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In many fields of science, the aim is to obtain structures characterized by small dimensions in the order of micro/nanometers. Small-sized systems are used in various industries such as cosmetology, medicine, and nutrition technology. One of the methods that allow obtaining small size systems is ultrasound treatment. Moreover, thanks to ultrasonic waves, also functionality and performance of the micro/nanomaterial can be altered. In this presentation we studied the influence of ultrasounds on size and chemosensory properties of microspheres sensitive towards lipophilic ions. An important aspect here is the time during which the ultrasounds were used.

Experimental

For the anion-selective system, the measurements were performed in 0.01 M HEPES buffer with pH 7.4, while the cation-selective system in 0.01 M Tris-HCl pH 9. To be able to work out the results in terms of the protonation degree of the chromo ionophore for the tested systems, 0.1M NaOH and 0.1M HCl were also used in the tests.

Confocal microscope

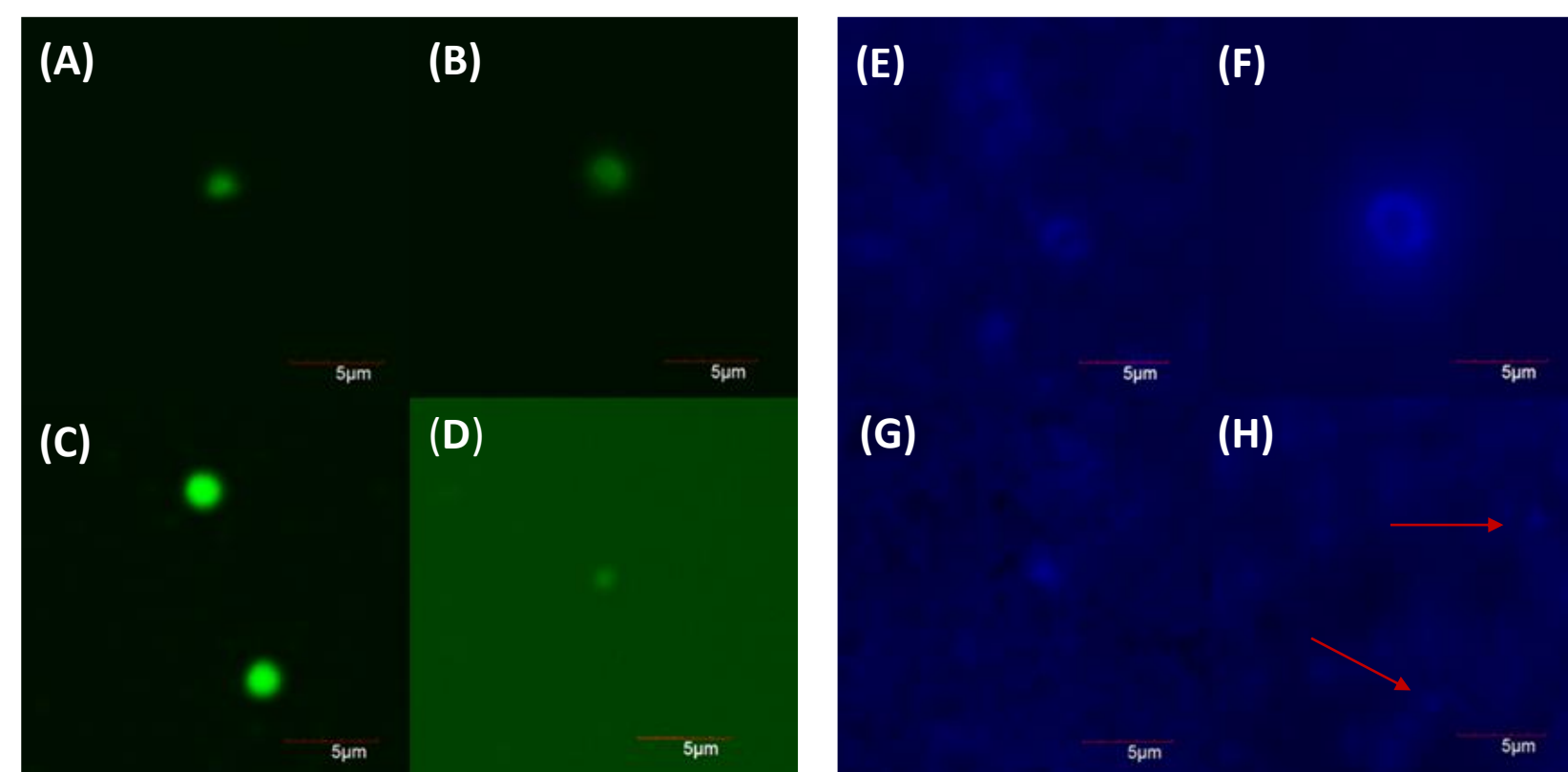


Figure 1 (left) Confocal microscope images of anion-selective microspheres:

