Jungbunzlauer

From nature to ingredients®

facts

Natural hair styling gel with Xanthan Gum

Introduction

Hair can never look good if it's not styled well. But it's not enough to create a great style – you have to keep it looking good. Styling gels therefore play a huge role in personal hair care and have become a mainstay of the hair care market.

While styling gels are typically designed specifically for use by either men or women, the principal behind the formulation is the same for both product types.

Conventional styling gel formulations contain several synthetic polymers. These are needed to thicken the gel, for film formation and to fixate the hair. The amount of polymer used and its final composition depend on the intended strength of the product. However, synthetic polymers in formulations that claim to be natural are strictly prohibited. Instead, manufacturers rely on the use of biopolymers to achieve the intended properties in hair styling gel. Nearly all natural styling products use xanthan gum as their thickening and film-forming ingredient. In a limited number of cases, xanthan gum may be used in combination with other gums, such as carrageenan or guar gum.[1,2]

Looking at consumer trends, there is a growing demand for more sustainable and environmentally friendly ingredients to be included in styling gel products for everyday use. However, hardly any of the synthetic polymers currently used are biodegradable; instead, they accumulate in the environment once the hair gel is rinsed off and flushed down the drain,[3] a fact that is becoming increasingly important for aware consumers.

In addition to this consumer-driven move towards more natural formulations, the regulatory environment is getting stricter, too. Restrictions on intentionally added microplastic particles are now in force in a number of countries and the European Chemical Agency is preparing to add microplastics to an extension of the REACH regulation. Even though microplastic particle definitions can vary significantly, consumer perceptions are formed based on the INCI list and not on the actual physical state of polymers.[3] Therefore solid, semi-solid and solute synthetic polymers are all deemed undesirable.

Jungbunzlauer's xanthan gum is manufactured by fermentation, using carbohydrates from renewable sources to feed the fermentation process. It is fully biodegradable and suitable for natural cosmetics, which allows us to provide COSMOS raw material approval for our personal and oral care grades. As a hydrocolloid with pseudoplastic properties, it is highly compatible with other cosmetic ingredients and allows excellent thickening and film forming in hair styling gel formulations. The Jungbunzlauer product range even includes highest-clarity xanthan gum from vegan production.

The following findings substantiate the suitability of xanthan gum to substitute common synthetic thickeners and film formers while offering excellent performance in terms of appearance and application.

Natural vs. synthetic polymer formulations: a comparison

Formulation with synthetic polymers

Hair gels with synthetic thickening and fixative polymers were prepared to act as representative standard formulations. In addition to the synthetic polymers, the hair gel contained glycerine as a moisturiser and sodium hydroxide for pH adjustment. It was formulated without any additional active substances to exclude any unwanted impacts on physical characteristics. The target viscosity range was determined after analysing one natural and five conventional market products. The concentrations of polymers were adjusted until the viscosity and rheological behaviour of the test formulations matched the target range. The primary focus of the experiment was to find a substitute for the fixative polymers Acrylates Crosspolymer-3 and VP/Methacrylamide/Vinyl Imidazole Copolymer. To facilitate comparison of the results from the two formulations, the same thickening polymer Acrylates/C10-30 Alkyl Acrylate Crosspolymer was used in each synthetic formulation.

Table 1: Synthetic hair styling gel formulations

Phase	INCI	Function	Synthetic 1	Synthetic 2
A	Aqua	Solvent	Qs to 100	Qs to 100
	Glycerine	Moisturiser	3%	3%
A1	Acrylates/C10-30 Alkyl Acrylate Crosspolymer	Thickening polymer	0.5%	0.5%
B	Sodium Hydroxide	pH regulation	Qs	Qs
C	Acrylates Crosspolymer-3	Fixative polymer	–	10%
	VP/Methacrylamide/Vinyl Imidazole Copolymer	Fixative polymer	15%	–
D	Preservative	Preservation	Qs	Qs

Despite the pared-down composition, formulating with the synthetic polymers was quite challenging and time-consuming. The thickening polymer was sprinkled into water, where it absorbed water until it was fully hydrated. The batch was then gently stirred to obtain a homogeneous product. At this point the viscosity was very low and the product turbid. Once the pH was neutralised, viscosity increased and the product became clearer.

