Shah MK (2003) Castellani's paint. Indian J Dermatol Venereol Leprol 69: 357–358.
Shephard AB, Nichols SC, Braithwaite A (1999) Moisture induced solid phase degradation of L-ascorbic acid Part 1: a kinetic study using tristimulus colorimetry and quantitative HPLC assay. Talanta 48: 585–593.
Slovak Pharmaceutical codex 1997, Herba, Bratislava, p. 309.
Šubert J, Cieslarová M (2006) Stabilizace zbarvení Castellanova roztoku bez fuchsinu ČL 2002 a kontrola její účinnosti. Čes Slov Farm 55: 29–31.
The Czech Pharmacopoeia 2002, Grada Publishing, Prague, p. 5615.
Wyszecki G, Stiles WS (2000) Color Science. Concepts and Methods, Quantitative Data and Formulae, 2nd Ed., Wiley, New York, 950 p.

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Effect of β-(1,3)-glucan on rheological properties and stability of topical formulations

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The paper deals with an effect of insoluble fungal β-(1,3)-glucan on rheological properties of topical preparations. Two types of hydrogels (based on carbomer and polyacrylamide) and two types of hydrocreams (based on polysorbate 80/Span 80™ and Brij 721™/Brij 72™) were prepared and investigated. The rheological properties of all these preparations were compared with the properties of placebos and they were measured after preparation and after 5 months of storage under different conditions : at 20 °C and 35 °C and after a triplicate freeze-thaw cycling process (−20° C/+20° C). In general it can be stated that with the exception of polyacrylamide hydrogel the β-(1,3)-glucan presence increased the apparent viscosity of assessed preparations by approximately 10–20%. In the case of hydrocreams it was observed that the triplicate freeze-thaw cycling process increased the apparent viscosity of β-(1,3)-glucan preparations by about 20–30%.

β-(1,3)-Glucans are natural polysaccharides, often used in various preparations mainly due to their immunostimulating properties. During the last years they were increasingly used as active substances in different topical preparations (Davis 1992, Klein 1999).

In water, β-(1,3)-glucans alone (similarly as other natural and semisynthetic polysaccharides) create viscous solutions, dispersions or gels (Böhm and Kulicke 1999; Burkus and Temelli 2005; Colleoni-Sirghie et al. 2003; Doublier and Wood 1995; Lee et al. 2005; Skendi et al. 2003). Our aim was to ascertain how the rheological properties and stability of topical preparations are influenced by the presence of fungal β-(1,3)-glucan.

We used insoluble fungal β-(1,3)-glucan from ligniperdous mushroom *Pleurotus ostreatus* with particle sizes below 100 μm (Natures Ltd., Slovakia). It creates viscous suspensions in water at about a 1–1.5% dry substance content. Four different types of topical preparations were prepared: (1) carbomer hydrogel (Carbopol 940™ 1%), (2) polyacrylamide hydrogel (Sepigel 305™ 2%), (3) body milk (polysorbate 80 2.75%, Span 80™ 2.25%) and (4) hydrocream (Brij 721™ 2.5%, Brij 72™ 2.5%). The body milk and hydrocream contained liquid paraffin 20% and 15%, respectively, as an oil phase. All the preparations were preserved by a mixture of methyl-, ethyl-, propyl-,

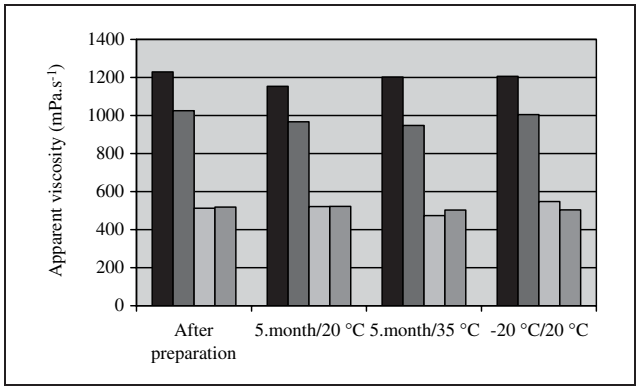

Fig. 1: Hydrogels: Apparent viscosity/storage temperature dependency ■ Carbomer hydrogel; ■ Carbomer hydrogel-placebo; □ Sepigel hydrogel; ■ Sepigel hydrogel-placebo

butylparaben, phenoxyethanol and imidazolidinyl urea. The β-(1,3)-glucan content was 1% (m/m) of the dry substance in all cases. All the types of topical preparations were prepared in a vacuum homogeniser Stephan UMC 5 (A. Stephan u. Söhne, GmbH & Co., Germany). Placebo samples without the β-(1,3)-glucan content were prepared in the same way. All samples were stored in PE bottles at 20 °C and 35 °C during a period of 5 months. Besides a triplicate freeze-thaw cycling process (−20 °C/+20 °C) was performed with the sample of each type of preparation. Rheological properties (share stress/share rate dependency, apparent viscosity) and physical stability of preparations with the β-(1,3)-glucan content vs. placebo were evaluated and compared after preparation and after 5 months of storage. They were measured by a Viscotester VT 500 (Haake Mess-Technik GmbH u. Co., Germany) at 20 °C, carrying out three parallel measurements. Apparent viscosity was measured and counted at a share rate 644.4 s^{-1}. All changes in rheological parameters mentioned in the text below were statistically significant.

