

Jungbunzlauer

From nature to ingredients®

facts

ERYLITE® Erythritol in hair shampoo



The general-purposed soap historically used to clean hair, regularly left it looking dull and lacklustre. Its softness and shine had to be restored by means of vinegar or citric acid. Nowadays it's hard to even imagine a personal care routine that doesn't include specialised hair care products such as shampoo and conditioners. In fact, today's hair care products are considered to play a major role in determining a person's appearance. But great hair care products not only improve the condition of our hair and scalp, they make us feel good too.

While a shampoo's most important function is of course to clean and degrease the scalp and hair, advertising for shampoos tends to highlight specific product claims such as "enhanced shine" or "luminosity" to emphasise their positive effect on our appearance, or "moisturising" or "hydrating" to indicate their nourishing properties. They might claim to tame frizz or reduce dandruff. Some shampoos claim a beneficial moisturising effect on the scalp. A currently trending claim is for "natural" shampoos. These contain ingredients that are organic and biodegradable, and have become very popular in recent years.^[1]

Shampoos consist primarily of a mixture of water and surfactants. Surfactants are responsible for cleansing and foaming; they increase viscosity and largely determine the hair's condition after shampooing. Other ingredients include emulsifiers, colouring additives, foam boosters, humectants, thickeners and preservatives. pH control is very important and fragrance oils are added for a pleasant scent. Conditioning substances such as silicones, polyquats and guar derivatives give the hair a smooth surface and thus improve combability. Another substance that has an exceptional ability to improve the combability of hair is erythritol, a sugar alcohol manufactured using a bio-based fermentation process.

Since the end of the 19th century shampoos have also been available on the market in powder form. Today, there is a renewed interest in powder- or tablet-form shampoos for reasons of sustainability. This has led Jungbunzlauer to develop a "shampoo tablet" formulation.

ERYLITE® – a fermentation-based polyol for personal care applications

ERYLITE® (INCI: Erythritol) is the first sugar alcohol, also called polyol, to be manufactured using a bio-based fermentation process. The fermentation and minimum processing make ERYLITE® a very interesting ingredient for end products destined for the "natural" shelf. It is furthermore COSMOS-approved and vegan. ERYLITE® can already be found in various personal care formulations. It is increasingly used in skin care products, where it acts as a powerful skin moisturising agent.^[2] It can be incorporated into rinse-off formulations like shower gels as well as leave-on products like body lotions, skin and hand creams. Contemporary personal care science is working on ways to incorporate these outstanding features into hair shampoo and conditioner formulas, as described in this article. However, recent product launches of shampoos and conditioners do not only focus on humectant properties.

ERYLITE® offers more sustainable solutions

The main raw material for ERYLITE® production is glucose derived from corn in accordance with Jungbunzlauer's sustainability strategies:

- Jungbunzlauer is committed to the SBTi (Science Based Targets initiative) and sets targets to reduce the emission of greenhouse gases in line with climate science, for example by further improving its energy management system.
- Jungbunzlauer performs regular calculation of the product carbon footprints (PCFs) in cooperation with a certified and independent external partner (myclimate).
- The production plant for ERYLITE® achieved ISO 50001 certification and implemented an energy management system focused on continuous improvement.

If the customer wishes the glucose can also be supplied by farmers committed to sustainable agriculture as verified by the FSA (farm sustainability assessment by SAI platform).^[3]



The ERYLITE® test program for claim substantiation

As per the cosmetics regulation EC/1223/09 Article 20 and the claims criteria legislation under Commission Regulation (EU) No. 655/2013, the product claims on a shampoo must be substantiated. Companies therefore devote a great deal of effort not only to the research and development of formulas but also to the substantiation of defined claims. There are quite a number of claims that can be advertised on the product label. Jungbunzlauer focused on three of them:

Combability

This is one of the most basic shampoo claims. Many hair care products promise better, smoother hair, and aim for combability. The comb should slide easily through the hair both in the wet and the dry state after application of the product.

Foaming

Greater foam stability and smoother foam formation are important sensory requirements for the consumer. Foam is usually the first visual indication of performance and consumers rely on foam as evidence for cleaning and distribution. If the foam consists of very fine, small bubbles, the consumer is given the impression of mild cleaning and assumes that their hair is being gently conditioned.

