

TEST REPORT B&R008-18-A, Review 2
Test Proposal B&R008-18, Review 1

Hair Combability Measurements

Evaluated Products:

Monat Renew Shampoo

Monat Restore Leave-in Conditioner

Monat Volume Revive Shampoo

Monat Volume Revitalize Conditioner

Monat Black Shampoo + Conditioner

Sponsor: **MONAT GLOBAL**
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SYNOPSIS OF TEST REPORT TR-B&R008-18-A-R2

- Study Code:** B&R008-18
- Title of Study:** Hair Combability Measurements
- Product Evaluated:** Monat Renew Shampoo; Monat Restore Leave-in Conditioner; Monat Volume Revive Shampoo; Monat Volume Revitalize Conditioner; Monat Black Shampoo + Conditioner.
- Study plan code:** PE-B&R008-18-R1
- Purpose of study:** The purpose of this study was to assess wet combability of hair tresses, using mechanic measures after applying cosmetic hair care products.
- Study Director:** Francini C. Picon
- Chronology of study:** The study was carried out from February 19th to February 22nd, 2018.
- Experimental Design:** In the present study, tresses of natural and bleached/dyed Caucasian hair were submitted 12 applications of the treatments as described below:
- Virgin Caucasian Hair - group **Virgin**;
 - Bleached and Dyed Hair – group **Bleached/Dyed**;
 - Virgin Hair + Monat Renew Shampoo (Normal Condition) – group **T01**;
 - Virgin Hair + Monat Renew Shampoo (Modified Condition) – group **T02**;
 - Bleached and Dyed Hair + Monat Renew Shampoo (Normal Condition) – group **T03**;
 - Bleached and Dyed Hair + Monat Renew Shampoo (Modified Condition) – group **T04**;
 - Virgin Hair + Monat Volume Revive Shampoo (Normal Condition) – group **T05**;
 - Virgin Hair + Monat Volume Revive Shampoo (Modified Condition) – group **T06**;
 - Bleached and Dyed Hair + Monat Volume Revive Shampoo (Normal Condition) – group **T07**;
 - Bleached and Dyed Hair + Monat Volume Revive Shampoo (Modified Condition) – group **T08**;
 - Virgin Hair + Monat Black Shampoo + Conditioner (Normal Condition) – group **T09**;
 - Virgin Hair + Monat Black Shampoo + Conditioner (Modified Condition) – group **T10**;
 - Bleached and Dyed Hair + Monat Black Shampoo + Conditioner (Normal Condition) – group **T11**;
 - Bleached and Dyed Hair + Monat Black Shampoo + Conditioner (Modified Condition) – group **T12**;
 - Virgin Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition) – group **T13**;
 - Virgin Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition) – group **T14**;
 - Bleached and Dyed Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition) – group **T15**;
 - Bleached and Dyed Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition) – group **T16**;
 - Virgin Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition) – group **T17**;
 - Virgin Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition) – group **T18**;

- Bleached and Dyed Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition) – group **T19**;
- Bleached and Dyed Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition) – group **T20**.

The wet combability of the tresses was evaluated after treatments (**Final**). The combability measures were obtained using the EMIC DL-500 test equipment (TESC 3.01 software), together with a fixed holder with a standard comb, coupled to a previously calibrated 20.0 N load cell.

Directions: Shampoo (Normal Condition): Apply 0,6 mL of Shampoo and rub the tresses for 30 seconds. Leave it on hair for 3 minutes. Rinse for 30 seconds and remove excess water.
Shampoo (Modified Condition): Apply 0,3 mL of Shampoo and rub the tresses for 30 seconds. Rinse for 30 seconds and remove excess water. Repeat the wash.
Conditioner: Apply 0.45 mL of Conditioner and rub it for 60 seconds. Rinse the tress for 30 seconds and remove excess water.

Conclusion: According to the results obtained, the treatments “Monat Renew Shampoo”, “Monat Volume Revive Shampoo”, “Monat Black Shampoo + Conditioner”, “Monat Renew Shampoo + Monat Restore Leave-in Conditioner” and “Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner”, on Normal or Modified conditions, showed significantly lower values of Combability Energy when compared with both virgin and bleached/dyed hair. The results show the hair has become easier to comb by to reduce wrinkling and to close the outer cuticles of the hair fiber. The table below summarizes the results of Reduction of Combability Energy obtained.

Reduction of Combability Energy (% and number of times) of treatments in wet condition.				
Treatment	Virgin/Natural Hair		Bleached/dyed hair	
	%	Number of times	%	Number of times
Monat Renew Shampoo (Normal Condition)	43	1.7	43	1.8
Monat Renew Shampoo (Modified Condition)	33	1.5	33	1.5
Monat Volume Revive Shampoo (Normal Condition)	39	1.6	41	1.7
Monat Volume Revive Shampoo (Modified Condition)	22	1.3	26	1.4
Monat Black Shampoo + Conditioner (Normal Condition)	45	1.8	55	2.2
Monat Black Shampoo + Conditioner (Modified Condition)	19	1.2	28	1.4
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition)	61	2.6	54	2.2
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition)	36	1.6	37	1.6
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition)	50	2.0	43	1.8
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition)	40	1.7	33	1.5