(A) without the use of ultrasound;
(B) after 5 minutes under ultrasound;
(C) after 15 minutes under ultrasound;
(D) after 30 minutes under ultrasound.

Figure 2 (right) Confocal microscope images of cation-selective microspheres:

(E) without the use of ultrasound;
(F) after 5 minutes under ultrasound;
(G) after 15 minutes under ultrasound;
(H) after 30 minutes under ultrasound.

without us. 5 minutes us. 15 minutes us. 30 minutes us.

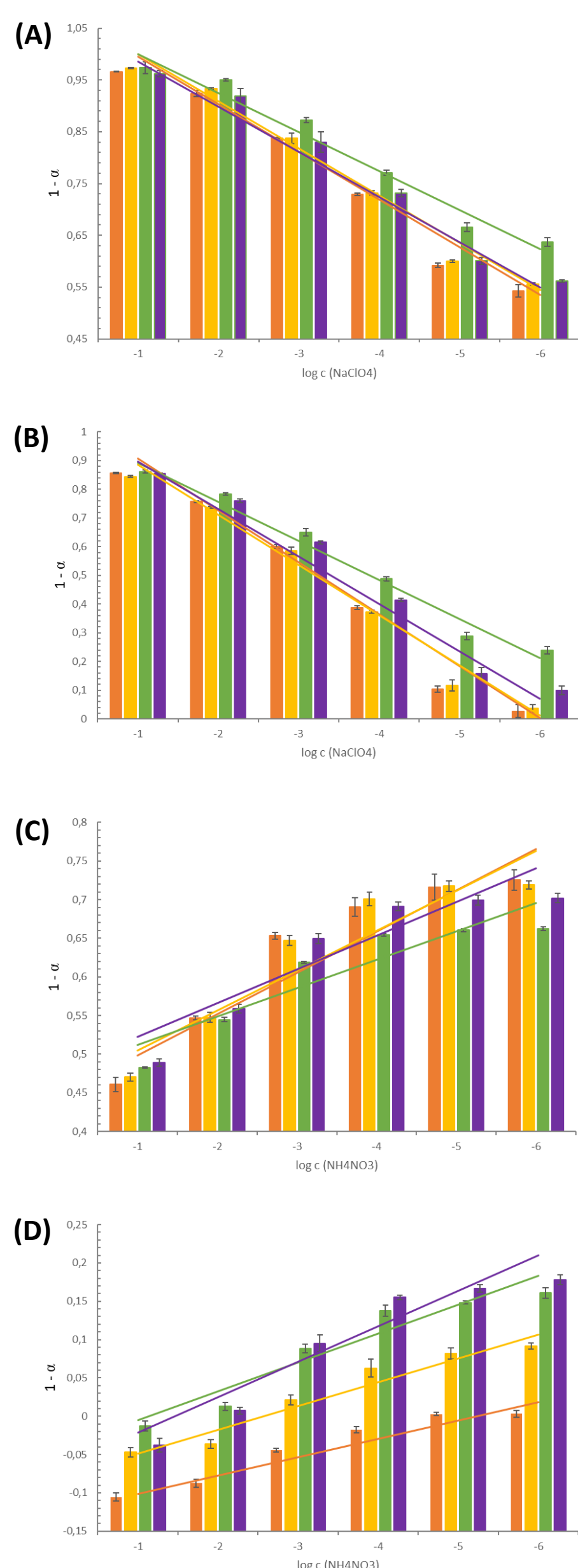


Figure 3 Protonation degree of chromoionophore in the presence of respective lipophilic ion for anion-selective microspheres (A,B), and cation-selective microspheres (C,D). Protonation degree was calculated based on spectrophotometric (A,C) and spectrofluorimetric (B, D) measurements.