Curl definition and manageability

Getting the hair cleaned, dried and into shape is a daily routine which consumers may look to make more time efficient. Frizzy and difficult to manage hair make the styling process more time consuming.^[4] Thus, consumers are particularly interested in formulas that help to tame the hair, improve its manageability and reduce styling time. "Shadow mapping" is a suitable method to illustrate manageability and curl definition. An optimally performing shampoo results in a uniformly shaped hair tress, which is shortened through a small wave.

Experimental part^[5]

Treatment compositions

In order to substantiate claims for ERYLITE® as a single ingredient, its performance was first analysed in a basic shampoo formulation containing different amounts of ERYLITE®. The tested formulations are shown in table 1. The matrix consisted of 9.8% sodium laureth sulfate and 4.25% cocamidopropyl betaine active substance. The viscosity was adjusted to 12–20 Pas (Viscosity Brookfield, Sp. 6 / 10 RPM) using sodium chloride. The pH was set to 4.9–5.1 using lactic acid.

Table 1: Basic shampoo formulation for claim substantiation

Ingredients	INCI	Supplier	Blank/%	3% ERYLITE®/%	5% ERYLITE®/%
Water, demin.	Aqua		Qs to 100	Qs to100	Qs to100
ERYLITE® Personal Care Grade	Erythritol	Jungbunzlauer	-	3.00	5.00
Texapon® N 70	Sodium Laureth Sulfate	BASF	14.0	14.0	14.0
TEGO® Betain F 50	Cocamidopropyl Betaine	Evonik	8.50	8.50	8.50

Additionally, suitable full formulations were developed to assess the conditioning effects of ERYLITE® in a hair shampoo formulation. These comprised one standard and one premium formulation as shown in table 2.

The ingredients of the standard shampoo formulation were chosen based on a cost-efficiency approach and contained 3% ERYLITE®. The premium formulation contained additional ingredients or ingredients of higher quality and the concentration of ERYLITE® was increased to 5% to improve performance.

Both formulations were formulated as pearl-shine, highly viscous gels. The pH value of both formulations was set to 4.9–5.1. The viscosity of the standard formulation was adjusted to 3–8 Pas (Viscosity Brookfield, Sp. 6 / 10 RPM). The viscosity of the premium formulation was set to 12–20 Pas (Viscosity Brookfield, Sp. 6 / 10 RPM).

Table 2: Formulation of full standard and premium shampoo formulation

			Full Standard formulation/%	Full Premium formulation/%
Ingredients	INCI	Supplier	Quantity	
Water	Aqua		Qs to 100	Qs to 100
Texapon® N 70	Sodium Laureth Sulfate, Aqua	BASF	12.0	12.0
TEGO® Betain F 50	Aqua, Cocamidopropyl Betaine	Evonik	4.00	4.00
Edeta® BD	Disodium EDTA	BASF	0.10	0.10
ERYLITE® Personal Care Grade	Erythritol	Jungbunzlauer	3.00	5.00
Comperlan® 100	Cocamide MEA	BASF	0.50	1.50
Coconut Oil, refined Ph. Eur.	Cocos Nucifera Oil	Gustav Heess	0.10	0.10
Lamesoft® PO 65	Aqua, Coco-Glucoside, Glyceryl Oleate, Citric Acid, Tocopherol, Hydrogenated Palm Glycerides Citrate, Lecithin, Ascorbyl Palmitate	BASF	1.00	1.00
PRODEW® 500	Aqua, Sodium PCA, Sodium Lactate, Arginine, Aspartic Acid, PCA, Glycine, Alanine, Serine, Valine, Proline, Threonine, Isoleucine, Histidine, Phenylalanine	Ajinomoto		1.50
Lanette® 16	Cetyl Alcohol	BASF		1.00
UCARETM Polymer JR-400	Polyquaternium-10	DOW Chemical	0.20	0.20
MerquatTM 550 PR Polymer	Aqua, Polyquaternium-7	Lubrizol	3.00	5.00
Euperlan® Bright	Aqua, Glycol Distearate, Sodium Laureth Sulfate, Cocamidopropyl Betaine, Sodium Benzoate, Citric Acid	BASF	3.00	5.00
Perfume			Qs	Qs
Preservative			Qs	Qs
L (+)-Lactic Acid 90% Personal Care Grade	Lactic Acid	Jungbunzlauer	Qs	Qs
Sodium Chloride	Sodium Chloride		Qs	Qs