Because synthetic thickening polymers are generally very pH sensitive, the choice of preservatives is restricted. Furthermore, a neutral pH is less suitable for skin and hair than slightly acidic products. Therefore, the pH was adjusted to 7.3 - 7.5 before adding the fixative polymers and finalising the formulation.

Natural Formulation with Xanthan Gum FNCS-PC

For the natural formulation, the synthetic polymers were replaced by xanthan gum. Xanthan gum has thickening and fixative properties and can be used as an all-in-one biopolymer. Several xanthan gum types were tested at concentrations between 3% and 5%. Based on the rheological findings, the best formulation for a hair styling gel application was found to be 5% XG FNCS-PC. FNCS-PC is an 80-mesh xanthan gum with high transparency, specifically developed for personal care applications. The full formulation is shown in table 2.

Table 2: Natural hair styling gel formulation with Xanthan Gum

Phase	Name	INCI	Function	5% XG FNCS-PC
A	Water	Aqua	Solvent	Qs to 100
	Glycerine	Glycerine	Moisturiser	3%
A1	Xanthan Gum FNCS-PC	Xanthan Gum	Thickening and fixative polymer	5%
B	Preservative		Preservation	Qs
C	Lactic Acid 90% Heat Stable PC Grade	Lactic Acid	pH regulation	Qs

This formulation is much easier to handle and less time-consuming than the synthetic formulation. Xanthan gum was sprinkled into water while stirring until it dissolved completely. All the other ingredients could then be added. Xanthan gum is stable over a wide pH range and very salt tolerant.

Measurements of physical attributes

Flow curve

A Haake™ RheoStress™ 1 rheometer from Thermo Fisher Scientific with a parallel-plate system (PP20) was used to measure the flow curve at 21°C. The apparent shear viscosity was measured by increasing the rotational shear rate from 0.01 s^{-1} to 100 s^{-1}. This provides information about product stability and product application. Low shear rates represent conditions during storage; the stability of the product at rest is evaluated. Increasing the shear rate causes stronger forces to deform the sample. Medium shear rates represent conditions when the hair gel is being applied.[4,5]

Oscillation measurement

It is widely known that specific rheological parameters are very closely linked to the sensory perception of a cosmetic product.[6,7] Information from oscillation measurement correlates directly with skin feeling and haptics. The rheology measurements were performed at 21°C using a modular compact rheometer (Anton Paar MCR 302 with a parallel-plate system (PP25)). Data were analysed using RheoCompass software.

As shown in figure 1, the storage modulus G' [Pa], loss modulus G" [Pa], yield stress G' (log) and flow point G'=G" were determined.

For hair gel applications it is important to define the gel character and gel strength. The gel strength is characterised by the solid portion of the product and can be analysed by measuring the storage modulus G'. The storage modulus determines the elasticity and gel character of the material. It is measured by placing the sample between two plates. The upper plate applies shear deformation with increasing amplitude or strain through dynamic oscillation.

The higher the value of the storage modulus, the higher the gel strength of the sample.

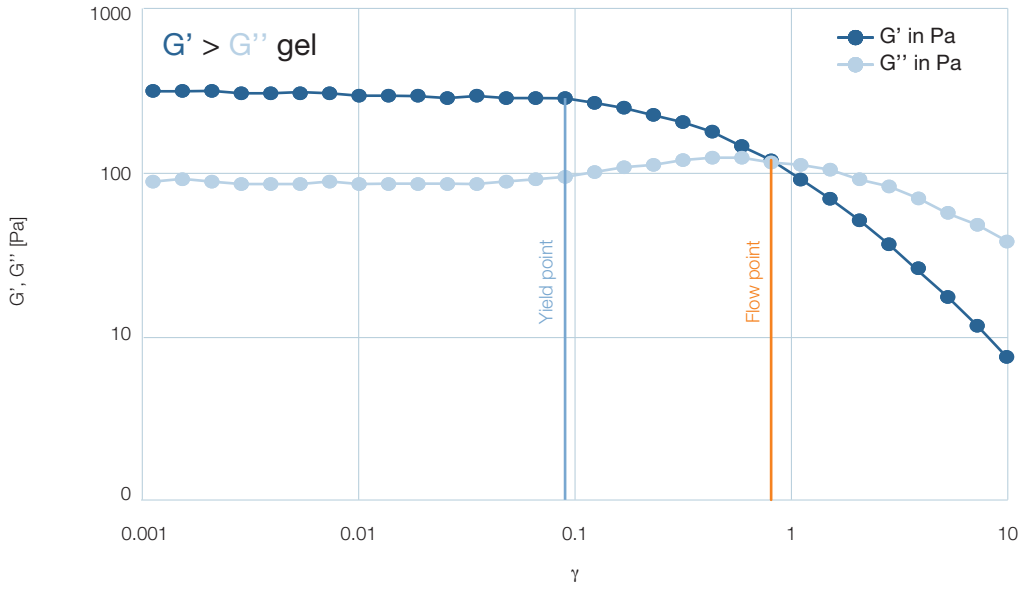
In addition to the storage modulus G', loss modulus G" was measured. This characterises the viscous and thus the fluid part of the product.

