

FORMALDEHYDE-INDUCED HAIR DAMAGES CONFIRM THE NECESSITY TO BAN IT FOR COSMETIC USAGE AND TO DEVELOP SAFER ALTERNATIVES FOR HAIR STRAIGHTENING.

Poster ID
HC_460

Kermool, Alain-Marc¹; Wayne Keuon, Yann¹; Mazilier, Christian¹; Ferro Oliveira, Natalia²; Flor, Camila³; Oliveira, Veronica²; Dal Belo, Susi²; Provot, Gerard¹.

¹ Technical and Scientific Department, L'OREAL R&I, France ² Product Performance Evaluation Department, L'OREAL R&I, Brazil

³ Haircare&Styling Products Development Department, L'OREAL R&I, USA. gerard.provot@rd.loreall.com

1 INTRODUCTION

Hair straightening is a raising consumer concern in the world and many ingredients have been proposed in the last 20 years. Many scientific literature and different authorities report the use, more specifically in Brazil, of some straightening products (Brazilian Keratin Treatment (BKT)) containing very high concentrations of formaldehyde (up to 19%) as active molecule for straightening. Several consequences of concern apart from which the irregular usage of formaldehyde are first of all, the high aerial dispersion of Formaldehyde because of hair flat ironing and brushing, possibly leading to hazardous consequences to both consumers and hair professionals [1-2]. A second observation we made in 2012 was the presence of very high amount of formaldehyde (up to 8,000ppm (µg/g of hair) in hair of Brazilian women (n=24). Even if 100% of this limited population presented formaldehyde in their hair, it was unclear whether there is a link the use of BKT in Brazil and these levels. Additionally, we wanted to assess whether such rates could modify the properties of the hair. For this purpose, we conduct a comparative study by measuring formaldehyde amount present in Brazilian and French hair women. Additionally, to these quantification, we also evaluated the hair integrity by measuring the denaturation temperature and the mechanical resistance of hair containing formaldehyde.

2 MATERIALS AND METHODS

COLLECTION OF HAIR

To the initial n=24 Brazilian consumers, a new set of hair was collected in 2019. Samples were collected from n=66 women attending to product performance evaluation in our Brazilian testing center in Rio, and from n=77 women in our French testing in Saint-Ouen. Hair samples were collected before application of hair products, by hair dressers collecting hair from different part of the head and by cutting the hair close to the scalp.

DETERMINATION OF FORMALDEHYDE AMOUNT IN HAIR

Quantity of formaldehyde in hair was determined as follows:

- About 20mg of hair (each from root to tip) were precisely weighed and extracted with 1.5mL of HCl 1N Eppendorf thermomixer at 80°C and stirred at 1440rpm for 16 hours
- Injection on an HPLC (Waters)/post derivatization (with acetylacetone) (Jasco)/Visible detection (@420nm) (Waters)
- Quantification by external calibration by comparing response of formaldehyde peak in hair extract solutions with those of standard solutions of formaldehyde.

HAIR INTEGRITY EVALUATION

Hair integrity was determined by measuring the denaturation temperature of hair by High Pressure Differential Scanning Calorimetry (DSC) measurement as follows:

- About 5mg of hair cut in small pieces (2mm) were precisely weighted in steel capsules for DSC measurement,
- A volume of 50µL of distilled water was added before sealing of the capsules.
- After an equilibrium time of ca 15 hours, the capsules were placed on a DSC equipment (Perkin Elmer), and heat from 30 to 190°C at a speed of 10°C/min.
- Denaturation temperature (Td) was determined on the thermogram as the maximum temperature of fusion

Complementary to DSC, the breakage extension (%) is measured on a traction test at a temperature of 25°C and a relative humidity of 50%.

These 2 methods allow to determine the hair resistance.

References:

1. Peixe M. E. and al. (2019) Hairdressers are exposed to high concentrations of formaldehyde during the hair straightening procedure. Environ Sci Pollut Res Int, 26: 27319-27329.
2. Henalt P. and al (2021) A methodological approach for quantifying aerial Formaldehyde released by some hair treatments-Modelling a hair-salon environment. J of the Air & Waste Mgmt Ass 71(6): 754-760.

Aknowlegments:

All colleagues who contribute to these investigations initiated more than 10 years ago.

L'ORÉAL
RESEARCH
& INNOVATION

3 RESULTS & DISCUSSION

FORMALDEHYDE AMOUNT IN HAIR

The testing of new hair collected in Brazil and France showed respectively:

- Presence of formaldehyde for 67% of the Brazilian women
 - Maximum value measured up to ca 8500 ppm
 - Mean formaldehyde value, ca 1700ppm (for the 67% positive)
- VS
- Only 4% of positive French women
 - Maximum value measured, 459 ppm
 - Mean formaldehyde value, ca 270 ppm (for the 4% positive)

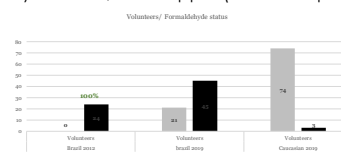


Figure 1: repartition of women positive to formaldehyde response in hair

MODIFICATION OF HAIR INTEGRITY

The values of denaturation temperature of hair measured by DSC were surprisingly higher than for natural hair used as reference. This result was a signature of a deep modification of hair structure and organization probably through reticulation. As formaldehyde was demonstrated with an infinite lastingness, this modification is supposed to be definitive.

Complementary to this finding, the traction tests carried out on the same hair highlighted a severe decrease of the break extension. This second finding was a second signature of formaldehyde presence, but very negative with a clear signal of weakening of hair material properties.

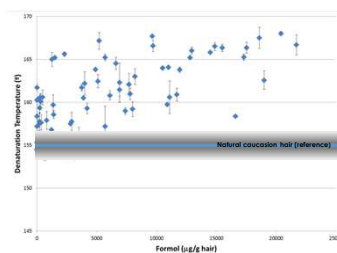


Figure 2: denaturation temperature of hair collected from Brazilian women in 2019

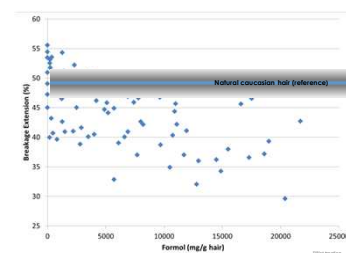


Figure 2: breakage extension values measured on hair collected from Brazilian women in 2019

4 CONCLUSIONS

The present data confirmed initial finding, and the presence of high amount of formaldehyde in hair of Brazilian women (up to 8,500ppm (µg/g of hair) VS 459 ppm in hair of French women. In addition, high level of occurrence 73% (n=90) VS 4% (n=77) was observed between the 2 populations. In 7 years (between the 2 hair collection times), it is difficult to conclude that the situation for Brazilian consumers has been improved as 2/3 of the tested population was still positive in 2019. And the amount found in Brazilian hair was tremendously higher than in the few positive women in France.

The consequences of formaldehyde in hair were demonstrated as correlating with a drastic loss of hair integrity as measured by DSC or breakage extension.

Finally, a non-visible and yet not evaluated long term effect is the consequence for women with « formaldehyde spiked hair » on their health because of permanent exposure by skin (scalp) contact and by breathing to this hidden « reservoir » of formaldehyde present on their head!