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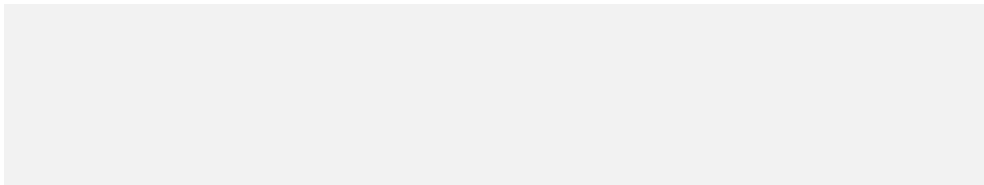
The results and discussion described in this report refer only to tested items.



AMENDMENTS TO THE TEST REPORT

Test Report B&R008-18-A, Review "1", issued on 03/13/2018, becomes obsolete after the issuance of this report named: Test Report B&R008-18-A, Review "2" issued on 03/13/2018.

Any reproduction of data from the formerly issued Test Report B&R008-18-A, Review "1" becomes impractical and invalid starting on the date of this new issuance.



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I – INTRODUCTION

Hair combability is one of the attributes immediately identified by a shampoo consumer after using the product. The improvement of this attribute is directly linked, microscopically, to the increase of softness of the hair fiber surface, which includes reduced wrinkling and closing of the outer cuticular layers of the fiber. Macroscopically, the existence of a smaller degree of aggregation and interaction among fibers is also necessary.

All these characteristics can be considered as the state of conditioning of the fiber that has to be improved, reducing the attrition during combing and, as a result, total energy dissipated.

There are many papers mentioned in the bibliography which use analytical techniques that intend to measure forces put into action during the act of combing in order to provide objective comparisons among different products or formulations. These techniques include from the use of combs equipped with electronic sensors, dynamometers equipped with fixed combs to complex robots that simulate combing under diverse angles, velocities and applied forces.



II – OBJECTIVE

The purpose of this study was to assess wet combability of hair tresses, using mechanic measures after applying cosmetic hair care products.

III – EXPERIMENTAL PROCEDURE

1. Generalities

1.1. Study Plan

The study was conducted per guidelines of study plan PE-B&R008-18-A-R1.

1.2. Dates

The study was approved to start on February 19th, 2018, and it was carried out from February 19th to February 22nd, 2018.

2. Identifying samples supplied by the Sponsor for the Study

- A27-156 Monat Renew Shampoo – 18J0115107;
- A27-044 Monat Volume Revive Shampoo – 18J0115104;
- A27-040 Monat Volume Revitalize Conditioner – 17J1227153;
- A17-062D Monat Black Shampoo + Conditioner – 18J0117146;
- A27-040 Monat Volume Revitalize Conditioner – 17J1227153;
- A27-042 Monat Restore Leave-In Conditioner – 18J0111087.

The formulations of the samples, forwarded by the Sponsor are listed in **Appendix I**. After the study, all residues of samples were filed per Kosmoscience® Quality Procedures under unique study identification code B&R008-18 for a six-month period.

3. Procedure for conducting evaluations

3.1. Experimental design

Sixty six tresses were prepared from Natural Caucasian hair and sixty six tresses were prepared from bleached/dyed Caucasian hair, weighing 3.0 g each and 27 cm long. All tresses underwent a standard pre-cleaning process with 10% Sodium lauryl ether sulfate (SLES) solution for 1 minute then rinsed with running water. The wet combability was measured (**Final** measures).

The tresses were split in 22 groups and submitted to 12 applications of the treatments:

Treatments	Study Code
Virgin Caucasian Hair	<i>Virgin</i>
Bleached and Dyed Hair	<i>Bleached /Dyed</i>
Virgin Hair + Monat Renew Shampoo (Normal Condition)	<i>T01</i>
Virgin Hair + Monat Renew Shampoo (Modified Condition)	<i>T02</i>
Bleached and Dyed Hair + Monat Renew Shampoo (Normal Condition)	<i>T03</i>
Bleached and Dyed Hair + Monat Renew Shampoo (Modified Condition)	<i>T04</i>
Virgin Hair + Monat Volume Revive Shampoo (Normal Condition)	<i>T05</i>

Virgin Hair + Monat Volume Revive Shampoo (Modified Condition)	T06
Bleached and Dyed Hair + Monat Volume Revive Shampoo (Normal Condition)	T07
Bleached and Dyed Hair + Monat Volume Revive Shampoo (Modified Condition)	T08
Virgin Hair + Monat Black Shampoo + Conditioner (Normal Condition)	T09
Virgin Hair + Monat Black Shampoo + Conditioner (Modified Condition)	T10
Bleached and Dyed Hair + Monat Black Shampoo + Conditioner(Normal Condition)	T11
Bleached and Dyed Hair + Monat Black Shampoo + Conditioner (Modified Condition)	T12
Virgin Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition)	T13
Virgin Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition)	T14
Bleached and Dyed Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition)	T15
Bleached and Dyed Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition)	T16
Virgin Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition)	T17
Virgin Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition)	T18
Bleached and Dyed Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition)	T19
Bleached and Dyed Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition)	T20

The treatments described above were applied 12 times and the measurements of final wet combability were taken of each tress.