Combing force measurement

Prior to each test, commercially available hair tresses of European bleached hair (Haarhaus Kerling, Germany) were pre-treated (washed) with a solution of 10% sodium laureth sulfate (SLES, surfactant solution) three times over a period of one minute to remove any remaining chemicals from the hair. The tresses had a length of 25 cm and a width of 2 cm. After three wash cycles, the hair tresses were detangled with a coarse comb (Herkules Sägemann 480/1637, Germany). The wet and detangled hair tresses were then analysed using a tensile tester equipped with a special measuring comb (Herkules Sägemann 372, Germany). The combing force needed for each tress was determined for five individual combing cycles. The average of these five measurements was defined as the baseline value. This baseline was specific to each hair tress and allowed for a “before and after treatment” comparison.

Afterwards, each pre-treated tress was rinsed under lukewarm water for 30 s. After rinsing, the hair tresses were washed ten times with the test product for a period of one minute each time. The combing force of each treated hair tress was again measured five times using the tensile tester. All measurements were performed on duplicate hair tresses. The method is visualised in figure 1.

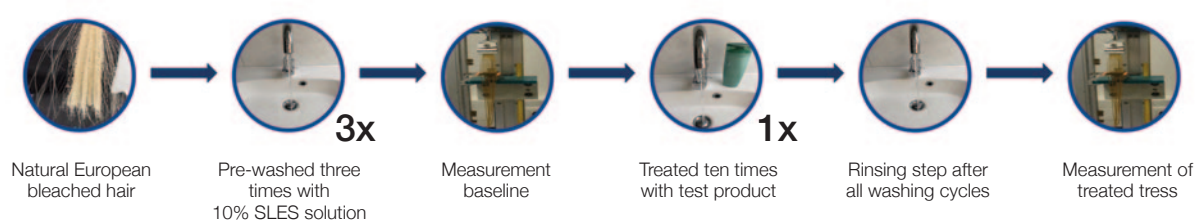


Figure 1: Schematic description of combing force method

Foam comparison

In order to provide reproducible results for foam behaviour, a standardised test was set up describing the process to create foam whilst washing hands.

First, hands were thoroughly pre-washed with neutral soap (10% SLES solution). Afterwards, the hands were washed by rubbing one palm against the other with the respective test product. Precisely 1.2 mL test shampoo and 1.2 mL water were applied on the moist left palm. The products were gently mixed in the palm with the index finger of the right hand. To create foam, the left hand remains motionless (stator) and the right palm (rotor) is moved forward and back while resting on the left hand. After 10 s, 1.2 mL water were again added and the right hand was moved forward and back for another 10 s. Quality and quantity of the foam formed were assessed visually and sensorially, and documented by photography.

Shadow mapping

A possible effect of ERYLITE® on the curl retention of naturally waved hair was investigated. Naturally waved hair tresses were treated and dried under standardised conditions. The resulting curl silhouette after treatment was evaluated comparatively behind parchment paper. This method is called shadow mapping. The best performing test products were evaluated by shadow mapping.

For this test, commercially available hair tresses of European natural wavy hair (Haarhaus Kerling, Germany) were pre-treated (washed) with a solution of 10% sodium laureth sulfate (SLES, surfactant solution) three times for a period of one minute each to remove any remaining chemicals from the hair. Afterwards, each pre-treated tress was washed three times with the test product for a period of one minute each time. After combing the wet hair tresses with a specific comb (Herkules Sägemann 480/1637, Germany) the tresses were hung to dry at room temperature (air conditioned room 21°C, 55% relative humidity) for 24 h. The curl silhouette was then assessed visually via shadow mapping.

