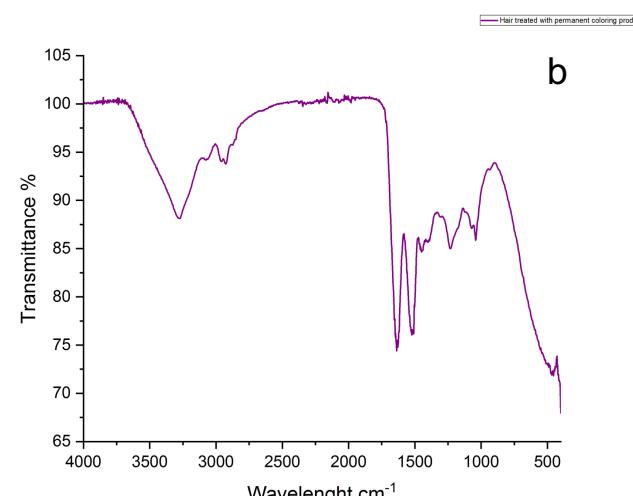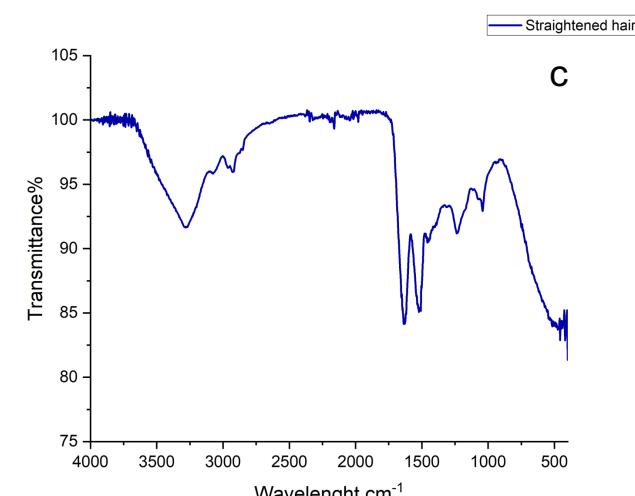
Fig.3 IR spectra of: (**a**) natural untreated hair (control) ; (**b**) hair treated with permanent coloring product; (**c**) straightened hair with hair flat iron.

Table 1. Assignment of bands found in the spectra of analyzed hair samples.

	ν_{as} N-H 3370-3320*	ν_{as} CH$_3$ 2975-2950*	ν_{as} CH$_2$ 2940-2915*	ν_s CH$_3$ 2885-2865*	ν_s CH$_2$ 2870-2840*	AMIDE I 1680-1630*	AMIDE II 1550-1510*	δ_s CH$_2$ 1480-1440*	AMIDE III 1305-1200*	ν SO$_3$ 1175-1040*	ν S=O 1071-1075*
a	3284-3273	2960	-	2877	-	1647-1629	1533-1527	1448	1232	1040	1071
b	3278-3273	2960	2920	-	-	1654-1630	1527	1448	1230	1041	1071
c	3282	2962	2927	-	-	1630	1517	1448	1236	1041	1075

*Pienpinijtham, Prompong et al. "Analysis of cosmetic residues on a single human hair by ATR FT-IR microspectroscopy." *Spectrochimica acta. Part A, Molecular and biomolecular spectroscopy* vol. 197 (2018): 230-236.