The procedure to apply the products is described in **Appendix II**.

3.2. Combability measurement

The combability measures were obtained using the EMIC DL-500 test equipment (TESC 3.01 software), together with a fixed holder with a standard comb, as illustrated in **Figure 1**, coupled to a previously calibrated 20.0 N load cell.



Figure 1. EMIC DL - 500 test device with comb holder.

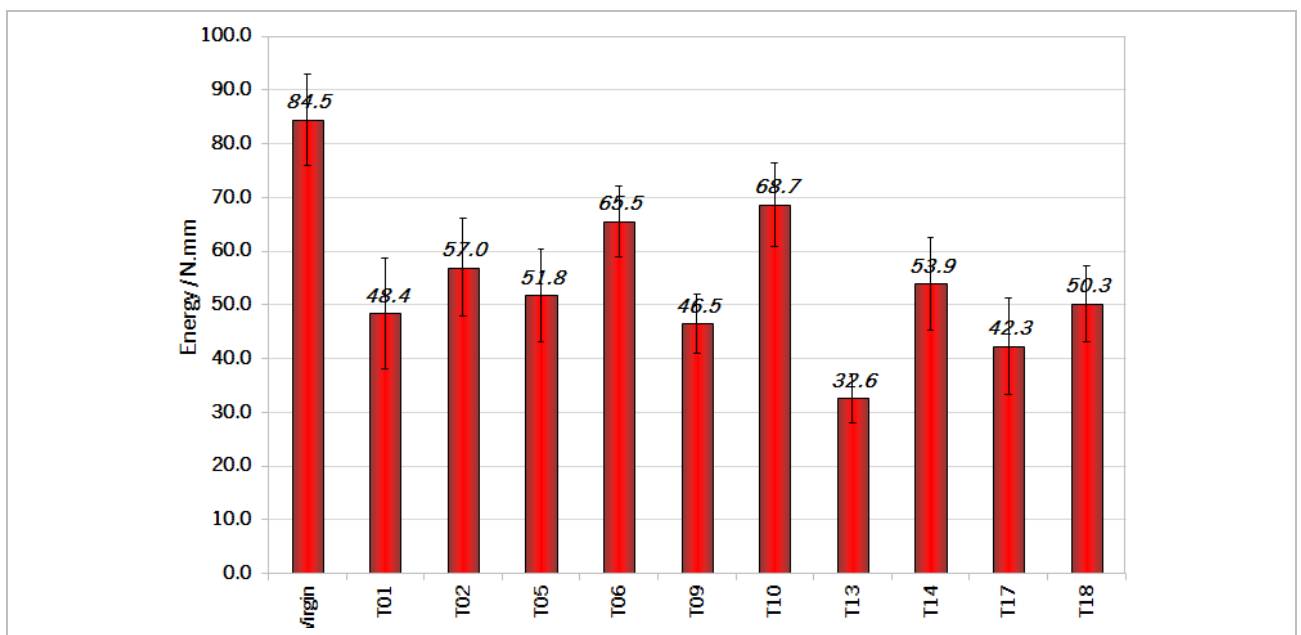
The procedure of combability measurement is described in **Appendix II**.

IV – RESULTS AND DISCUSSION

Graphs were built with the results obtained from the combability tests - **Appendix III**, to compare the treatments conducted on wet and dry tresses.

Virgin Hair

Graph 1 illustrates the data for Energy (N.mm) obtained for combability of wet tresses.



Graph 1. Results of **Energy** (N.mm) for **Wet** natural tresses. Mean \pm standard deviation.

The Energy values data of the treatments were statistically analysed in relation to the **Virgin** group, using one-way ANOVA, followed by a Dunnett's post-test, considering a 95% confidence interval. The complete statistical analysis is listed in **Appendix IV. Table 1** summarizes the obtained results.

Table 1. Results of the statistical analysis for wet combability. Confidence interval of 95%.

Treatment	Showed significant differences?
Virgin vs. T01	Yes
Virgin vs. T02	Yes
Virgin vs. T05	Yes
Virgin vs. T06	Yes
Virgin vs. T09	Yes
Virgin vs. T10	Yes
Virgin vs. T13	Yes
Virgin vs. T14	Yes
Virgin vs. T17	Yes
Virgin vs. T18	Yes

According to the results obtained, the treatments **T01, T02, T05, T06, T09, T10, T13, T14, T17** and **T18** for **wet** combability, showed lower values of Combability Energy when compared to the group **Virgin**.



The comparison between treatments was statistically analyzed by applying the bimodal, unpaired Student's t-test, considering a 95% confidence interval. **Table 2** shows the summarized results of statistical analysis. The statistical analysis is described in **Appendix IV**.

