Tensile Strength Hair Data

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Tradename: Mycofuse® Protect

Code: 16916

CAS #: 7732-18-5 & 999999-99-4 & 68333-16-4 (or) 1686112-36-6

Test Request Form #: 6629

Lot #: N190605B

Sponsor: *Active Concepts, LLC; 107 Technology Drive Lincolnton, NC 28092*
Study Director: *Maureen Danaher*
Principle Investigator: *Parisa Mehrzadeh*

Test Performed:
Tensile Strength

Introduction

The study was conducted to measure the Tensile Strength of hair when treated with **Mycofuse® Protect.**

Methods & Materials

This study was conducted using Royal Impression's 100% Unprocessed Brazilian Virgin Human Hair to analyze the effect of **Mycofuse® Protect** on several parameters of a Tensile Strength test after thermal damage. Two hair swatches were collected: one was sprayed with 5.0% **Mycofuse® Protect** in a water solution and left to dry, while the other was untreated. Both hair swatches were passed through a flat iron 25 times at 232°C (450°F). A third hair swatch was set aside as a control. Photo images of each hair swatch were captured and qualitatively analyzed.

Gaston College Textile Technology Center located in Belmont, North Carolina was asked to perform Tensile Strength on swatches provided by Active Concepts, LLC. Gaston College used an Instron 5966 to perform the test, using test method ASTM-D2256-10. This method specifies the test conditions for determining the tensile properties of hair using the single-strand method. The process determines the quality of the raw material and aides in controlling the quality of the end product. To determine tensile strength and elongation at break, specimens are clamped in the appropriate grips and extended at constant rate until failure occurs. This process was performed in triplicated per sample to provide an average.

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According to ASTM-D2256-10, single-strand hair specimens are broken on a tension testing machine at a predetermined elongation rate and the breaking force and the elongation at break are determined. Elongation at a specified force or the force or tenacity at a specified elongation may also be obtained. Breaking force, breaking tenacity, elongation, initial and chord modulus, and breaking toughness of the test specimen, in terms of linear density, may be calculated from machine scales, dials, recording charts, or by an interfaced computer.

Results

Figure 1. Untreated Control (Left) Untreated Straightened Hair (Middle) vs. 5.0% **Mycofuse® Protect** Treated Straightened Hair (Right)

As imaged in Figure 1, 5.0% **Mycofuse® Protect** Treated Straightened Hair was able to smooth and protect the hair strands after heat stress was applied compared to the Untreated Straightened Hair. The treated hair swatch had the least amount of flyaway hairs, and overall softer and shinier compared to the Untreated Control and Untreated Straightened Hair.

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Table 1. Linear Density Data

Linear Density (den)						
	Avg	**SD**	**CV**	**Q(95%)**	**Max**	**Min**
Untreated Control	22.32	5.93	26.55	2.45	43.45	12.07
Untreated, Straightened Hair	26.94	6.75	25.01	2.99	33.59	3.9
5.0% Mycofuse® Protect Treated	41.71	7.04	16.88	2.97	55.32	29.05

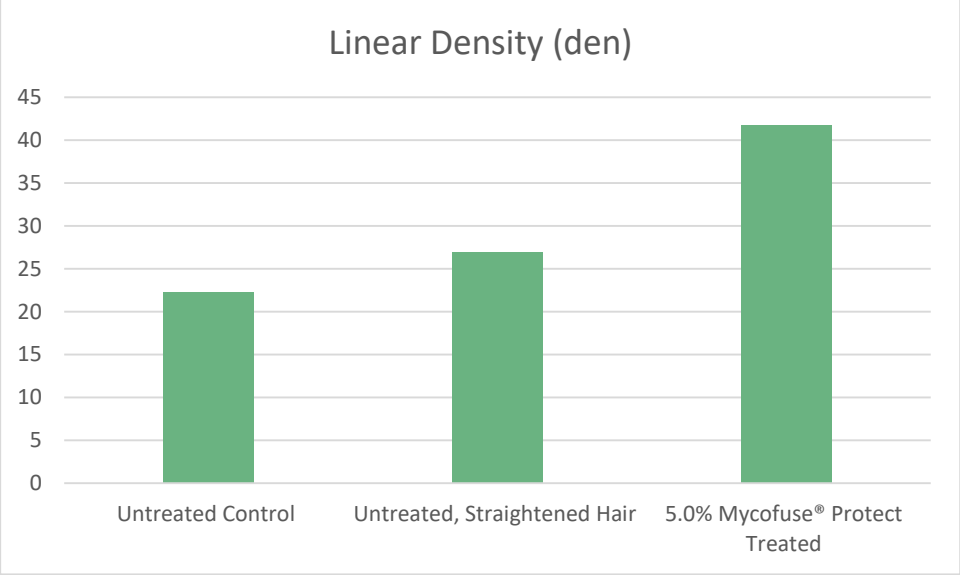

Figure 2. Linear Density, defined as hair fiber mass per meter of fiber.