METHOD
- Bruker SENTERRA Spectrometer
- Laser 638 nm
- Objective: 50x
- Laser power: 1mW
- Acquisition time: 10sec
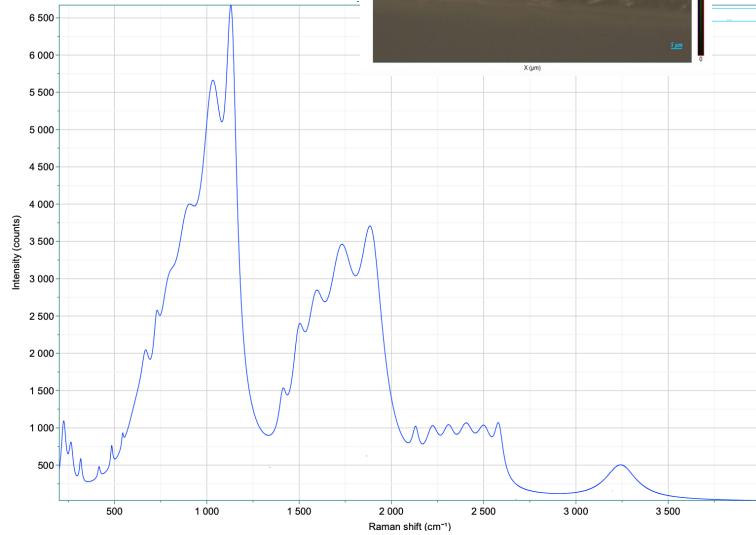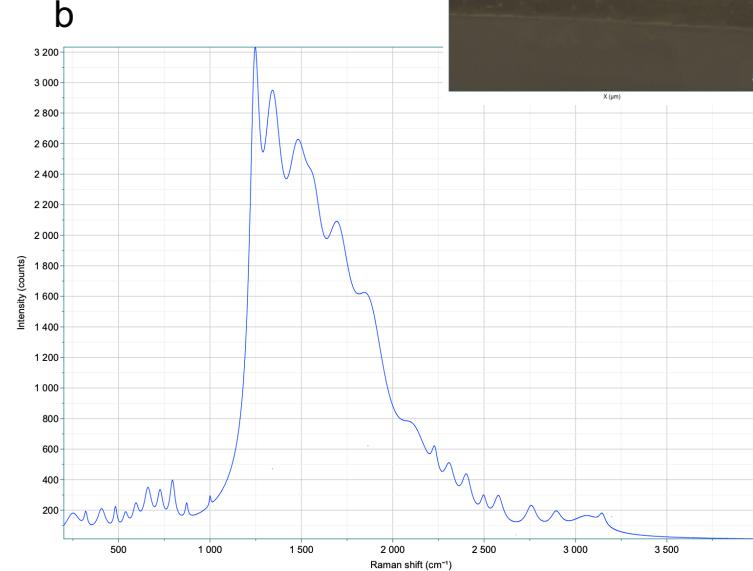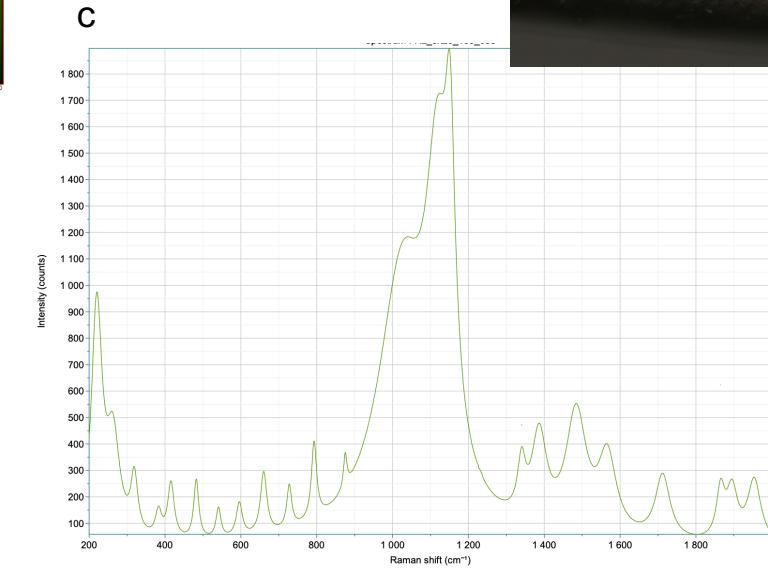
OBJECTIVE
- ✓ Evaluation of changes in the chemical and structural composition of hair subjected to stress procedures compared with untreated natural hair.


Fig. 4 Raman Spectra and hair structure by Confocal Microscopy at 50x of (**a**) Natural untreated hair; (**b**) Hair treated with permanent coloring product; (**c**) Straightened hair with hair flat iron obtained with λ_0 638.

OBJECTIVE

✓ Measurement of the hair samples' mass loss and the variation in the enthalpy due to the loss of bound water after exposition at various Relative Humidity percentages.

SAMPLES PREPARATION

- Glass desiccator
- Saturated Potassium Sulphate solution
- Temperature: 25°C
- RH 97%
- Exposition time: 7days