Table 2. Statistical analysis. 95% of confidence interval.	
Baseline vs. Final	Are there statistical difference?
	Wet combability
T01 x T02	No
T05 x T06	Yes
T09 x T10	Yes
T13 x T14	Yes
T17 x T18	No

According to the results for **wet** combability, the tresses submitted to the treatment **T01** and **T17** showed no significantly difference in values of Combability Energy when compared to the treatments **T02** and **T18**, respectively. Also according to the results obtained, for **wet** combability, the tresses submitted to the treatments **T05**, **T09** and **T13** showed significantly lower values of Combability Energy when compared to the treatments **T06**, **T10** and **T14**, respectively.

Table 3 shows the results of "Reduction of Combing Energy, **RE**", in percentage and in number of times, calculated for treatments groups compared to control group, according to **Equations 2** and **3**, respectively.

$$RE = 100 * \left(\frac{E_{CTRL} - E_{TRT}}{E_{CTRL}} \right)$$

Equation 2. Calculating Reduction of Combing Energy (%) of **TRT** treatments compared to the **CTRL** group. Where: E_{CTRL} = Energy values for CTRL group; E_{TRT} = Energy values for the treatments.

$$RE = \frac{E_{CTRL}}{E_{TRT}}$$

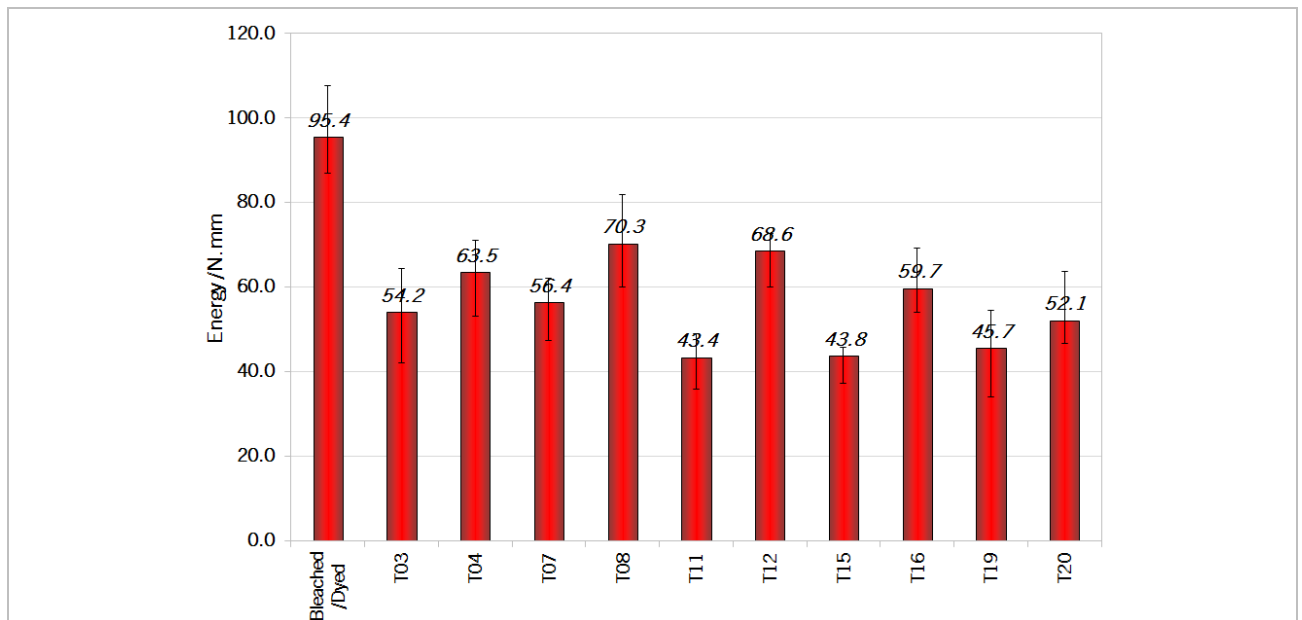
Equation 3. Calculating Reduction of Combing Energy (number of times) of **TRT** treatments compared to the **CTRL** group. Where: E_{CTRL} = Energy values for CTRL group; E_{TRT} = Energy values for the treatments.

Table 3. Reduction of Combability Energy (% and number of times) of treatments in relation to the *Virgin* group.

Treatment	Wet Combability	
	%	Number of times
Monat Renew Shampoo (Normal Condition)	43	1.7
Monat Renew Shampoo (Modified Condition)	33	1.5
Monat Volume Revive Shampoo (Normal Condition)	39	1.6
Monat Volume Revive Shampoo (Modified Condition)	22	1.3
Monat Black Shampoo + Conditioner (Normal Condition)	45	1.8
Monat Black Shampoo + Conditioner (Modified Condition)	19	1.2
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition)	61	2.6
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition)	36	1.6
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition)	50	2.0
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition)	40	1.7

Bleached/Dyed Hair

Graph 2 illustrates the data for Energy (N.mm) obtained for combability of wet tresses.



Graph 2. Results of Energy (N.mm) for Wet natural tresses. Mean \pm standard deviation.

The Energy values data of the treatments were statistically analysed in relation to the *Bleached/Dyed* group, using one-way ANOVA, followed by a Dunnett's post-test, considering a 95% confidence interval. The complete statistical analysis is listed in **Appendix IV. Table 4** summarizes the obtained results.