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Results

Anion-selective

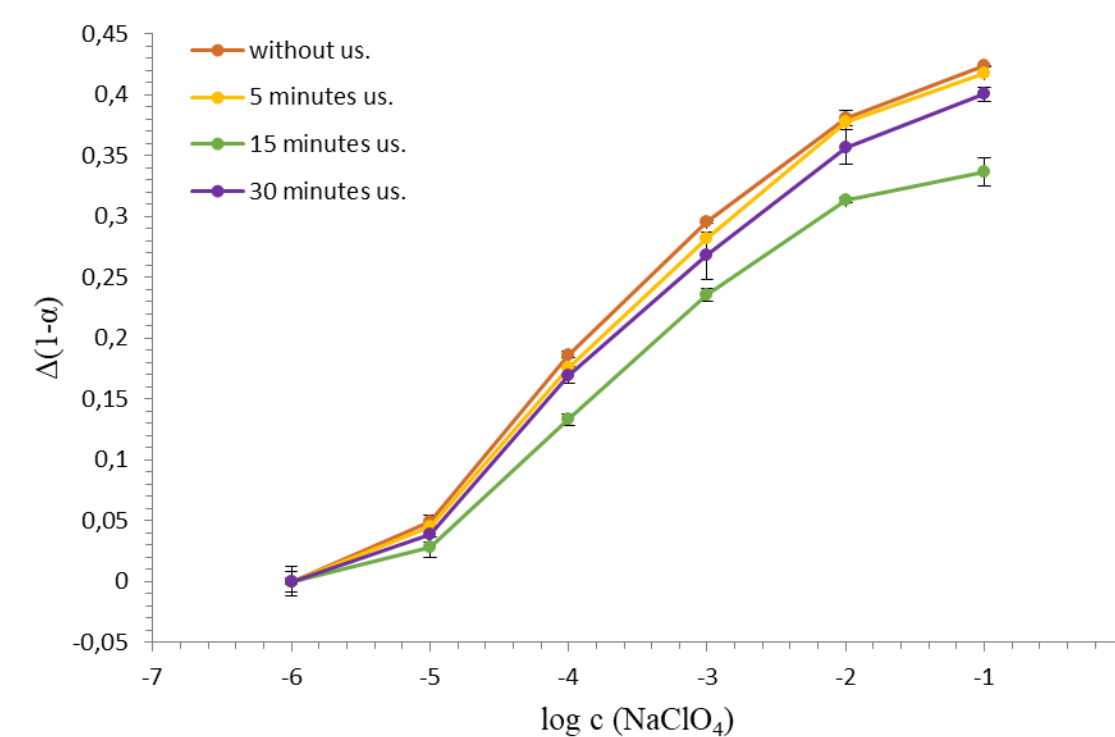


Figure 4 Spectrophotometric calibration towards perchlorates with a signal based on change of protonation degree of chromoionophore for anion-selective microspheres treated for different times with ultrasounds.

