

RHEOLOGY AND STORAGE TESTS OF DEAD SEA SHAMPOO

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Received: 23.10.2003, Final version: 22.12.2003

ABSTRACT:

Changes in the rheological properties of hair shampoo samples differing in the content of Dead Sea (DS) salt were studied. The rheological properties were tested during a 28-day storage period at three different storage temperatures (cold, room temperature and accelerated conditions). Steady rheological tests were performed and the conductivities of the shampoo samples were determined. The parameters of the power law model; the consistency coefficient and the flow behavior index were used to quantify the effect of storage time and temperature on the rheological behavior of hair shampoo in the presence of DS salt. The consistency coefficient of the salt free shampoo samples stored at 8°C and at room temperature decreased with storage time, and the rheological behavior changed from shear thinning to Newtonian. On the other hand, the samples stored at 45°C exhibited a shear thinning behavior, which did not change with storage time. Shampoo samples with 1.5 wt% DS salt content, showed the maximum viscosity and the rheological behavior of the samples did not change with the storage time. An exception were the samples stored at 45°C, which behaved like the salt free samples stored at room temperature. The conductivity of hair shampoo increased linearly with storage time and salt concentration. A discontinuity at a salt concentration of 1.5% was observed. However, the conductivity of hair shampoo increased with increasing the storage temperature.

ZUSAMMENFASSUNG:

Die rheologischen Eigenschaften von Haarshampoo als Funktion von unterschiedlichem Gehalt an Salz aus dem Toten Meer wurden untersucht. Speziell wurde der Einfluss einer 28-tägigen Lagerung bei drei unterschiedlichen Temperaturen (8°C, Raumtemperatur, 45°C) analysiert, wobei stationäre rheologische Tests durchgeführt und die Leitfähigkeit der Shampoo Proben bestimmt wurde. Die Parameter des Potenzgesetzes, der Konsistenzfaktor und der Fließindex wurden benutzt, um den Effekt der Lagerzeit und der Temperatur auf das rheologische Verhalten des Haarshampoos bei Vorhandensein von Salzen zu quantifizieren. Der Konsistenzfaktor der salzfreien Shampoo Proben bei 8°C und bei Raumtemperatur nahmen mit der Lagerzeit ab und das rheologische Verhalten änderte sich von scherverdünnendem zu newtonschem Verhalten. Andererseits zeigten die Proben, die bei 45°C gelagert wurden, zwar eine Scherverdünnung, die sich mit der Lagerzeit allerdings nicht veränderte. Shampoo Proben mit 1.5% w/w Salzgehalt zeigten die höchste Viskosität und das rheologische Verhalten der Proben änderte sich nicht während der Lagerung. Wiederum eine Ausnahme bildeten die Proben, die bei 45°C gelagert wurden, die sich wie die bei Raumtemperatur gelagerten salzfreien Proben verhielten. Die Leitfähigkeit des Haarshampoos stieg linear mit der Lagerzeit und der Salzkonzentration an, wobei eine Unstetigkeit bei einer Salzkonzentration von 1.5% w/w beobachtet wurde. Die Leitfähigkeit des Haarshampoos stieg jedoch mit der Erhöhung der Lagertemperatur.

RÉSUMÉ:

Les changements dans les propriétés rhéologiques d'échantillons de shampoings différant dans le contenu en sel de la mer morte ont été étudiés. Les propriétés rhéologiques ont été testées durant des périodes de stockage de 28 jours à 3 températures de stockage différentes (froide, température ambiante et conditions accélérées). Des tests rhéologiques à l'état stationnaire ont été entrepris et les conductivités des échantillons de shampoing ont été déterminées. Les paramètres du modèle en loi de puissance, le coefficient de cohérence et l'index de comportement d'écoulement ont été utilisés pour quantifier l'effet du temps de stockage et de la température sur le comportement rhéologique des shampoings en présence de sel de la mer morte. Le coefficient de cohérence des échantillons de shampoings sans sel stockés à 8°C et à température ambiante décroît avec le temps de stockage, et le comportement rhéologique passe de rhéo-amincissant à Newtonien. D'autre part, les échantillons stockés à 45°C présentent un comportement rhéo-amincissant, qui ne dépend pas du temps de stockage. Les échantillons de shampoing avec 1.5% en poids de sel de la mer morte montrent une viscosité maximale et le comportement rhéologique des échantillons ne dépend pas du temps de stockage. Une exception fut les échantillons stockés à 45°C, qui se comportent comme les échantillons sans sel stockés à température ambiante. La conductivité des shampoings augmente linéairement avec la concentration en sel et le temps de stockage. Une discontinuité pour une concentration en sel de 1.5% en poids a été observée. Cependant, la conductivité du shampoing augmente avec l'augmentation de la température de stockage.