As demonstrated in Table 1 and Figure 2, the linear density of 5.0% **Mycofuse® Protect** increased by 15.1% compared to the untreated hair, and 10.8% compared to the untreated straightened hair. Table 2 displays standard or value that is the threshold for significance.

Table 2. t-Test: Two-Sample Assuming Unequal Variances

	Mycofuse Protect	*Untreated, Straightened Hair*
Mean	44.33	27.956
Variance	36.0824	20.67329895
Observations	20	20
Hypothesized Mean Difference	0	
df	35	
t Stat	9.719972712	
P(T<=t) one-tail	8.86595E-12	
t Critical one-tail	1.689572458	
P(T<=t) two-tail	1.77319E-11	
t Critical two-tail	2.030107928	

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Table 3. Force to Rupture Data

Force to Rupture (g)						
	Avg	**SD**	**CV**	**Q(95%)**	**Max**	**Min**
Untreated Control	67.62	12.13	31.25	8.72	103.4	34.83
Untreated, Straightened Hair	43.37	16.37	38.43	7.39	79.17	1.83
5.0% Mycofuse® Protect Treated	64.28	13.12	20.42	5.54	94.2	40.5

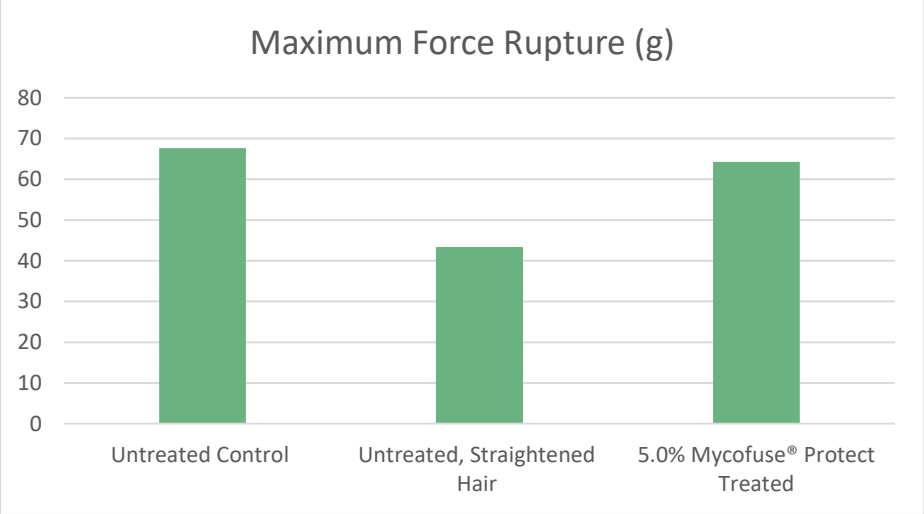

Figure 3. Force to Rupture, defined as the force measured in gram-force (g) necessary to rupture the hair

As evidenced in Table 3 and Figure 3, 5.0% **Mycofuse® Protect** increased the force to rupture by 9.7% compared to the untreated straightened control, and behaved comparatively to the untreated control. Table 4 displays standard or value that is the threshold for significance.