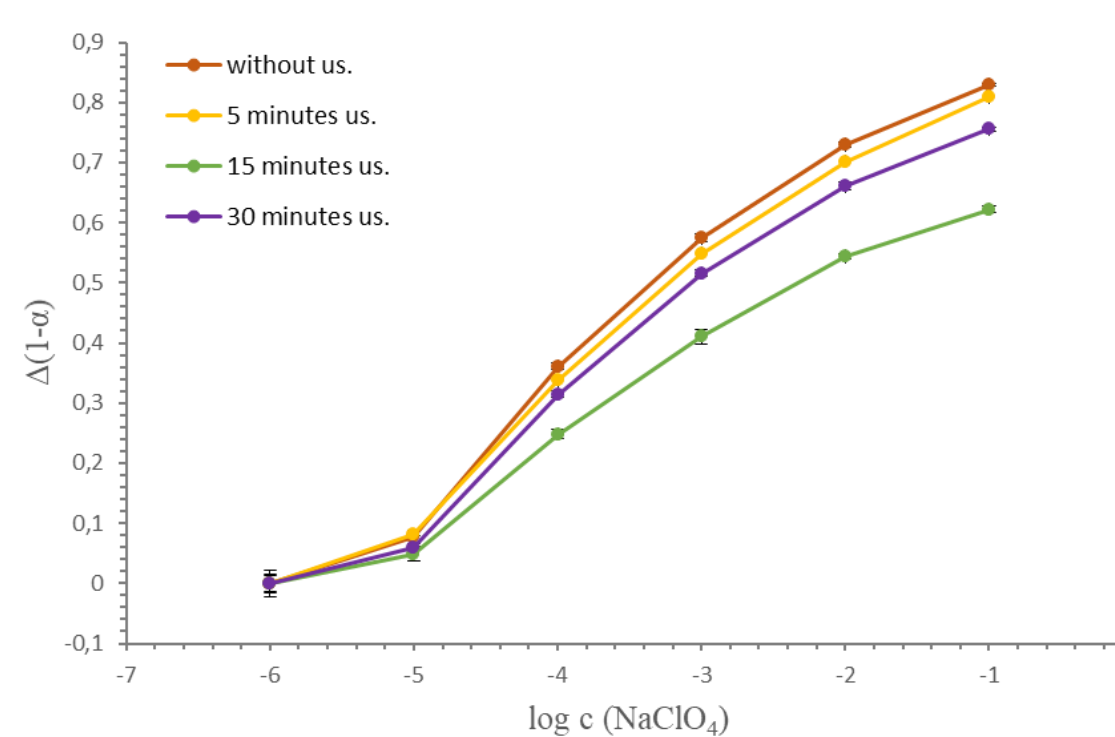


Figure 5 Spectrofluorimetric calibration towards perchlorates with a signal based on change of protonation degree of chromoionophore for anion-selective microspheres treated for different times with ultrasounds.

Cation-selective

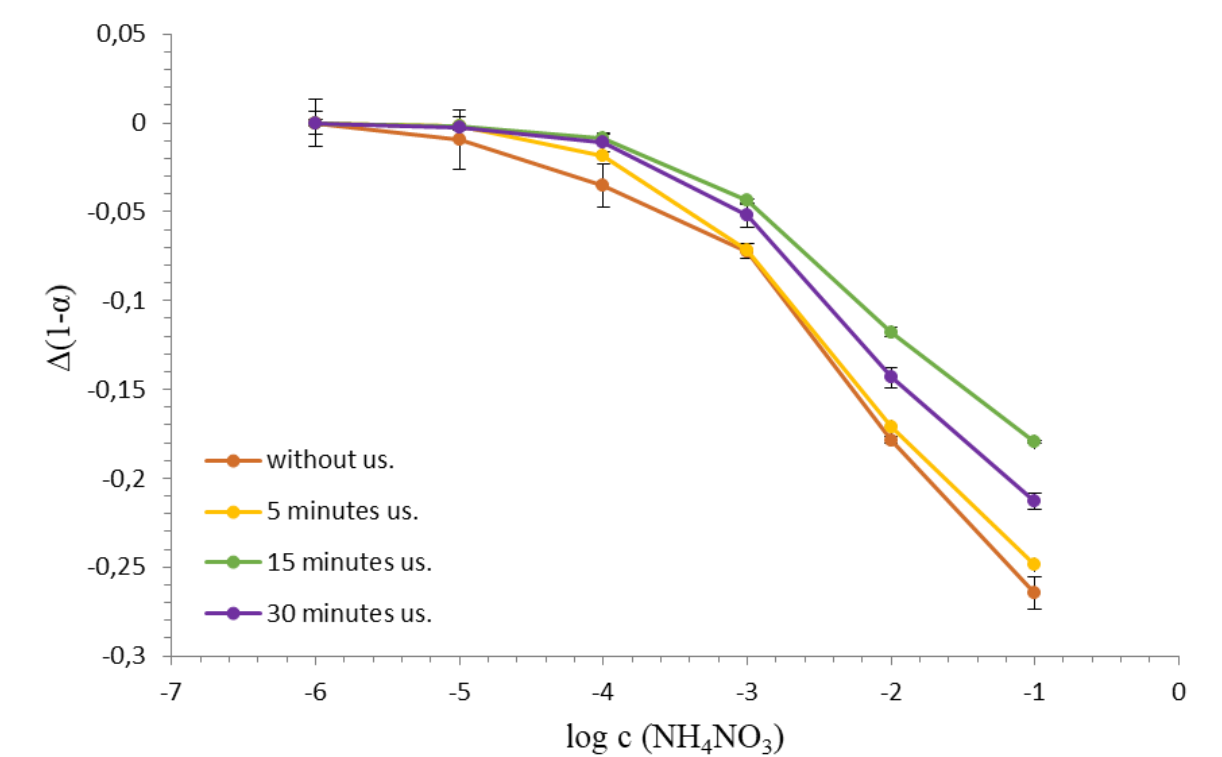


Figure 6 Spectrophotometric calibration towards ammonium cations with a signal based on change of protonation degree of chromoionophore for cation-selective microspheres treated for different times with ultrasounds.