According to the results obtained, it can be stated that all the preparations were stable during the monitored five-month-period. In the case of carbomer hydrogel the β-(1,3)-glucan presence affected the rheological properties of the preparation. It increased the apparent viscosity by 19.3 %. This rise also remained unchanged after 5 months of storage. A dependency on the temperature during storage was not observed.

In the case of polyacrylamide hydrogel not any effect of the β-(1,3)-glucan presence on rheological properties was observed. After 5 months of storage at 35 °C the apparent viscosity of β-(1,3)-glucan preparation decreased by 8.2%. Both carbomer and polyacrylamide hydrogels had plastic and pseudoplastic trait, carbomer gel also had tixotropic behaviour.

As for the polysorbate 80/Span 80™ body milk, the β-(1,3)-glucan presence increased the apparent viscosity by 10.3% after preparation and 16.7% after 5 months/ 20 °C of storage respectively. In this case we observed the effect of a triplicate freeze-thaw cycling process. This increased the apparent viscosity of β-(1,3)-glucan preparation by 20.2% and placebo by 2.9%. This body milk demonstrated rheopectic behaviour.

In the case of Brij creams we observed a similar effect of the freeze-thaw cycling process. It increased the apparent viscosity of β-(1,3)-glucan preparation and placebo by 30.4% and 20.1%, respectively. The presence of β-(1,3)-glucane in the preparation increased this viscosity by 21.9% after preparation, but there was not any significant difference after 5 months of storage regardless the storage temperature. Hydrocreams were tixotropic.

Incompatibilities and other effects on the stability and properties of preparations were not observed.

In conclusion we can state that with the exception of polyacrylamide hydrogel the β-(1,3)-glucan presence increased the apparent viscosity of the assessed preparations by approximately 10–20%. The effect of time and temperature during storage was not in general the same, what is probably connected with the different inner structure of the topical preparations.

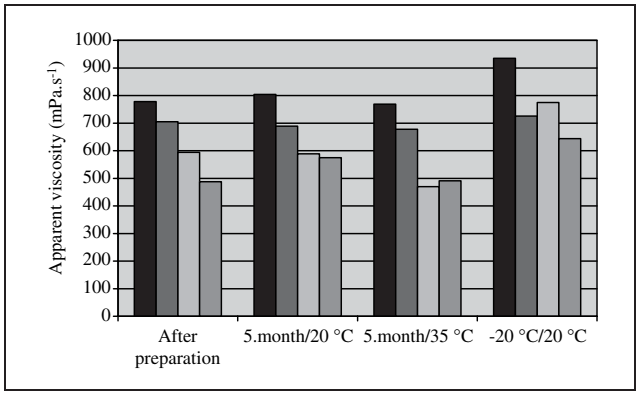

Fig. 2: Hydrocreams: Apparent viscosity/storage temperature dependency ■ Polysorbate/SPAN body milk; ■ Polysorbate/SPAN body milk-placebo; □ BRIJ hydrocream; ■ BRIJ hydrocream-placebo

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References

Böhm N, Kulicke WM (1999) Rheological studies of barley (1–3)(1–4)-β-glucan in concentrated solution: Mechanistic and kinetic investigation of the gel formation. Carbohydr Res 315: 302–311.

Burkus Z, Temelli F (2005) Rheological properties of barley β-glucan. Carbohydr Polym 59: 459–465.

Colleoni-Sirghie M, Kovalenko IV, Briggs JL, Fulton B, White PJ (2003) Rheological and molecular properties of water soluble (1,3)(1,4)-β-D-glucans from high-β-glucan and traditional oat lines. Carbohydr Polym 52: 439–447.

Davis WB (1992) Unique bacterial polysaccharide polymer gel in cosmetics, pharmaceuticals and foods. US 5, 158, 772.

Doublier JL, Wood PJ (1995) Rheological properties of aqueous solutions of (1,3)(1,4)-beta-D-glucan from oats (*Avena sativa* L.). Cereal Chem 72: 335–340.

Klein B (1999) β-D-glucan topical composition. WO 9,921,531.

Lee S, Warner K, Inglett GE (2005) Rheological properties and baking performance of new oat beta-glucan-rich hydrocolloids. J Agric Food Chem 53: 9805–9809.

Skendi A, Biliaderis CG, Lazaridon A, Izydorczyk MS (2003) Structure and rheological properties of water soluble β-glucans from cultivars of Avena sativa and *Avena bysantina*. J Cereal Sci 38: 15–31.