Table 4. Results of the statistical analysis for wet combability. Confidence interval of 95%.

Treatment	Showed significant differences?
Bleached/Dyed vs. T03	Yes
Bleached/Dyed vs. T04	Yes
Bleached/Dyed vs. T07	Yes
Bleached/Dyed vs. T08	Yes
Bleached/Dyed vs. T11	Yes
Bleached/Dyed vs. T12	Yes
Bleached/Dyed vs. T15	Yes
Bleached/Dyed vs. T16	Yes
Bleached/Dyed vs. T19	Yes
Bleached/Dyed vs. T20	Yes

According to the results obtained, the treatments **T03, T04, T07, T08, T11, T12, T15, T16, T19** and **T20**, for **wet** combability, showed significantly lower values of Combability Energy when compared to the group **Bleached/Dyed**.

The comparison between treatments were statistically analysed by applying the bimodal, unpaired Student's t-test, considering a 95% confidence interval. **Table 5** shows the summarized results of statistical analysis. The statistical analysis is described in **Appendix IV**.

Table 5. Statistical analysis. 95% of confidence interval.

Baseline vs. Final	Are there statistical difference?
	Wet combability
T03 x T04	No
T07 x T08	Yes
T11 x T12	Yes
T15 x T16	Yes
T19 x T20	No

According to the results for **wet** combability, the tresses submitted to the treatment **T03** and **T19** showed no significantly difference in values of Combability Energy when compared to the treatments **T04** and **T20**, respectively. Also according to the results obtained, for **wet** combability, the tresses submitted to the treatments **T07, T11** and **T15** showed significantly lower values of Combability Energy when compared to the treatments **T08, T12** and **T16**, respectively.

Table 6 shows the results of "Reduction of Combing Energy, **RE**", in percentage and in number of times, calculated for treatments groups compared to control group, according to **Equations 2** and **3**, respectively.



Table 6. Reduction of Combability Energy (% and number of times) of treatments in relation to the *Bleached/Dyed* group.

Treatment	Wet Combability	
	%	Number of times
Monat Renew Shampoo (Normal Condition)	43	1.8
Monat Renew Shampoo (Modified Condition)	33	1.5
Monat Volume Revive Shampoo (Normal Condition)	41	1.7
Monat Volume Revive Shampoo (Modified Condition)	26	1.4
Monat Black Shampoo + Conditioner (Normal Condition)	55	2.2
Monat Black Shampoo + Conditioner (Modified Condition)	28	1.4
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition)	54	2.2
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition)	37	1.6
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition)	43	1.8
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition)	33	1.5



V – CONCLUSION

In the present study, tresses of natural and bleached/dyed Caucasian hair were submitted 12 applications of the treatments as described below:

- Virgin Caucasian Hair – group **Virgin**;
- Bleached and Dyed Hair – group **Bleached/Dyed**;
- Virgin Hair + Monat Renew Shampoo (Normal Condition) – group **T01**;
- Virgin Hair + Monat Renew Shampoo (Modified Condition) – group **T02**;
- Bleached and Dyed Hair + Monat Renew Shampoo (Normal Condition) – group **T03**;
- Bleached and Dyed Hair + Monat Renew Shampoo (Modified Condition) – group **T04**;
- Virgin Hair + Monat Volume Revive Shampoo (Normal Condition) – group **T05**;
- Virgin Hair + Monat Volume Revive Shampoo (Modified Condition) – group **T06**;
- Bleached and Dyed Hair + Monat Volume Revive Shampoo (Normal Condition) – group **T07**;
- Bleached and Dyed Hair + Monat Volume Revive Shampoo (Modified Condition) – group **T08**;
- Virgin Hair + Monat Black Shampoo + Conditioner (Normal Condition) – group **T09**;
- Virgin Hair + Monat Black Shampoo + Conditioner (Modified Condition) – group **T10**;
- Bleached and Dyed Hair + Monat Black Shampoo + Conditioner (Normal Condition) – group **T11**;
- Bleached and Dyed Hair + Monat Black Shampoo + Conditioner (Modified Condition) – group **T12**;
- Virgin Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition) – group **T13**;
- Virgin Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition) – group **T14**;
- Bleached and Dyed Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition) – group **T15**;
- Bleached and Dyed Hair + Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition) – group **T16**;
- Virgin Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition) – group **T17**;
- Virgin Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition) – group **T18**;
- Bleached and Dyed Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition) – group **T19**;
- Bleached and Dyed Hair + Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition) – group **T20**.



According to the results obtained, the treatments “Monat Renew Shampoo”, “Monat Volume Revive Shampoo”, “Monat Black Shampoo + Conditioner”, “Monat Renew Shampoo + Monat Restore Leave-in Conditioner” and “Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner”, on Normal or Modified conditions, showed significantly lower values of Combability Energy when compared with both virgin and bleached/dyed hair. The results show the hair has become easier to comb by to reduce wrinkling and to close the outer cuticles of the hair fiber.

The table below summarizes the results of Reduction of Combability Energy obtained.