Table 4. t-Test: Two-Sample Assuming Unequal Variances

	Mycofuse Protect	*Untreated, Straightened*
Mean	67.0152	43.8468
Variance	166.786676	144.7360227
Observations	25	25
Hypothesized Mean Difference	0	
df	48	
t Stat	6.563284026	
P(T<=t) one-tail	1.71955E-08	
t Critical one-tail	1.677224196	
P(T<=t) two-tail	3.4391E-08	
t Critical two-tail	2.010634758	

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Table 5. Time to Rupture data

Time to Rupture (sec)						
	Avg	**SD**	**CV**	**Q(95%)**	**Max**	**Min**
Untreated Control	26.65	26.65	29.25	3.22	36.23	2.45
Untreated, Straightened Hair	24.60	28.53	115.99	12.65	110.63	0.34
5.0% Mycofuse® Protect Treated	57.08	28.55	50.01	12.05	104.75	8.55

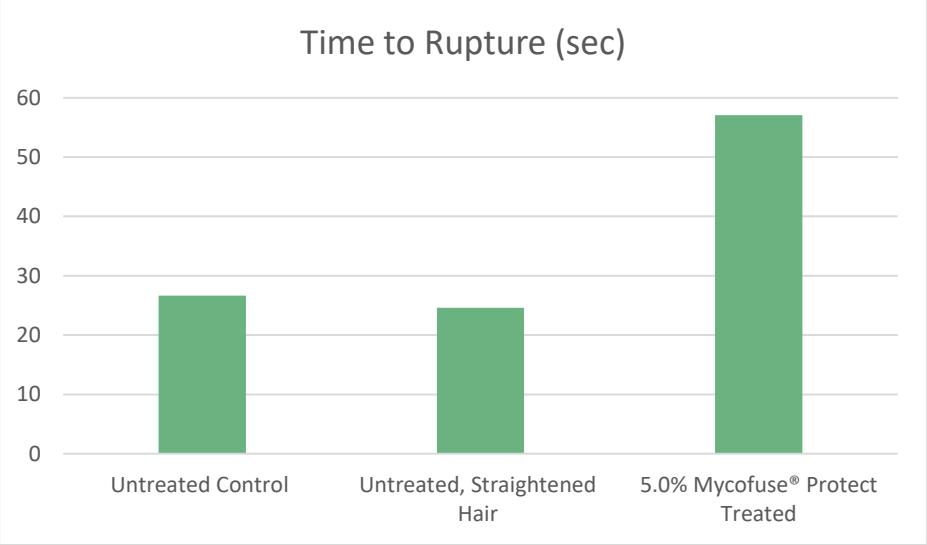

Figure 4. Time to Rupture, defined as how long it takes to rupture the hair in seconds (sec)

As shown in Table 5 and Figure 4, hair treated with 5.0% **Mycofuse® Protect** increased the time to rupture by 18.2% and 19.9% to the untreated hair and untreated straightened hair, respectively. Table 6 displays standard or value that is the threshold for significance.

Table 6. t-Test: Two-Sample Assuming Unequal Variances

	Mycofuse Protect	*Untreated, Straightened*
Mean	64.44173913	24.05652174
Variance	548.2880696	782.0389328
Observations	23	23
Hypothesized Mean Difference	0	
df	43	
t Stat	5.310154289	
P(T<=t) one-tail	1.82239E-06	
t Critical one-tail	1.681070703	
P(T<=t) two-tail	3.64479E-06	
t Critical two-tail	2.016692199	

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Table 7. Work to Break data

Work to Break (g*cm)						
	Avg	**SD**	**CV**	**Q(95%)**	**Max**	**Min**
Untreated Control	26.24	12.4	47.26	5.12	52.00	1.05
Untreated, Straightened Hair	33.67	44.87	133.27	19.89	166.7	0.01
5.0% Mycofuse® Protect Treated	63.91	62.77	98.22	26.5	223.06	11.98