Another important parameter of cosmetic products is their spreading behaviour, which can also be evaluated by oscillation measurement. Yield point and flow point are two meaningful values to describe the spreading behaviour of a hair gel.

The sample starts to flow at the yield point, which marks the end of the linear viscoelastic range.

At a certain applied stress, the lines of G' and G" cross. This point is called the flow point. It is defined as the minimum stress that has to be applied to make the gel flow. The higher the flow point, the more difficult it is to spread the gel.[5,8]

Figure 1: Oscillation curve: G’ and G” of a sample hair gel in relation to applied strain

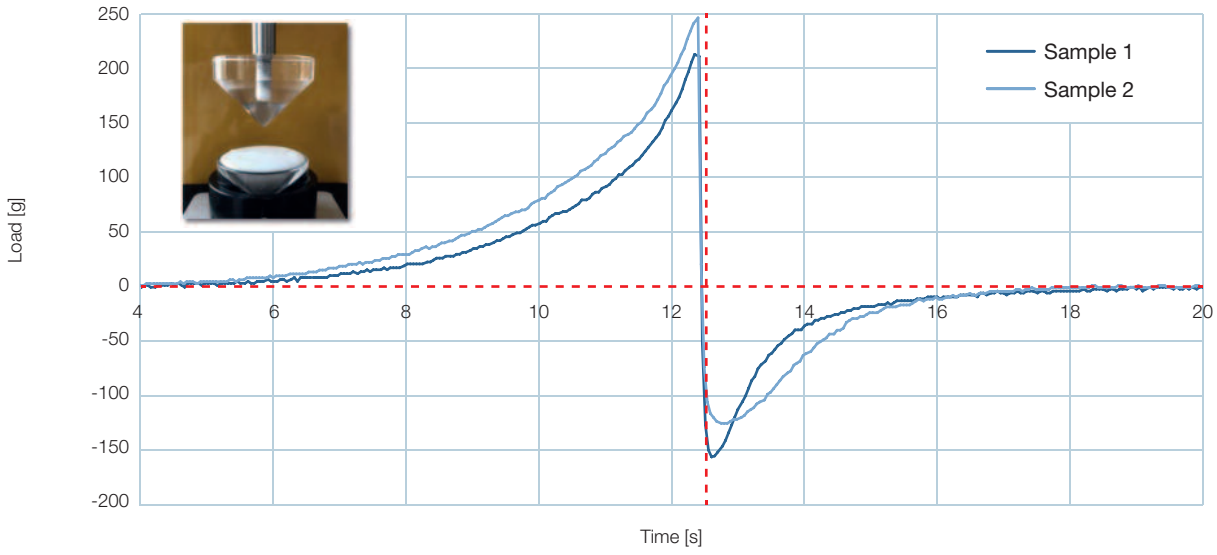


Texture analysis

Stickiness is a relevant attribute in cosmetic science. Consumers expect a pleasant and not-too-sticky texture. The stickiness of a cosmetic product can be evaluated by a compression test. This was carried out with a Brookfield CT3 texture analyser, using a spreadability fixture (TA-SF). A specific cone-shaped probe penetrates the sample and then withdraws to its starting point. The texture analyser measures the force required to penetrate the sample and withdraw the probe (figure 2).