Reduction of Combability Energy (% and number of times) of treatments in wet condition.				
Treatment	Virgin/Natural Hair		Bleached/dyed hair	
	%	Number of times	%	Number of times
Monat Renew Shampoo (Normal Condition)	43	1.7	43	1.8
Monat Renew Shampoo (Modified Condition)	33	1.5	33	1.5
Monat Volume Revive Shampoo (Normal Condition)	39	1.6	41	1.7
Monat Volume Revive Shampoo (Modified Condition)	22	1.3	26	1.4
Monat Black Shampoo + Conditioner (Normal Condition)	45	1.8	55	2.2
Monat Black Shampoo + Conditioner (Modified Condition)	19	1.2	28	1.4
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Normal Condition)	61	2.6	54	2.2
Monat Renew Shampoo + Monat Restore Leave-in Conditioner (Modified Condition)	36	1.6	37	1.6
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Normal Condition)	50	2.0	43	1.8
Monat Volume Revive Shampoo + Monat Volume Revitalize Conditioner (Modified Condition)	40	1.7	33	1.5



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VII – HISTORY OF REVIEWS

Review	Description	Date
0	First issuance	March 20 th , 2018
1	The Sponsor identification was replaced, the code number of samples was added on page 9 and the conclusions were re-written.	March 13 th , 2018
2	The identification of samples was updated on page 9	March 13 th , 2018



APPENDIX I – Formulation of the samples forwarded by the Sponsor

Unreported.

APPENDIX II – Experimental Procedure

1. Preparing hair samples

Sixty six tresses were prepared from Natural Caucasian hair and sixty six from double bleached Caucasian hair, weighing 3.0 g each and 27 cm long. All tresses underwent a standard pre-cleaning process with 10% Sodium lauryl ether sulfate (SLES) solution for 1 minute then rinsed with running water. The tresses were dried in a controlled environment at $55 \pm 5\%$ relative humidity and $22 \pm 2^\circ\text{C}$, during 24 hours before tests.

2. Treatments of the Tresses

2.1. Groups T01, T03, T05, T07, T09 and T11

- a) Wet the tress for 20s and remove excess water.
- b) Apply 0,6 mL of Shampoo and rub the tresses for 30 seconds. Leave it on hair for 3 minutes. Rinse for 30 seconds and remove excess water.
- c) Repeat the steps a and b until 12 cycles.
- d) Comb the tresses for 5 times to remove the knots.

2.2. Groups T02, T04, T06, T08, T10 and T12

- a) Wet the tress for 20s and remove excess water.
- b) Apply 0,3 mL of Shampoo and rub the tresses for 30 seconds.. Rinse for 30 seconds and remove excess water. Repeat the wash.
- c) Repeat the steps a and b until 12 cycles.
- d) Comb the tresses for 5 times to remove the knots.

2.3. Groups T13, T15, T17 and T19

- a) Wet the tress for 20s and remove excess water.
- b) Apply 0,6 mL of Shampoo and rub the tresses for 30 seconds. Leave it on hair for 3 minutes. Rinse for 30 seconds and remove excess water.
- c) Apply 0.45 mL of Conditioner and rub it for 60 seconds. Rinse the tress for 30 seconds and remove excess water.
- d) Repeat the steps a, b and c until 12 cycles.
- e) Comb the tresses for 5 times to remove the knots.

2.4. Groups T14, T16, T18 and T20

- a) Wet the tress for 20s and remove excess water.
- b) Apply 0,3 mL of Shampoo and rub the tresses for 30 seconds. Rinse for 30 seconds and remove excess water. Repeat the wash.
- c) Apply 0.45 mL of Conditioner and rub it for 60 seconds. Rinse the tress for 30 seconds and remove excess water.

- d) Repeat the steps a, b and c until 12 cycles.
- e) Comb the tresses for 5 times to remove the knots.

3. Combability Tests

- a) The EMIC DL-500 (software TESC 3.01) test equipment was used together with a fixed holder with a standard comb as illustrated in **Figure 1** coupled to a previously calibrated 20.0 N load cell.
- b) Before starting the procedure, the hair tresses were manually massaged with a comb to remove knots.
- c) The tresses were fastened to a claw coupled to a load cell on the movable driving shaft of the device. The tresses were inserted through the comb teeth fastened to the base of the device under the driving axle, which is moved vertically at a constant speed of 300 mm/min.
- d) The force graph in function of the displacement was obtained, the area integral of which corresponds to the total energy spent in the process.
- e) The entire experiment was conducted in a controlled environment at $22 \pm 2^\circ\text{C}$ and $55 \pm 5\%$ relative humidity.

APPENDIX III – Experimental data achieved

Data obtained for wet combability energy (N.mm) of the tresses submitted to the study groups.

