

## SUMMARY OF THE PHD THESIS

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### INVESTIGATION OF SPONTANEOUS REACTIONS OF CHIRAL INVERSION AND PEPTIDIZATION WITH THE SELECTED PROTEINOGENIC AMINO ACIDS

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The aim of this PhD thesis was investigation of the oscillating reactions of amino acids carried out *in vitro*, with the amino acids dissolved in aqueous or aqueous-organic solutions and kept under the mild external conditions (i.e., at  $21\pm 2^\circ\text{C}$ , normally considered as the room temperature). This investigation demonstrated susceptibility of the examined amino acids to spontaneously undergo the enantiomerization and condensation processes. Moreover, it was shown that the spontaneous chiral inversion and condensation take place in the parallel.

Investigations with use of the thin-layer chromatography coupled with mass spectrometry (TLC-MS) demonstrated the parallel processes of spontaneous enantiomerization and condensation with such amino acids, as *L*-cysteine and *L*-methionine. Moreover, enantiomerization of *L*-methionine was confirmed with use of polarimetry. Condensation of these two amino acids was also demonstrated with use of the high-performance liquid chromatography (HPLC) applied in continuous mode. Application of continuous mode to tracing concentration changes of the amino acids of interest pointed out to the non-linear nature of these processes, whereas the presence of the newly formed peptides was confirmed with use of the high-performance liquid chromatography coupled with mass spectrometry (MS).

Similar investigations with use of HPLC-DAD and HPLC-ELSD were carried out for *L*-phenylalanine, *L*-phenylglycine, and the binary solutions of *L*-phenylalanine-*L*-hydroxyproline, *L*-cysteine-*L*-phenylalanine, and *L*-cysteine-*L*-phenylglycine. Amino acids in the binary systems also undergo the oscillating concentration changes, yet with the amplitudes different from those observed in the monocomponent solutions.

In the course of the studies, it was shown that the peptides spontaneously formed in the solutions self-organize into the peptide nano- and microstructures, and the shape of these structures depends on the functional groups of amino acids. Owing to its thiol group, cysteine is able to form the disulfide bridges and assume spherical structures, while the phenylalanine-derived peptides organize in the micro- and nanofibers. Investigation of peptide structures was carried out with use of the scanning electron microscopy (SEM). At an initial stage, the precipitation of peptide structures was monitored with use of turbidimetry. Owing to application of this technique, it was shown that certain *L*-amino acids assume the circadian rhythm of the oscillations, which does not happen with their *D*- or *DL*-counterparts.

Peptide structures originating from the spontaneous oscillatory reactions of amino acids could probably find applications in nanotechnology, nanobiotechnology, and nanomedicine.