Results and discussion

Combing force measurement

For basic claim substantiation of ERYLITE® in hair care, its performance was tested in a basic shampoo formulation containing different amounts of the ingredient. Additionally, two full formulations were tested to demonstrate its effect in a representative shampoo product. The results of the combing force measurements are shown in figure 2.

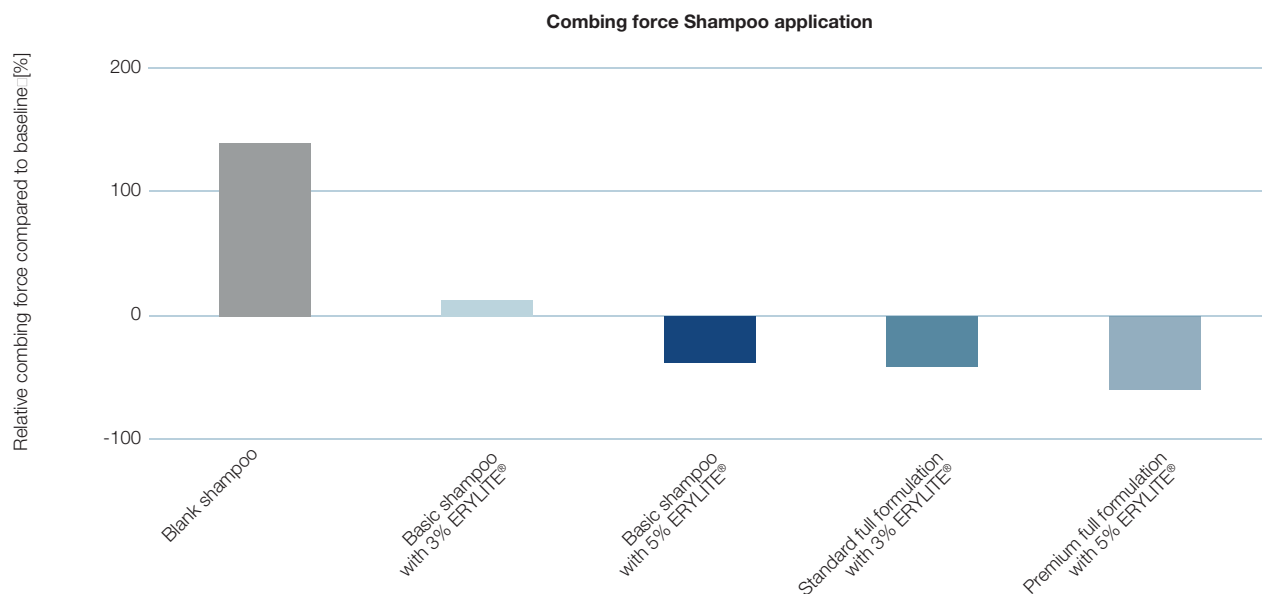


Figure 2: Results of combing force test – Shampoo application

Figure 2 shows the results of the combability tests for the tresses treated with a basic shampoo formulation versus the tresses treated with full shampoo formulations containing ERYLITE®. The result for the untreated tress, only prewashed with 10% SLES solution, defines the baseline. The higher the value, the more force is needed to comb through and the more negative the effect of the shampoo on the hair compared to baseline. Washing with the blank shampoo formulation considerably increased the combing force needed. When the tresses were treated with a 3% ERYLITE® basic shampoo the combing force needed was quite similar to the baseline. The 5% ERYLITE® basic shampoo reduced the necessary combing force remarkably.

When comparing the results of formulations containing ERYLITE®, all full shampoo formulations were found to decrease the combing force needed compared to the baseline, so they clearly showed a positive impact. The standard full formulation, which contained 3% ERYLITE® as well as other actives, showed a comparable performance to the basic shampoo with 5% ERYLITE®. It decreased the combing force needed by 40% compared to the baseline. The premium full formulation containing 5% ERYLITE® in combination with additional actives decreased the combing force needed by 60%.

Overall, a positive impact of the treatments on the combing force was demonstrated, proving the positive influence of ERYLITE® in combination with other active ingredients in a complete hair care formulation. Thus the claim of combing force reduction for ERYLITE® is also validated in the full shampoo formulations.

