facts

Face gel with Xanthan Gum as a natural thickener
Introduction

In an environment that promotes the “metrosexual” man, younger men, in particular, have no inhibitions about extending their personal care beyond the toothbrush and razor. Currently growth in the men’s product market is outpacing that in women's products and most manufacturers of personal care products now offer a range of sub-brands specifically for men. With men paying more and more attention to their appearance, a large number of pleasurable rather than purely functional men's personal care products have found their way on to the shelves. Face gels are frequently found right at the front of men's bathroom cabinets: with their clear, light appearance they leave the skin feeling well moisturized and fresh and are popular for everyday use.

A desirable feature for all face gels is crystal-clear transparency, combined with a firm texture and agreeable skin feeling. This is achieved by the addition of a transparent thickener. The choice of thickener depends on factors such as purity, colour and smell, as well as on the rheology profile. Increasingly, customers also expect their products to fulfil other criteria, including natural formulations, non-GMO raw materials, ethical and animal-friendly status.

Xanthan gum has the ideal rheology profile for many personal care applications. This fact sheet was designed to demonstrate that it is ideal as a natural thickener for face gels.

Natural versus synthetic thickening agents

Thickeners are used to enhance the stability and performance of a cosmetic product, as well as to improve consistency, volume, and viscosity. They can be divided into natural or synthetic thickeners. Whereas carbomers, a synonym for polyacrylates, are examples of synthetic thickeners frequently used in personal care, xanthan gum is of 100% natural origin and biodegradable. Carbomers are synthesized from fossil raw materials. Carbomers and xanthan gum are both very efficient and show good water retention. They form gels of different strengths in aqueous solutions and are available as transparent grades. At very high concentrations, xanthan gum can exhibit an unpleasant sticky skin feeling, whereas carbomers remain pleasant even at high viscosities. Xanthan gum is very stable over a wide range of pH and salt concentrations, carbomers on the other hand, are more sensitive to pH and high ion content. In summary, each thickener has some advantages over the other and there are also many similarities between them. From a consumer point of view the most noticeable difference is the source, which in the case of xanthan gum is natural.

The serious ecological consequences arising from the accumulation of plastics in nature and the finiteness of fossil raw materials are causing many consumers to give preference to products containing natural ingredients. Consequently, the search is on for alternatives to synthetic thickeners.

The challenge is to find natural thickeners that can replace synthetic thickeners without compromising the appearance, texture or skin sensation of the face gel.
The relationship between rheology and sensory perception

The rheology and the sensory perception of a cosmetic product are very closely linked. They represent complementary approaches to understanding and improving the properties and behaviour of a cosmetic product. Indeed, some specific rheological measurements correlate directly with sensorial properties and skin feeling.

Viscoelasticity and gel strength
Viscoelasticity is the most important rheological property of almost all cosmetic products. It describes the ratio of the product’s elasticity and solidity to its viscosity and fluidity. When applying a face gel, character and strength of the gel are of special interest. Gel strength can be measured by determination of the elastic modulus.

Figure 1: Amplitude sweep with elastic modulus in relation to applied strain in two samples with significantly different gel strengths

Elastic modulus is tested by placing a sample between two plates. Shear deformation with increasing amplitude or strain through dynamic oscillation is then applied via the upper plate. The elastic modulus results as a material property by the applied strain. This determines the elasticity and gel character of the material. The higher the value of the elastic modulus, the higher the gel strength of the measured sample.
Flow point and spreadability

A second, very important characteristic that differentiates cosmetic products is their spreading behaviour on the skin. Is the product easy to spread, for example like massage oil, or does it show a certain resistance during spreading, more like a very fatty hand cream? Rheology is a very helpful tool in evaluating spreadability, too. Spreadability can be determined by measuring the flow point. The sample is again placed between two plates, and the upper plate rotated using increasing shear stress as discontinuous rotation in one direction.

Figure 2: Three face gels with increasing gel strength and elastic modulus, from left to right

To correlate this property directly to the sensory perception of a cosmetic product: the higher the elastic modulus, the more rigid and stiff a specific cosmetic product will appear to be.

At a certain applied stress the sample starts flowing and passes the point of linear elastic deformation, represented by the sharp angle in one line on the graph. This so-called flow point defines the minimal stress which has to be applied to make the material flow. The higher this applied stress, the stronger the tested sample. This flow point translates directly to skin feeling and the sensory perception of a cosmetic product.

The higher the measured flow point, the higher the resistance and the harder it is to spread a cosmetic product on the skin.
**Texture analysis and stickiness**

A pleasant and not too sticky texture is also very important in a cosmetic product. Texture and especially stickiness can be evaluated by a simple compression test using a texture analyser. A specific probe initially penetrates the sample and withdraws to the starting point. This set-up enables constant measuring of the force required to penetrate the sample and the adhesive force displayed during withdrawal.

**Figure 4:** Compression test of two samples with significantly different texture profiles

The negative section of the graph in Figure 4 enables evaluation of the stickiness of a cosmetic product. The negative peak value records the adhesive force of the sample and the amount of material sticking to the probe. The area under the x-axis shows the adhesiveness of the sample by recording the energy required to break the contact between probe and sample.

Adhesiveness translates directly to skin feeling and can be correlated to the cling formation and stickiness of a cosmetic product. The higher the adhesiveness the more elongated the cling formation and the longer the texture of a cosmetic product, resulting in a stronger perception of stickiness.

