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Enhancing Sensory and Rheological Properties of Serums and Creams with Lotus Water: A Comprehensive Textural and Rheological Analysis

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Abstract

This study explores the impact of lotus water on the sensory and rheological properties of serums and creams. Through rheological and textural analyses, we found that increasing the proportion of lotus water in formulations reduces average holding power, indicating improved spreadability and reduced greasiness. Friction force measurements revealed lower initial friction but higher long-term friction in lotus water-containing products, suggesting rapid absorption and lasting skin residue. Rheological data showed increases in storage modulus (G') and loss modulus (G"), along with improved yield stress, enhancing application smoothness. These findings highlight lotus water's potential as a valuable textural modifier in cosmetic formulations.

Keywords: Lotus Water, Rheological Properties, Textural Analysis, Serums, Creams

1. Introduction

In recent years, consumer demand for cosmetic products has evolved beyond mere efficacy to include a superior sensory experience. This trend has driven the beauty industry to seek natural ingredients capable of enhancing both product performance and texture. Lotus water, celebrated for its hydrating, soothing, and anti-inflammatory properties, has emerged as a promising candidate [1]. Derived from the Nelumbo nucifera plant, lotus water has been a staple in traditional Asian medicine and skincare for centuries. Its rich composition of antioxidants, vitamins, and minerals not only nourishes the skin but also aids in maintaining skin health. This study aims to evaluate the effects of incorporating lotus water into serums and creams on their rheological and textural properties, focusing on improving spreadability, smoothness, and overall application experience [2]. We hypothesize that lotus water can significantly enhance these properties, offering a more delightful and effective skincare experience.

2. Materials and Methods

The study employed a combination of rheological and textural analyses to evaluate the effects of lotus water on serums and creams. Serum and cream formulations were prepared with varying concentrations of lotus water replacing distilled water. The formulations included a control with water and increments of 10%, 20%, 30%, 50%, and 100% lotus water substitution. An Anton Paar MCR 302 rheometer was used to measure key rheological parameters, including viscosity, storage modulus (G'), loss modulus (G''), and yield stress. Viscosity was measured across a shear rate range of 0.01-100 s^{-1}, while oscillatory tests determined G' and

G'' within the linear viscoelastic range (LVR). Yield stress was measured using a stress ramp from 0 to 100 Pa. A Texture Technologies TA.XT Plus texture analyzer was employed to assess adhesiveness and friction force over 5 and 30 minutes using a cylindrical probe.

3. Results

Impact on Average Holding Power

The incorporation of lotus water into the formulations led to a notable decrease in the average holding power of both serums and creams (Figure.1). For the cream formulations, the average holding power decreased from 341 g in the control formulation to 269 g when 100% of the water was replaced with lotus water. This trend was consistent across all intermediate concentrations, indicating a dose-dependent relationship. Similarly, in the serum formulations, the average holding power exhibited a steady decline as the percentage of lotus water increased, reflecting reduced viscosity and improved spreadability.

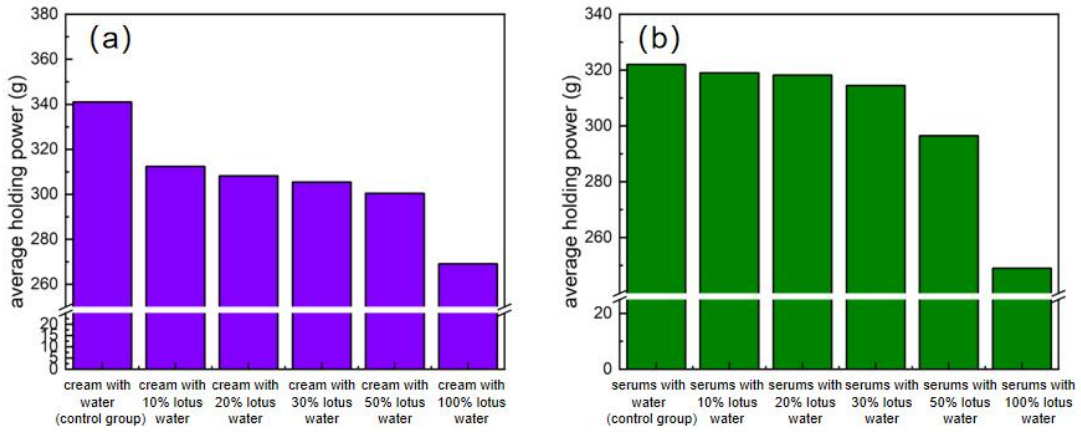

Figure 1. Average holding power of creams (a) and serums (b) with varying concentrations of lotus water.