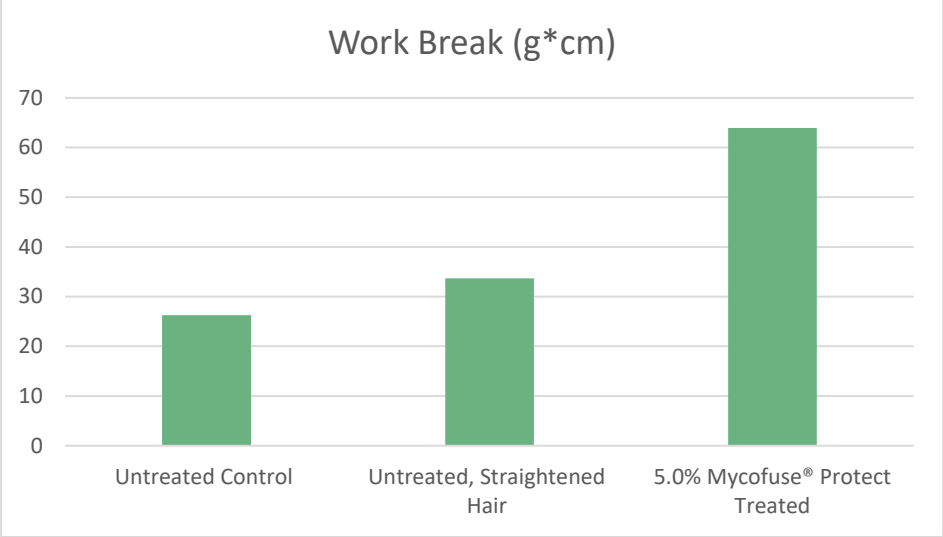

Figure 5. Work to Break, defined as the total energy required to break the hair fiber

As displayed in Table 7 and Figure 5, 5.0% **Mycofuse® Protect** was able to increase the work to rupture by 20.9% and 15.5% compared to the untreated hair and untreated straightened hair. Table 8 displays standard or value that is the threshold for significance.

Table 8. t-Test: Two-Sample Assuming Unequal Variances

	Mycofuse Protect	*Untreated, Straightened*
Mean	68.01521739	25.70782609
Variance	3683.75009	1296.688018
Observations	23	23
Hypothesized Mean Difference	0	
df	36	
t Stat	2.875056552	
P(T<=t) one-tail	0.003371386	
t Critical one-tail	1.688297714	
P(T<=t) two-tail	0.006742772	
t Critical two-tail	2.028094001	

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Discussion

Hair damage is an inevitable consequence from every day grooming and styling habits. Hair strands commonly undergo thermal damage as a result. As shown in Figure 1, the Untreated Straightened Virgin Hair is visibly damaged with frayed endings as well as a number of unmanageable flyaway hairs. In comparison, 5.0% **Mycofuse® Protect** Treated Straightened Hair exhibits smoother ends and overall healthier hair appearance. This hair swatch was deemed softer and more manageable than the untreated counterpart. The swatch overall appeared healthier, felt smoother, and was easily combed. The observations made during the hair swatch study suggests that **Mycofuse® Protect** is able to prevent thermal damage as a pre-treatment to heat styling.

Tensile strength is defined as the resistance of a material to break under tension. Gaston College Textile Technology Center assessed the following tensile strength factors; Linear Density, Force to Rupture, Time to Rupture, and Work to Break on Untreated Virgin Hair (control), Untreated Straightened Virgin Hair, and 5.0% **Mycofuse® Protect** Treated Straightened Virgin Hair. These parameters were found to be statistically significant ($p < 0.05$) as demonstrated in Tables 2, 4, 6, and 8.

Linear Density describes the hair fiber mass, or strand thickness. As shown in Figure 2, the linear density of 5.0% **Mycofuse® Protect** increased by 15.1% compared to the untreated hair, and 10.8% compared to the untreated straightened hair. The results indicate that the treated hair swatches have thicker, denser strands resulting in stronger hair.

Force to rupture is the measured force necessary to rupture the hair. Force to rupture indicates how much power or damage is required to break the hair fiber. Figure 3 shows improvement in this parameter when hair was treated with **Mycofuse® Protect**. 5.0% **Mycofuse® Protect** increases the force to rupture by 9.7% compared to the untreated straightened control, and behaved comparatively to the untreated control. The increased force to rupture is a direct result of increased linear density.

Time to rupture is the time it takes for a hair strand to break. As shown in Figure 4, hair treated with 5.0% **Mycofuse® Protect** increased the time to rupture by 18.2% and 19.9% to the untreated hair and untreated straightened hair, respectively. This indicates that the treated hair is able to tolerate force for a longer period.

Work to rupture is described as the total energy required for a hair strand to break. Figure 5 shows that 5.0% **Mycofuse® Protect** was able to increase the work to rupture by 20.9% and 15.5% compared to the untreated hair and untreated straightened hair.

Parameters tested within this set of data are solely based on linear stress applied to the hair. Linear stress applied as a direct parallel force is not the ideal measure of real world stress and strain applied to the hair on a daily basis. Based on the images captured from the hair swatch study in combination with data provided from Gaston College's tensile strength analysis, **Mycofuse® Protect** offers significant thermal protection to hair by improving parameters such as Linear Density, Force to Rupture, Time to Rupture, and Work to Rupture.