Foam behaviour

In order to provide a reproducible rating for foam behaviour, a test procedure was set up describing the cleaning of the hands with water and surfactant solution. The results are shown in figure 3.

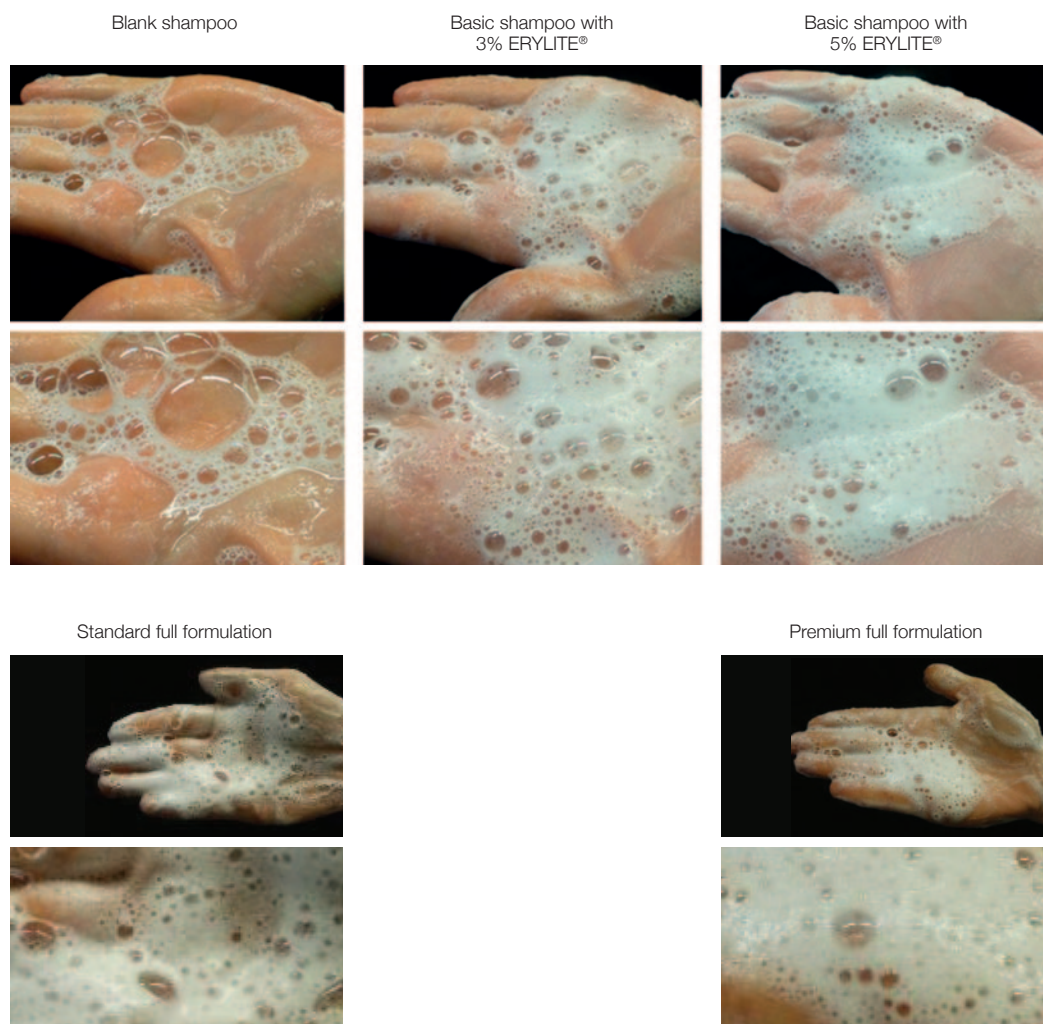


Figure 3: Foam behaviour comparison of all tested formulations

ERYLITE® influenced foam density and the size of individual bubbles. Figure 3 clearly shows that the individual bubbles were smaller in the basic shampoos containing ERYLITE® compared to the blank shampoo formulation. Both the volume and the stability of the foam were evidently increased. Moreover, the foam produced by the basic shampoo containing 5% ERYLITE® was even denser than that of the formulation containing 3%, demonstrating that the larger amount of ERYLITE® in the 5% formulation amplified the effects. The texture of the foam was softer in both basic shampoos containing ERYLITE®. Results with the full shampoo formulations confirmed that the ability of ERYLITE® to form smaller and finer foam bubbles was maintained in both the standard and premium full shampoo formulations.