Friction Force Analysis

Friction force measurements provided insights into the application experience of the formulations (Table 1). In the short term (5 minutes), formulations containing lotus water demonstrated lower friction forces compared to the control, suggesting faster absorption and a smoother application process. However, after 30 minutes, the friction force of lotus water-containing formulations exceeded that of the control, indicating the presence of a lasting residue on the skin. This residue effect is interpreted as a sensation of continued hydration and nourishment, which may enhance consumer perception of the product's efficacy.

Table 1. Friction force of creams and serums with and without lotus water, as measured by a texture analyzer simulating finger friction on the skin for 5 minutes and 30 minutes.

Sample	Friction Force (g) -5 min	Friction Force (g) -30 min
cream with water (control group)	18.4	13.3
cream with 100% lotus water	13.5	27.6
Serums with water (control group)	20.1	14.8
Serums with 100% lotus water	17.4	22.9

Rheological Properties

Rheological analysis revealed significant changes in the structural properties of the formulations with the addition of lotus water (Figure 2). Both the storage modulus (G') and loss modulus (G'') increased with higher concentrations of lotus water in a dose-dependent manner. This increase suggests enhanced structural stability and a more luxurious feel during

application. Additionally, the yield stress, which is critical for product flow and spreadability, improved with the incorporation of lotus water, facilitating easier and more even distribution across the skin.

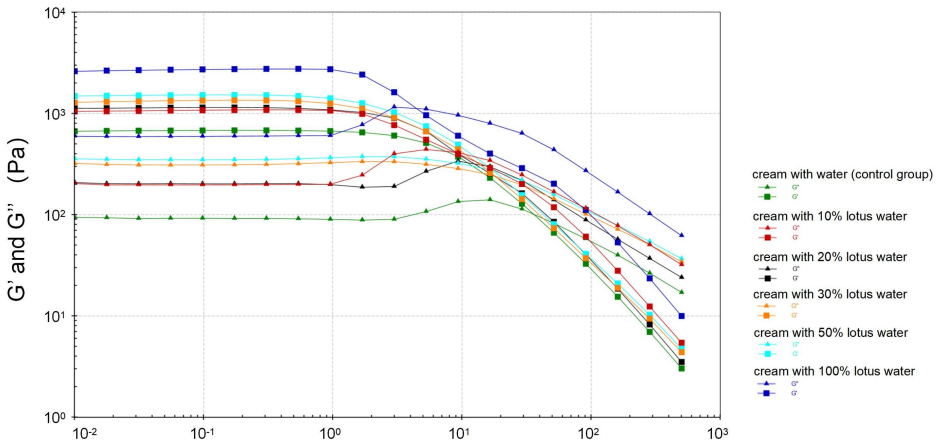

Figure 2. Rheological behavior of creams with different concentrations of lotus water.

4. Discussion

The results of this study underscore the multifaceted impact of lotus water on the sensory and rheological properties of serums and creams. The reduction in average holding power and short-term friction force aligns with consumer preferences for products that are lightweight and easy to apply. This is particularly significant given the growing demand for skincare products that deliver immediate sensory gratification while maintaining long-term benefits. The initial decrease in friction force can be attributed to the unique molecular structure of lotus water, which may enhance the lubricity of the formulations during application. The subsequent increase in friction force after 30 minutes suggests that lotus water components remain on the skin surface, providing sustained moisturization and a perceptible residue that consumers often associate with product effectiveness.

The rheological findings further support the role of lotus water in modifying the structural properties of cosmetic formulations. The increase in G' and G" indicates a more robust gel network, which can enhance the stability of active ingredients and improve the overall texture of the product. This is particularly important for serums, which often require a balance between liquidity and stability to ensure even distribution of high concentrations of active components.

In the broader context of cosmetic formulation, these results contribute to the understanding of how natural ingredients can be leveraged to optimize product performance. Previous studies have explored the use of various botanical extracts to enhance skincare products, but the specific rheological and textural effects of lotus water have not been extensively investigated. This study fills a gap in the literature by demonstrating the practical benefits of lotus water as a textural modifier. Future research could explore the synergistic effects of lotus water with other natural ingredients, such as hyaluronic acid or glycerin, to further enhance the sensory and rheological properties of serums and creams. Additionally, long-term stability studies and consumer perception trials would provide valuable insights into the commercial viability and market acceptance of lotus water-containing products.

5. Conclusion

This study demonstrates that lotus water is an effective textural modifier in serums and creams. Its addition reduces average holding power and short-term friction force, improving spreadability and initial sensory experience. The increased G', G", and yield stress enhance product structure and application smoothness. While long-term friction force increases, this

residue effect can be positioned as a positive attribute, suggesting sustained skin benefit. These findings position lotus water as a valuable ingredient for enhancing both the sensory and functional dimensions of skincare products.

References

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