The force needed to penetrate the sample (positive peak maximum) characterises the firmness. The force required to withdraw the cone and break the contact between probe and sample reflects the adhesiveness (negative peak maximum). It correlates directly to the sensory perception. The positive section represents the spreadability and the negative section the stickiness. The higher the adhesiveness, the more elongated the cling formation and the stickier the product.[5]

Figure 2: Compression test of two samples with significantly different texture profiles. Sample one is firmer and more adhesive than sample two.



Performance testing

In addition to rheology, the performance of the formulation was analysed using two established industry methods – the curl retention test and a sensory evaluation.

Curl retention test

The curl retention test characterises the hair styling properties and humidity resistance of a styling gel. 0.5 g of each test product was applied to wet tresses of natural European bleached hair. Three replicate tresses were shaped into curls by winding them onto hair rollers for 24 hours. The tresses were then stored in a climate chamber at a temperature of 21°C and a relative humidity of 75%. After certain time intervals (15 minutes, 30 minutes, 1 hour, 5 hours, 24 hours), the length of the curls was measured and documented photographically. The longer the shape of the curl is maintained and the shorter the tresses appear, the better the product's curl retention performance.

Sensory evaluation

Again 0.5 g of the test product was applied to European bleached hair. A panel of trained experts then evaluated the attributes fixation, combability, residues, static charge after combing, and ease of application. A paired comparison test was conducted according to DIN/ISO 5495.[9]

Results and discussion

Analysis of several benchmark products provided data for the creation of representative formulations. A target range for the viscosity measurements was then defined based on the data obtained. Since the products differed widely in terms of oscillation data, no specific target range was determined for this parameter. Analysis of the benchmark products using the texture analyser revealed substantial variation in respect of firmness and adhesiveness. This means that there was no specific target value that had to be achieved.

Formulation testing

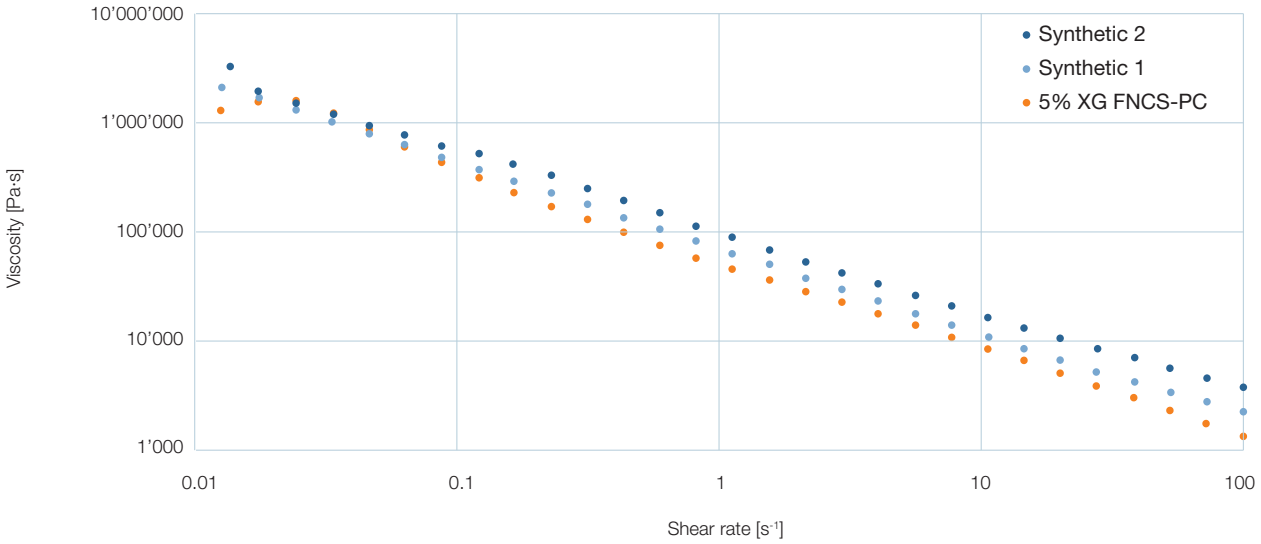
To evaluate the performance of xanthan gum as a natural thickening and fixative agent in hair styling gel, a formulation containing xanthan gum was compared to two synthetic formulations that were developed in-house. The formulations were characterised for rheology, texture profiles and performance.