Shadow mapping

The shadow mapping test was performed to characterise the manageability of hair, including the silhouette definition of naturally wavy hair. The results from all tested formulations are shown in figure 4.

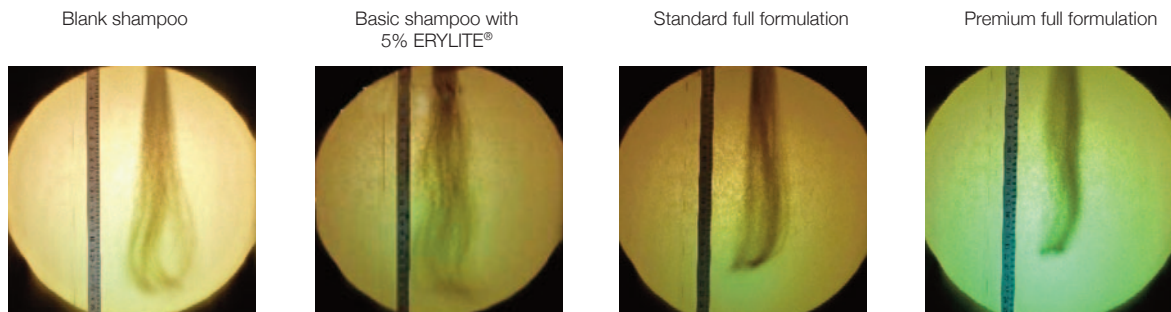


Figure 4: Shadow images behind parchment paper

It can be seen that the tress treated with the blank shampoo formulation had quite a triangular shape and a final length of 23.5 cm. After addition of 5% ERYLITE® to the basic shampoo formulation, the curl of the tress was slightly more evident and resulted in a shorter (22.5 cm) length. In total, the addition of 5% ERYLITE® led to visibly more defined curls and supported the manageability of wavy hair.

Comparison of the standard and premium full shampoo formulations revealed well defined curl silhouettes for both formulations.

These results indicate that the curl definition already demonstrated for the basic shampoo containing ERYLITE® is further improved when using a full formulation shampoo.



ERYLITE® in solid formulations: shampoo tablets

Its solid, crystalline physical form makes ERYLITE® a suitable ingredient for water-free hair care products, such as single-use powder sachets or tablets, to which the consumer adds water to create a ready-to-use shampoo. Although serving a still somewhat niche market, these formats offer convincing benefits such as the possibility for more sustainable, plastic-free packaging, a multi-sensory user experience and the option of free-from-preservative formulations. ERYLITE® is a perfect fit for these formulas, contributing a nourishing effect and improved combability, as well as offering the additional advantage of being readily water-soluble, thus supporting a fast dissolution of the tablet.

To prove the benefits of ERYLITE® in a water-free formulation, a single-use shampoo tablet was developed (table 3). In addition to ERYLITE®, the bulk tablet was composed of a sulfate-free surfactant combination and an effervescent system plus microcrystalline cellulose as a filler.

Table 3: Jungbunzlauer shampoo tablet formulation

Phase	Ingredients	INCI	Function	Supplier	Quantity/%
A	Jordapon® SCI	Sodium Cocoyl Isethionate	Cleansing, foaming	BASF	24.0
	TEGO® Natural Betaine	Betaine	Cleansing, foaming	Evonik	3.50
	ERYLITE® Personal Care Grade	Erythritol	Moisturising, fast dissolution	Jungbunzlauer	21.0
B	Pharmacel® 102	Microcrystalline Cellulose	Filler	DFE Pharma	22.0
	CITROCOAT® N	Citric Acid, Monosodium Citrate	Flash foaming (effervescence), pH	Jungbunzlauer	14.0
	BICAR® Food 0/13	Sodium Bicarbonate	Flash foaming (effervescence)	Solvay	12.0
	XG FFCS-PC	Xanthan Gum	Foam texture, creaminess	Jungbunzlauer	2.00
C	Argania Spinosa Kernel Oil	Argan Oil	Nourishing	Naturschönheit	1.00
	Perfume	Perfume	Fragrance		0.50