KEY WORDS: shampoo, Dead Sea salt, rheology of cosmetics, conductivity, storage time

© Appl. Rheol. 14 (2004) 96-103

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Volume 14 · Issue 2

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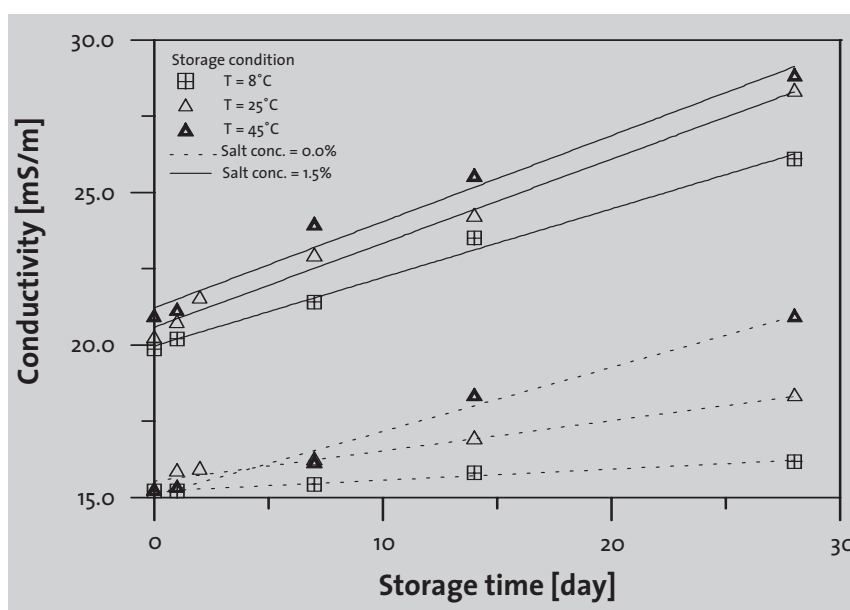
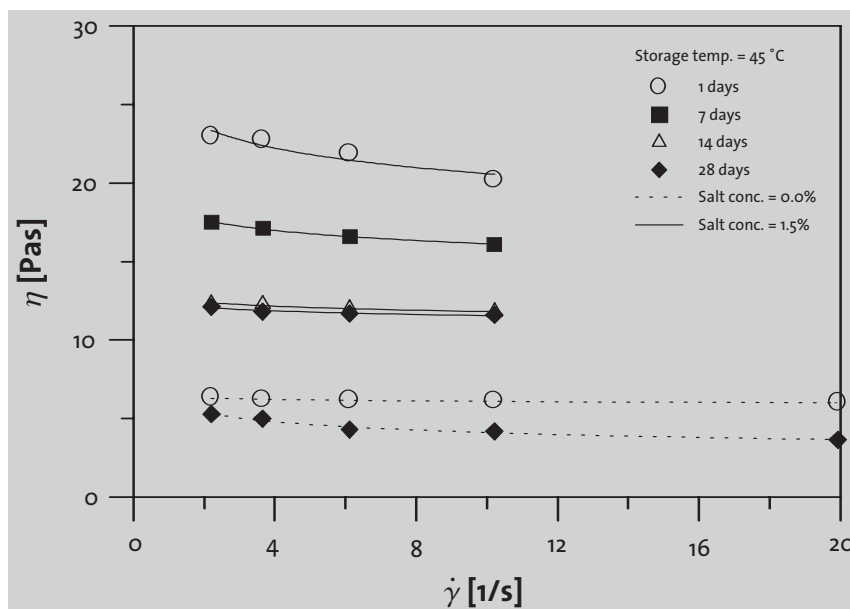


Figure 8 (above): Effect of storage time on the viscosity of shampoo samples stored at 45°C.

Figure 9 (below): Effect of storage temperature on the conductivity of shampoo samples stored for different periods.

4 CONCLUSIONS

The addition of DS salt to hair shampoo changed its rheological behavior over a 28-day storage period. The viscosity of salt free shampoo decreased with storage time and the rheological behavior changed from a shear thinning to Newtonian. The shampoo samples containing 1.5 wt% DS salt, which have the maximum viscosity, did not exhibit a clear change with storage time. It should be stated here, that the observed change in the rheological behavior was limited to shear rate range of 2.2 – 28.38 s⁻¹, and did not cover the overall shape of the flow curves. The addition of DS salt of shampoo maximized the linear increase of the conductivity with storage time. Reducing the storage temperature from the room temperature to 8°C did not show a significant change in the rheological behavior for both the salt free and salted shampoos. On the other

hand, storing the shampoo samples at 45°C affected their rheological properties especially in the case of the salted samples, where the viscosity decreased with storage time.

ACKNOWLEDGEMENT

The authors are grateful to Dr. Hussam El-Haffar and Mrs. Suha Abu-Salha from Ammon Co. for their kind cooperation and material supply.

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