Xanthan gum demonstrates shear thinning behaviour. At very low shear rates it shows high viscosity and excellent stabilising properties. Viscosity is reduced at higher shear stress, giving good distributability and pleasant haptics.

Hence, xanthan gum FNCS-PC provides excellent rheological properties for hair styling gel applications.[4,5]

As regards flow behaviour and viscosity, a slightly more pronounced shear thinning behaviour was observed with the xanthan gum formulation, although at very low shear rates the formulations had the same viscosity (figure 3). All in all, the differences are very small and not readily apparent to the consumer.

Figure 3: Rheology results: flow curves of two synthetic formulations and one natural formulation

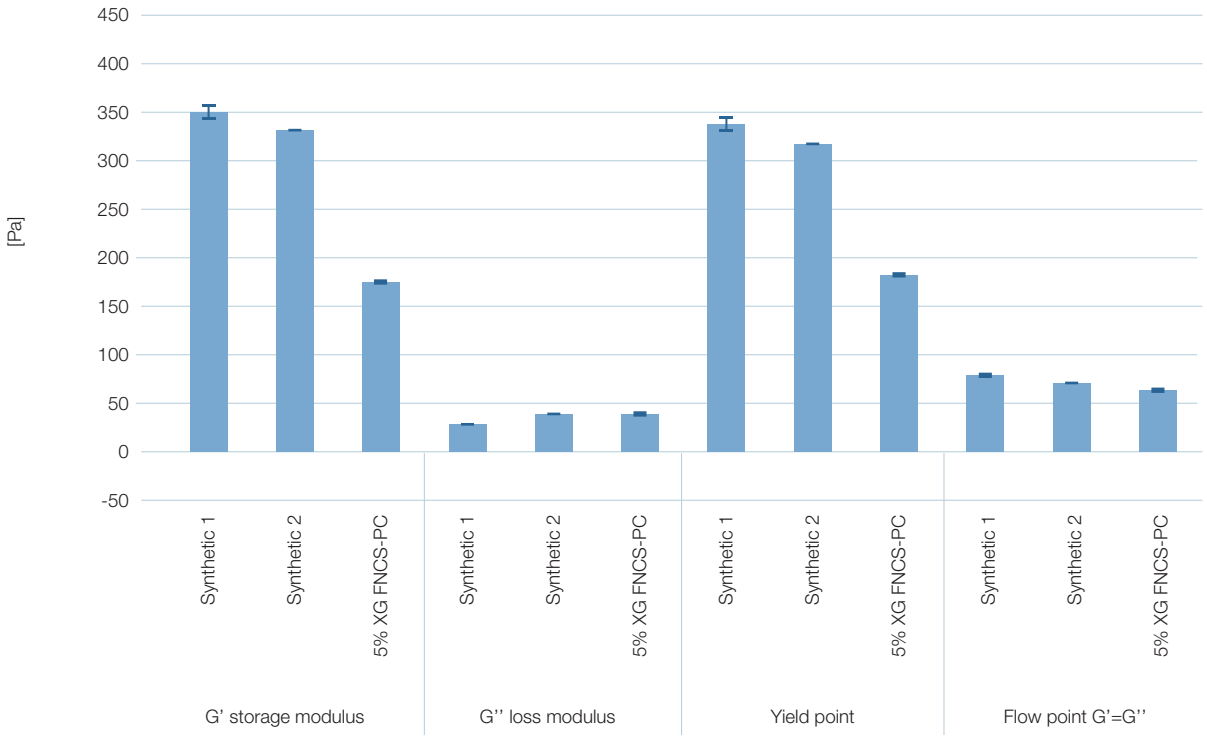


The results of the oscillation measurements are presented in figure 4.

Big differences are only detectable by evaluating the storage modulus G' and the yield point. The formulation with XG FNCS-PC features the smallest storage modulus G''. This means that it contains the weakest gel structure or elastic portion. Formulations Synthetic 1 and 2 show quite high storage modulus values and thus a stronger gel structure compared to XG FNCS-PC. The same is true for the yield point values.