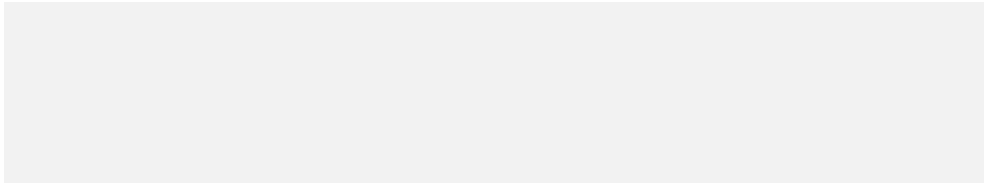
<i>Wet combability</i>			
<i>Virgin</i>	<i>Bleached/Dyed</i>	<i>T01</i>	<i>T02</i>
91.71	93.89	45.27	67.60
82.14	90.58	66.35	63.01
74.00	79.88	37.35	42.16
88.27	110.53	44.53	60.26
94.68	109.48	54.24	51.87
76.06	88.28	42.72	57.11

<i>Wet combability</i>			
<i>T03</i>	<i>T04</i>	<i>T05</i>	<i>T06</i>
61.84	62.61	39.65	67.22
62.48	54.56	57.29	70.85
40.02	61.13	48.12	66.03
49.47	58.28	62.96	72.27
46.26	75.01	56.58	62.81
64.91	69.56	46.08	53.86

<i>Wet combability</i>			
<i>T07</i>	<i>T08</i>	<i>T09</i>	<i>T10</i>
50.78	73.83	43.18	55.79
52.00	88.15	46.89	67.00
55.73	53.41	48.87	76.94
63.65	64.36	38.08	64.89
53.19	67.83	54.20	75.45
63.24	74.18	48.02	71.96

<i>Wet combability</i>			
<i>T11</i>	<i>T12</i>	<i>T13</i>	<i>T14</i>
53.38	67.22	40.94	52.00
35.83	66.98	27.71	46.31
43.91	75.45	34.67	45.44
41.60	71.23	30.70	51.28
42.22	66.44	31.24	67.28
43.27	64.35	30.39	61.28

<i>Wet combability</i>			
<i>T15</i>	<i>T16</i>	<i>T17</i>	<i>T18</i>
41.87	68.22	33.99	44.01
42.85	56.41	58.09	48.73
43.69	53.56	41.15	46.40
42.78	71.02	33.20	45.37
44.39	46.29	45.53	54.93
47.33	62.92	41.73	62.38



<i>Wet combability</i>	
<i>T19</i>	<i>T20</i>
42.10	47.68
39.18	66.42
36.65	66.30
50.72	38.14
44.36	48.84
60.89	45.29



APPENDIX IV – Statistical analysis

Method: One-way ANOVA, Dunnett's post-test. Confidence interval: 95%.

Data: Values of Combing Energy: **Virgin vs. Treatments**.

Software: GraphPad™ Prism® 6.0.

One-way analysis of variance			
F	18.73		
P value	< 0.0001		
P value summary	****		
Are differences among means statistically significant? (P < 0.05)	Yes		
R square	0.7730		
ANOVA table	SS	DF	MS
Treatment (between columns)	11885	10	1188
Residual (within columns)	3491	55	63.47
Total	15375	65	
Dunnett's multiple comparisons test	Mean Diff.	95% CI of diff.	Significant?
Virgin vs. T01	36.07	23.15 to 48.99	Yes
Virgin vs. T02	27.48	14.55 to 40.40	Yes
Virgin vs. T05	32.70	19.78 to 45.62	Yes
Virgin vs. T06	18.97	6.049 to 31.89	Yes
Virgin vs. T09	37.94	25.02 to 50.86	Yes
Virgin vs. T10	15.81	2.884 to 28.73	Yes
Virgin vs. T13	51.87	38.95 to 64.79	Yes
Virgin vs. T14	30.55	17.62 to 43.47	Yes
Virgin vs. T17	42.20	29.27 to 55.12	Yes
Virgin vs. T18	34.17	21.25 to 47.09	Yes

Method: One-way ANOVA, Dunnett's post-test. Confidence interval: 95%.

Data: Values of Combing Energy: **Bleached/DyedBleached/dyed vs. Treatments**.

Software: GraphPad™ Prism® 6.0.

One-way analysis of variance			
F	29.44		
P value	< 0.0001		
P value summary	****		
Are differences among means statistically significant? (P < 0.05)	Yes		
R square	0.8426		
ANOVA table	SS	DF	MS
Treatment (between columns)	24037	10	2404
Residual (within columns)	4490	55	81.65
Total	28527	65	
Dunnett's multiple comparisons test	Mean Diff.	95% CI of diff.	Significant?
Bleached/Dyed vs. T03	60.37	45.71 to 75.02	Yes
Bleached/Dyed vs. T04	51.01	36.35 to 65.66	Yes
Bleached/Dyed vs. T07	58.10	43.45 to 72.75	Yes
Bleached/Dyed vs. T08	44.24	29.58 to 58.89	Yes
Bleached/Dyed vs. T11	71.16	56.51 to 85.82	Yes
Bleached/Dyed vs. T12	45.92	31.27 to 60.57	Yes
Bleached/Dyed vs. T15	70.71	56.06 to 85.37	Yes
Bleached/Dyed vs. T16	54.80	40.14 to 69.45	Yes
Bleached/Dyed vs. T19	68.88	54.23 to 83.54	Yes
Bleached/Dyed vs. T20	62.42	47.77 to 77.07	Yes

Method: bimodal, unpaired Student's T-test. Confidence interval: 95%.