In summary, a direct correlation can be established between different mechanical and rheological measurements and the resulting sensory perception. This makes it easier to understand and hence improve the formulation of a cosmetic product. It follows that some of the sensory properties of face gels can be directly interpreted from different rheological parameters. The gel strength, for example, directly correlates to the elastic modulus. Spreading behaviour can be evaluated with the help of the flow point, and stickiness and texture correlate directly with the results of the adhesive behaviour test.
Natural-based thickeners in face gels

To find the most suitable natural thickening agent for a face gel, a basic formulation for a natural face gel for men was thickened using different natural agents. We compared two different xanthan gum types, XG FNCS PC (a clear solution type for personal care) and XG FNCSP PC (a clear solution, smooth-flow type for personal care), with cosmetic grade carrageenan.

Sensory evaluation was performed to characterize and compare the formulations thickened by the three different hydrocolloids. A sensory panel, consisting of 23 panellists, classified the different formulations in a ranking test of the attributes gel strength, spreadability, and stickiness. All sensory results were supported by the corresponding rheological measurements for elastic modulus, flow point, and adhesiveness.

A direct correlation can be found for the different face gels tested with regard to gel strength and elastic modulus. The sensory panel found the face gel thickened by carrageenan to be the significantly weakest gel with the lowest gel strength. No significant difference could be observed between the two xanthan gum types. Results from rheological measurements and the determination of the elastic modulus confirmed this finding. The formulation thickened by carrageenan clearly showed the lowest elastic modulus and therefore forms the weakest and softest gel. In contrast both xanthan gum types possess a much higher elastic modulus, even at the same concentration, resulting in highly elastic and firm gels.

Results of gel strength evaluation of face gel formulations thickened with one of the two xanthan gum types or with carrageenan.

Figure 5a: Results of the sensory evaluation (p < 0.001)

Figure 5b: Amplitude sweep and determination of elastic modulus
In the final test, the formulation with XG FNCS PC ranked significantly highest for stickiness in the sensory evaluation of texture and displayed the most unpleasant cling formation. No significant differences between XG FNCSP PC and carrageenan were found regarding stickiness and cling formation. These results correlate directly with the results from the compression test and texture analysis. The face gel thickened by XG FNCS PC exhibits the stickiest texture profile and the formulation thickened by carrageenan had the lowest adhesiveness.

Results of spreadability evaluation of face gel formulations thickened with one of the two xanthan gum types or with carrageenan

Figure 6a: Results of the sensory evaluation

![Sensory ranking test with n=23](image)

Figure 6b: Strain/stress correlation and determination of the flow points

![Strain/Stress diagram](image)

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Results of the texture evaluation of face gel formulations thickened with one of the two xanthan gum types or with carrageenan

Figure 7a: Results of the sensory evaluation (p < 0.01)

Based on these findings, XG FNCS PC shows the best performance in respect of gel strength and spreading behaviour. Additionally, due to its exceptional transparency it enables the production of very clear face gels and was found to be the best choice of natural thickening agent for completely water-based formulations.

Figure 7b: Compression test and determination of adhesiveness
To assess the performance of xanthan gum as a natural thickening agent in face gels it was compared with commercially available, conventional face gels thickened using synthetic polymers. A sensory evaluation was performed in which the sensory panel compared the natural-based JBL Face Gel formulation containing XG FNCSP PC to two commercial face gels for men. A ranking test of the attributes gel strength, spreadability, and cooling sensation resulted in no significant differences in any of the three attributes. It may be concluded that the natural-based JBL formulation, thickened solely with xanthan gum, shows comparable gel performance to the conventional face gels containing synthetic thickeners.
The texture of the different face gels was evaluated in more detail by means of a compression test. The JBL face gel containing xanthan gum showed a completely different texture profile to the conventional face gels tested. With regard to adhesiveness, Jungbunzlauers face gel thickened solely with xanthan gum required slightly greater energy and more time to break the contact between probe and sample, resulting in a slightly more elongated cling formation and longer texture. This could result in a slightly greater sensory perception of stickiness.

Figure 9: Compression test of two commercially available face gels for men and Jungbunzlauers face gel with xanthan gum
This comparison of a face gel thickened solely by xanthan gum with two conventional face gels containing synthetic polymers provides a direct answer to the question as to whether synthetic polymers can readily be replaced by a natural thickening agent such as xanthan gum. As regards gel strength and spreading behaviour, xanthan gum, used at high concentrations (up to 2.0%), is a very good alternative to conventional synthetic gelling or thickening agents such as carbomers. At very high concentrations of xanthan gum the texture and feel of the thickened cosmetic product on the skin may result in an unpleasant perception of stickiness. With some adjustment of the concentration or combination with other natural thickeners a better texture could be achievable. Overall, perfectly clarified xanthan gum, with its pseudoplastic behaviour, is an ideal candidate for use alone or in combination with other thickeners and thus is a very good alternative to synthetic thickeners.

Conclusion

Xanthan gum shows exceptional performance in cosmetic applications such as face gels. Several tests have shown that Jungbunzlauers XG FNCS P PC is a very suitable alternative to synthetic thickeners in such gels. A formulation containing purely xanthan gum was compared to commercially available face gels containing synthetic thickeners. The formulation was comparable in terms of texture, spreadability and appearance. In terms of stickiness, the formulation with xanthan gum is not comparable to the benchmark, however, an improvement can be targeted by some adjustment to the concentration or combination of xanthan gum with other thickeners.

Bibliography


www.brookfieldengineering.com/applications/personal-care-products/moisturizing-cream-spreadability
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. Jungbunzlauer offers different grades of xanthan gum for food applications as well as pharmaceutical and personal care products.

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