Fig 9. Drying chamber with hair samples at day0

TGA METHOD

- TG Mettler TA 3000
- Heat from 25.00°C to 65.00°C at 20.00°C/min
- Hold for 30.0 min at 65.00°C
- Heat from 65.00°C to 180.00°C at 20.00°C/min
- Hold for 30.0 min at 180.00°C
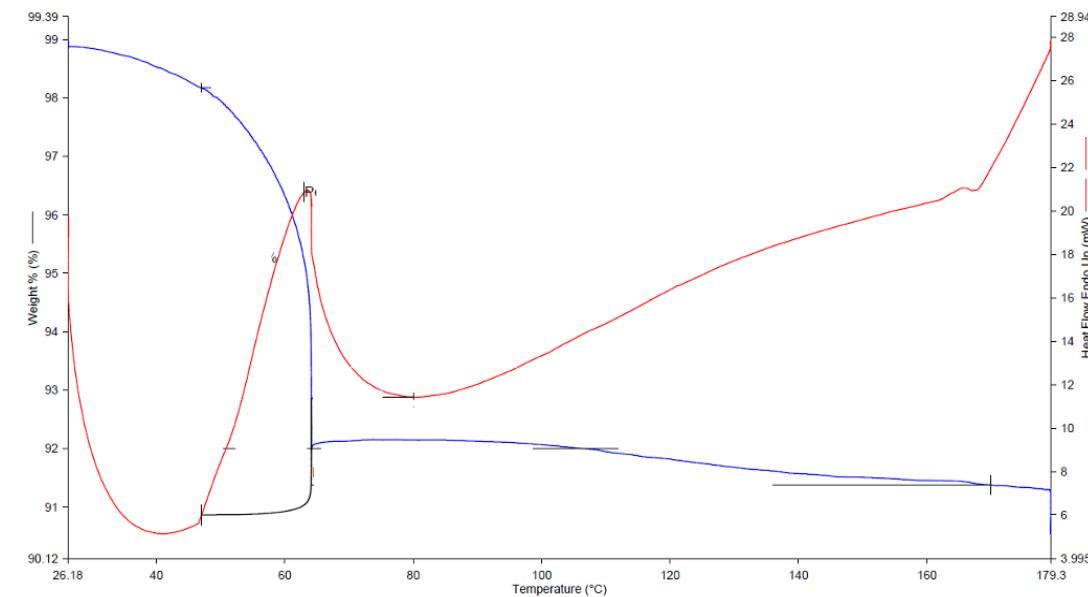
Fig 10. Thermogram of one hair sample give as an example.

HAIR COSMETIC FORMULATIONS

Strengthening shampoo formulated with plant extracts, Caffeine and Keratin to protect hair from daily damage and keep it healthy and strong.

Intensive mask with nourishing ingredients and Panthenol designed to repair and protect damaged hair.

Protective pre-shampoo lotion enriched with Caffeine and Panthenol, protects and fortifies hair from root to tip.

Biphasic oil that combines nourishing oils and protective agents to strengthen and protect hair.