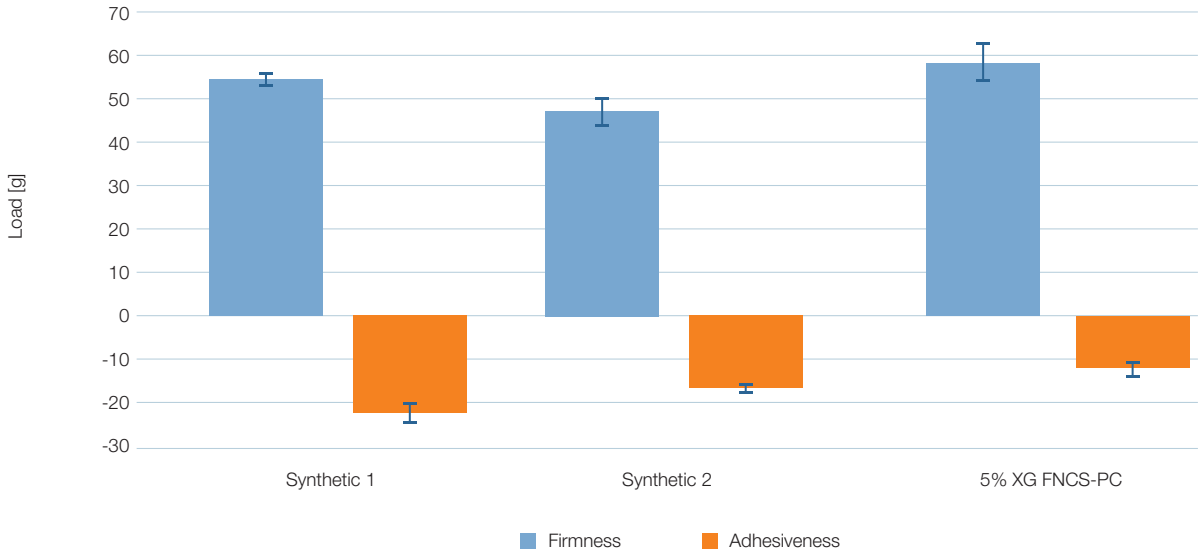
Comparing the values of loss modulus G" and flow point, the differences between the three formulations are small and are most likely imperceptible in terms of sensory attributes.

Figure 4: Rheology results: oscillation measurement (n=2)



The results of texture analysis are shown in Figure 5. The formulation with 5% XG FNCS-PC shows much higher firmness and slightly lower adhesiveness. As a result, the hair styling gel with xanthan gum is more compact and a greater force is needed to penetrate the sample. The probe can be removed more easily compared to the synthetic formulations because the gel is less sticky. The synthetic formulations also differ from each other in terms of firmness. The gel texture was already indicated by the oscillation data, which characterise the gel structure.

Figure 5: Texture analyser results



Curl retention test

Figure 6: Curl retention results (n=3)