Data: Values of Combing Energy: **Treatments**

Software: GraphPad™ Prism® 6.0.

- Virgin hair

Unpaired t test	Wet Combability		
	T01 vs T02	T05 vs T06	T09 vs T10
P value	0.1560	0.0114	0.0002
P value summary	ns	*	***
Significantly different? (P < 0.05)	No	Yes	Yes
One- or two-tailed P value?	Two-tailed	Two-tailed	Two-tailed
t, df	t=1.534 df=10	t=3.090 df=10	t=5.668 df=10
How big is the difference?			
Mean ± SEM of column C	48.41 ± 4.225 N=6	51.78 ± 3.519 N=6	46.54 ± 2.231 N=6
Mean ± SEM of column D	57.00 ± 3.677 N=6	65.51 ± 2.711 N=6	68.67 ± 3.205 N=6
Difference between means	8.592 ± 5.601	13.73 ± 4.442	22.13 ± 3.905
95% confidence interval	-3.888 to 21.07	3.830 to 23.62	13.43 to 30.83
R square	0.1905	0.4885	0.7626
F test to compare variances			
F,DFn, Dfd	1.320, 5, 5	1.685, 5, 5	2.064, 5, 5
P value	0.7681	0.5808	0.4453
P value summary	ns	ns	ns
Significantly different? (P < 0.05)	No	No	No
P value	0.1560	0.0114	0.0002
P value summary	ns	*	***
Significantly different? (P < 0.05)	No	Yes	Yes

Unpaired t test	Wet Combability	
	T13 vs T14	T17 vs T18
P value	0.0003	0.1185
P value summary	***	ns
Significantly different? (P < 0.05)	Yes	No
One- or two-tailed P value?	Two-tailed	Two-tailed
t, df	t=5.324 df=10	t=1.707 df=10
How big is the difference?		
Mean ± SEM of column C	32.61 ± 1.898 N=6	42.28 ± 3.712 N=6
Mean ± SEM of column D	53.93 ± 3.527 N=6	50.30 ± 2.880 N=6
Difference between means	21.32 ± 4.005	8.022 ± 4.698
95% confidence interval	12.40 to 30.25	-2.446 to 18.49
R square	0.7392	0.2257
F test to compare variances		
F,DFn, Dfd	3.452, 5, 5	1.660, 5, 5
P value	0.2001	0.5915
P value summary	ns	ns
Significantly different? (P < 0.05)	No	No
P value	0.0003	0.1185
P value summary	***	ns
Significantly different? (P < 0.05)	Yes	No

- Bleached/Dyed hair

<i>Unpaired t test</i>	<i>Wet Combability</i>		
	<i>T03 vs T04</i>	<i>T07 vs T08</i>	<i>T11 vs T12</i>
P value	0.1019	0.0252	< 0.0001
P value summary	ns	*	****
Significantly different? (P < 0.05)	No	Yes	Yes
One- or two-tailed P value?	Two-tailed	Two-tailed	Two-tailed
t, df	t=1.801 df=10	t=2.629 df=10	t=8.871 df=10
How big is the difference?			
Mean ± SEM of column C	54.16 ± 4.196 N=6	56.43 ± 2.317 N=6	43.37 ± 2.322 N=6
Mean ± SEM of column D	63.53 ± 3.070 N=6	70.29 ± 4.736 N=6	68.61 ± 1.644 N=6
Difference between means	9.362 ± 5.199	13.86 ± 5.272	25.24 ± 2.845
95% confidence interval	-2.222 to 20.95	2.115 to 25.61	18.90 to 31.58
R square	0.2448	0.4087	0.8873
F test to compare variances			
F,DFn, Dfd	1.868, 5, 5	4.178, 5, 5	1.995, 5, 5
P value	0.5096	0.1427	0.4665
P value summary	ns	ns	ns
Significantly different? (P < 0.05)	No	No	No
P value	0.1019	0.0252	< 0.0001
P value summary	ns	*	****
Significantly different? (P < 0.05)	No	Yes	Yes

<i>Unpaired t test</i>	<i>Wet Combability</i>	
	<i>T15 vs T16</i>	<i>T19 vs T20</i>
P value	0.0022	0.3054
P value summary	**	ns
Significantly different? (P < 0.05)	Yes	No
One- or two-tailed P value?	Two-tailed	Two-tailed
t, df	t=4.074 df=10	t=1.080 df=10
How big is the difference?		
Mean ± SEM of column C	43.82 ± 0.7850 N=6	45.65 ± 3.629 N=6
Mean ± SEM of column D	59.74 ± 3.827 N=6	52.11 ± 4.754 N=6
Difference between means	15.92 ± 3.907	6.462 ± 5.981
95% confidence interval	7.213 to 24.62	-6.865 to 19.79
R square	0.6241	0.1045
F test to compare variances		
F,DFn, Dfd	23.77, 5, 5	1.716, 5, 5
P value	0.0034	0.5677
P value summary	**	ns
Significantly different? (P < 0.05)	Yes	No
P value	0.0022	0.3054
P value summary	**	ns
Significantly different? (P < 0.05)	Yes	No