IN VIVO COSMETICS EFFICACY TESTING

TEST PROTOCOL

- ❖ 10 informed consent volunteers
- ❖ Frequency of application: 2 times/week
- ❖ Duration of study: 15 days
- ❖ Time points analyzed: T0-T15 days
- ❖ Characterization of collected samples: Optical Microscopy, FT-IR, RAMAN
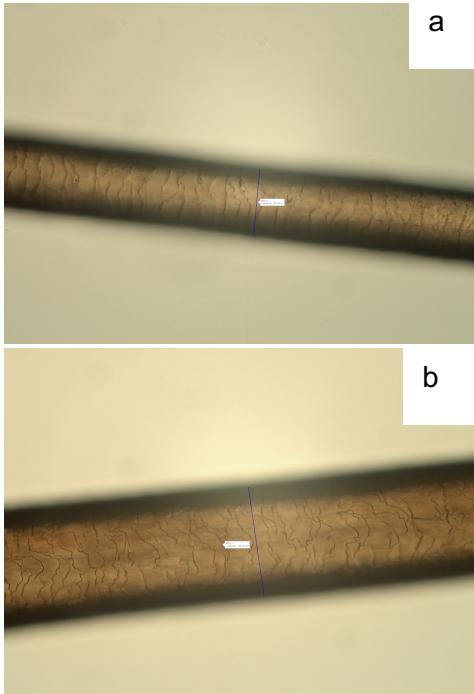
Fig.5 Hair's structure observed under Optical Microscopy at 40x magnification:(**a**) before hair treatment and (**b**) after hair treatment.
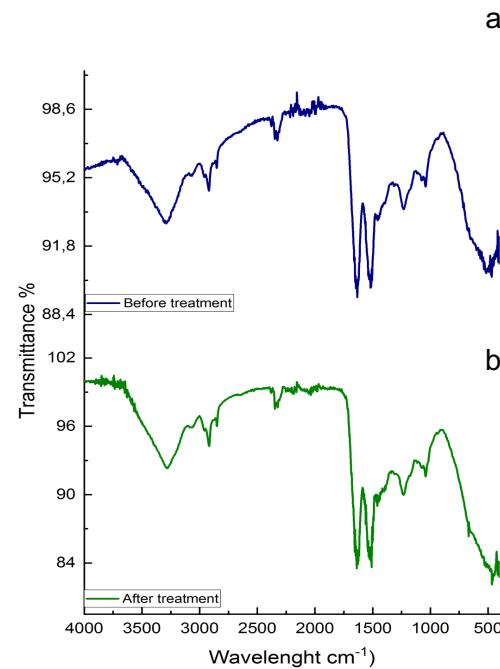
Fig.6 FT-IR analysis of hair (**a**) before hair treatment and (**b**) after hair treatment.
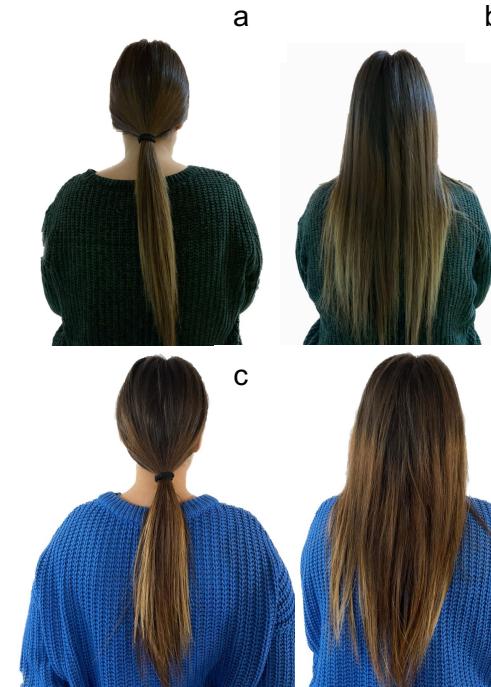
Fig.7 Hair of a volunteer reference (**a, b**) before hair treatment and (**c, d**) after hair treatment.
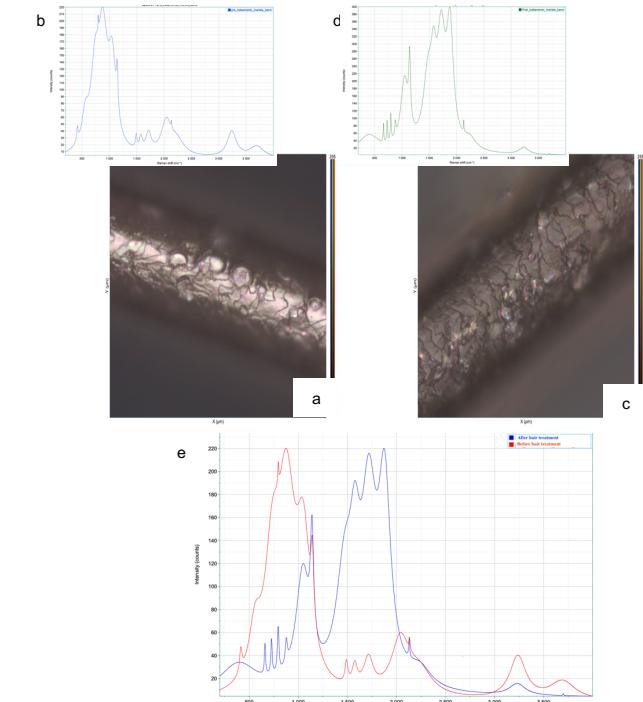
Fig. 8 Images of: Structure by Confocal Microscopy at 50x of hair (**a**) before hair treatment and (**c**) after hair treatment; Raman Spectra of hair (**b**) before hair treatment and (**d**) after hair treatment obtained with λ_0 638; (**e**) Overlapping of (**b,d**) Raman Spectra.

CONCLUSIONS

- ✓ Hair stressors have a significant impact on hair health, manifesting in structural and physiochemical damage.
- ✓ The analysis techniques used have provided a detailed understanding of the mechanisms of hair deterioration.
- ✓ Hair cosmetic products specifically developed to strengthen and repair hair from the effects of stress have shown promising in vivo results.
- ✓ The multi-method approach is an effective model for future research in hair health assessment and development of cosmetic hair care products.

FUTURE PROSPECTIVES

- ➤ Expand analyses to study a wider range of stressors and further study the combined effects of different stressors on hair.
- ➤ Integrate new technologies and analytical methodologies to improve understanding of hair damage and repair mechanisms.
- ➤ Develop specific cosmetic products to selectively treat each damage generated by different stressors.

ACKNOWLEDGEMENT

THANK YOU FOR YOUR ATTENTION!