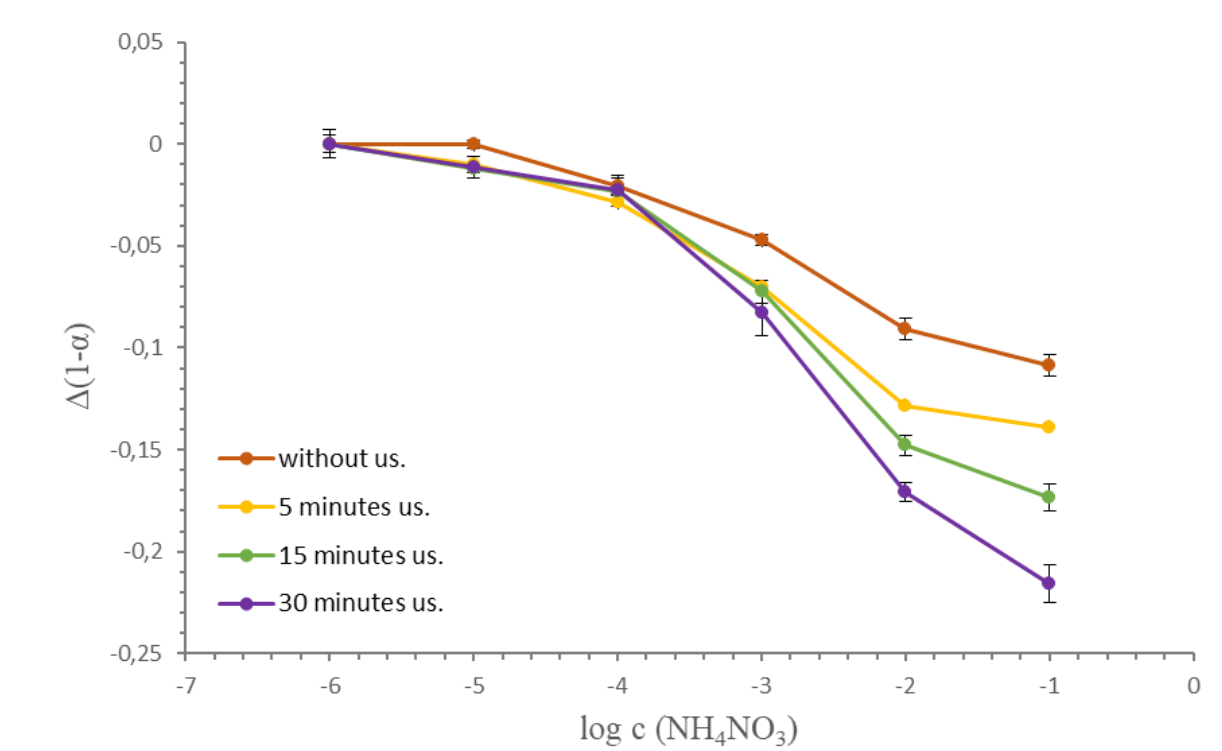


Figure 7 Spectrofluorimetric calibration towards nitrates with a signal based on change of protonation degree of chromoionophore for cation-selective microspheres treated for different times with ultrasounds.

Conclusions

Summarizing the obtained results:

- for both the anion and cation-selective microspheres, the size of the spheres was reduced after 30 minutes of ultrasound compared to the remaining times; generally, the size of the microspheres is in the range of 2-5 μm
- ultrasound affects the linearity range and sensitivity of both types of microspheres
- the effect of ultrasound is visible both in the case of spectrophotometric and spectrofluorimetric measurements
- ultrasounds reduce the sensitivity and linearity range for anion-selective microspheres at 15-30 minutes for both spectrophotometric and spectrofluorimetric measurements
- the reduction of the sensitivity and range of linearity is also visible in the case of cation-selective microspheres, but only in the case of spectrophotometric measurements
- the use of ultrasounds, especially for a long time, significantly increases the sensitivity and linearity range of cation-selective microspheres in spectrofluorimetric measurements