Hair tresses were treated according to the method described earlier with three different test solutions:

- Benchmark shampoo powder
- Benchmark shampoo powder + ERYLITE®
- Jungbunzlauer shampoo tablet formulation

All test solutions were prepared by dissolving the shampoo powders in tap water (3 g/100 mL). Where applicable, ERYLITE® was added to these powders at a use rate of 1 g/100 mL, corresponding to 25 wt% in the dry blend. Tensile tests were performed as described previously.

The results are shown in figure 5. The benchmark increased the combing force by 10% compared to the baseline value, but adding ERYLITE® reduced the required combing force slightly. The full shampoo tablet formulation developed by Jungbunzlauer performed best, reducing the combing force by approximately 40% compared to the benchmark. These findings underline the suitability of ERYLITE® as a nourishing agent in innovative, water-free shampoo formats.

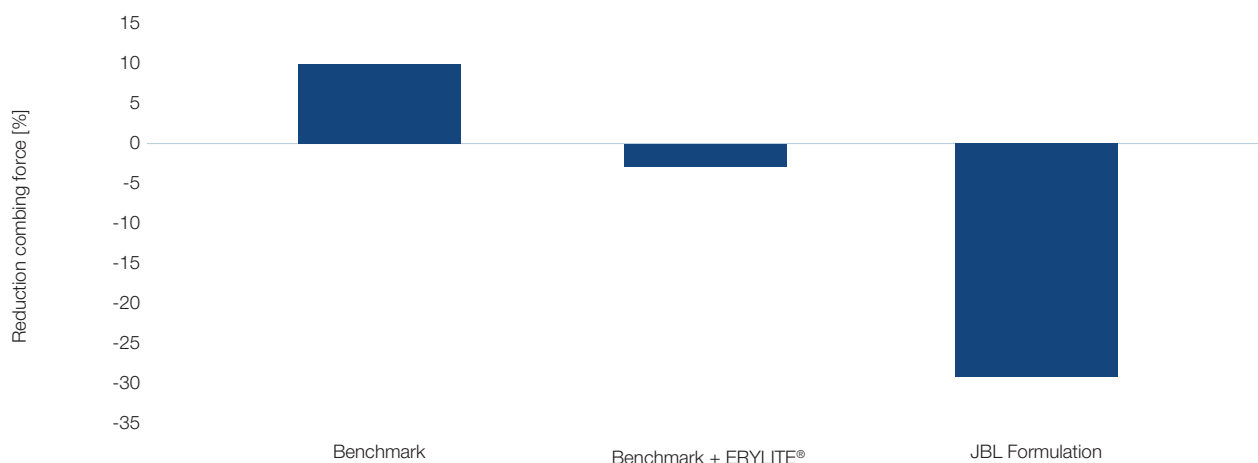


Figure 5: Results of combing force tests – Application of shampoo powders and tablet

Summary

ERYLITE®, already known to be a potent moisturising agent in skin care applications, has proven beneficial effects in hair care as well. Apart from having a smoothing effect, the use of hair care products containing ERYLITE® led to improved combability as demonstrated by a reduction in the combing force needed. Furthermore the treated hair had a more defined curl silhouette which could make styling much easier. ERYLITE® thus delivers on many of the basic requirements of modern hair care.

Moreover, ERYLITE® functions very well as a nourishing ingredient in innovative, water-free product formats, such as shampoo tablets and powders.

Overall, Jungbunzlauer's personal care grade ERYLITE®, which is COSMOS and NATRUE approved, demonstrates excellent performance in hair care, enabling the formulation of effective formulations and new product formats.

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About Jungbunzlauer

Jungbunzlauer is one of the world's leading producers of biodegradable ingredients of natural origin. We enable our customers to manufacture healthier, safer, tastier and more sustainable products. Due to continuous investments, state-of-the-art manufacturing processes and comprehensive quality management, we are able to assure outstanding product quality.

Our mission "From nature to ingredients®" commits us to the protection of people and their environment.

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