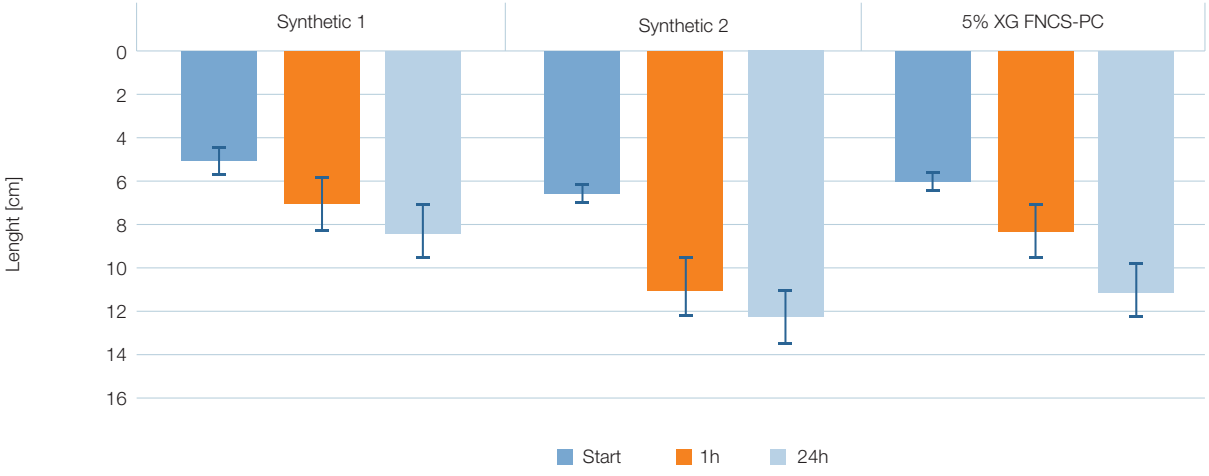


Figure 6 shows the measured length of the hair tresses in cm. Formulation Synthetic 1 shows the best curl retention performance. After 24 hours the hair tresses elongated 3.2 cm, corresponding to around 60% compared to the starting value. The hair tresses treated with the xanthan gum hair styling gel were 5.2 cm longer after 24 hours, equal to 86%, while the hair tresses treated with the Synthetic 2 formulation elongated by 85%, 5.7 cm in total. Overall, XG FNCS-PC results in a slightly weaker curl retention than Synthetic 1, but performs as well as the formulation Synthetic 2.

Sensory
Our trained in-house sensory panel evaluated the hair styling gel products on hair tresses prepared according to a standardised procedure.

In the first test, the two synthetic formulations were evaluated. Overall, formulation Synthetic 1 was preferred over Synthetic 2, especially in terms of combability, stickiness and ease of application.

The formulation with XG FNCS-PC was then tested against the Synthetic 1 and Synthetic 2 formulations. On statistical evaluation no significant differences were detectable. Thus, the in-house sensory panel could not distinguish between the synthetic formulations and the natural formulation with xanthan gum.[9]

Summary

In summary, measurements taken with the rheometer and texture analyser are very precise and allow for in-depth characterisation of hair gel products. Furthermore, rheological data give some indication of sensory perception. Spreading behaviour can be evaluated based on the yield point and the flow point. The results of the adhesive behaviour test correlate directly with the stickiness of a hair styling gel.

Synthetic formulations were compared to a hair styling gel formulation formulated purely with 5% xanthan gum. In terms of rheology, texture, performance testing and sensory attributes, the natural hair styling gel with xanthan gum was comparable with synthetic formulations.

Overall, xanthan gum shows exceptional performance in hair styling gel applications. Jungbunzlauer's xanthan gum FNCS-PC is an all-in-one solution to replace synthetic thickeners and styling polymers. Xanthan gum FNCS-PC is natural, vegan, COSMOS approved and readily biodegradable. It is easy to handle and shows excellent stability over a wide pH range.

In light of the consumer-driven demand for more natural products and potential changes in the regulatory environment, greater attention is now being paid to the search for natural performance ingredients.

Our all-natural hair styling gel with xanthan gum is a striking example of how excellent product performance can be achieved while remaining environmentally friendly.

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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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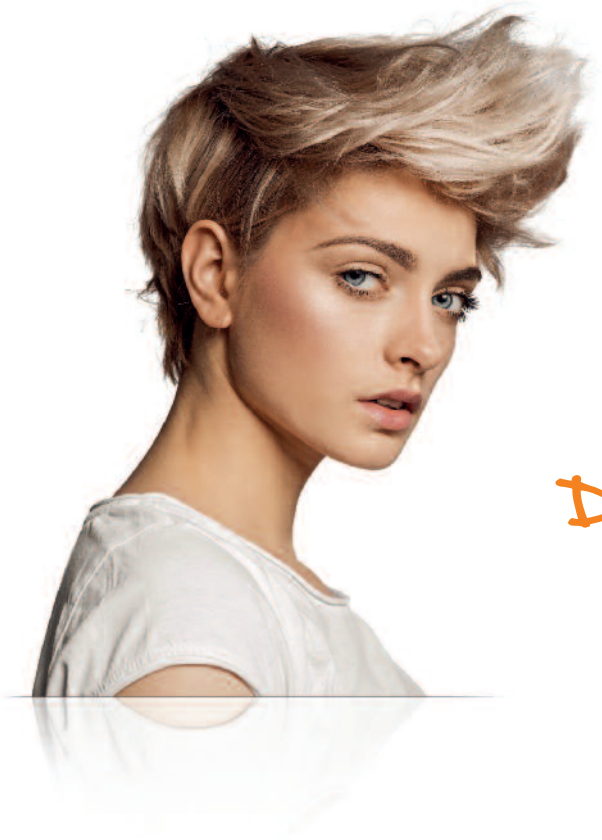

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