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SURFACE CHARACTERIZATION OF HYDROGEL-BASED MICROSPHERES

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INTRODUCTION: Microspheres with alginate as the main component are widely used in pharmacy, biotechnology, and medicine. Surface characteristics including roughness, charge, and mechanical properties may have a significant impact for applications where biocompatibility is a crucial requirement. Indeed surface imaging of hydrogels, in particular if they are spherical, is complicated due to the high water content and the curvature. AFM provides the possibility to obtain three-dimensional images of surfaces within an aqueous environment, at high resolution. In addition to imaging, the elastic properties can be evaluated by analyzing force-distance curves (1). Recent study aims at comparing surface topography and elastic properties of alginate-based microbeads and multi-component microcapsules prepared from various components under different conditions.

METHODS: Microbeads were manufactured by atomizing 1.5 wt% sodium alginate (SA) Keltone HV (Kelco, San Diego, USA), in PBS, with a coaxial-air-flow encapsulator. The droplets were gelled during 3 min in a bath containing 1.5 wt% $BaCl_2$ and 0.9 wt% NaCl (20°C). After gelling, Ba-alginate beads were washed three times in 0.9 wt% NaCl. The beads were stored in their washing solutions at 4^oC. Microcapsules were prepared from beads of 1.5 wt% SA/sodium cellulose sulphate (SCS), 1:1, gelled by reacting with 1.5 wt% $CaCl_2$ in 0.9 wt% NaCl (20°C) and subsequently transferred into 0.1 wt% poly(L-lysine) (PLL) or 1.2 wt% poly(methylene-co-guanidine) hydrochloride (PMCG) in 0.9 wt% NaCl (pH 7.4) to produce the capsule membrane (2). Capsules were rinsed three times with 0.9 wt% NaCl solution. Additional coating was performed using 0.15 wt% SCS (Acros Organics, Geel, Belgium) in 0.9 wt% NaCl during 10 min under gentle mixing.

A home built AFM (Institute of Nuclear Physics, Cracow) working in contact mode was employed. Measurements were performed with a standard "liquid cell" (NaCl 0.9%, at room temperature) and unsharpened Si_3N_4 cantilevers (Park Scientific Instruments, Switzerland). Their spring constant was 0.03 N/m for a tip radius of 50 nm. Roughness was calculated according to (3). Young's modulus was determined assuming a conical or parabolic shape for the AFM tip (4).

RESULTS: Surface scanning revealed remarkable differences of both surface roughness and Young's modulus. *Figure* 1 shows selected AFM images of two different types of microcapsules studied. (Note the difference in the gray scale.) The values of the average roughness and Young's modulus calculated for both microspheres and Ba-alginate microbeads are compared in *Table* 1.

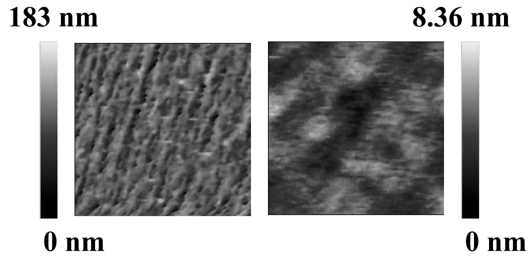

Fig. 1: AFM images of SA-based mocrosphere: SA/SCS//Ca//PMCG//SCS (left) and SA//Ca//PLL (right).

Table 1. Average roughness (AR) and Young's modulus (YM) of selected SA-based microspheres.

	AR (nm)	YM (kPa)
SA//Ca//PLL	1.18	1.04
SA//Ba	3.03	6.95
SA/SCS//Ca//PMCG// SCS	26.14	369

DISCUSSION & CONCLUSIONS: The study identified and quantified the influence of the components and preparation conditions on the morphology and elasticity of alginate-based microspheres and, therefore, the results may serve to adjust these parameters for specific applications.

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