Sensitive lateral flow test strips for rapid on-site control of authenticity and composition of meat products

Elena A. Zvereva, Olga D. Hendrickson, Demid S. Popravko, Anatoly V. Zherdev, Boris B. Dzantiev

A.N. Bach Institute of Biochemistry, Federal Research Centre «Fundamentals of Biotechnology» of the Russian Academy of Sciences, Moscow, Russian Federation

Introduction: Immunochromatographic analysis (ICA) is an efficient approach to estimate the composition of food products. Test strips for the ICA contain immobilized immunoreagents at different zones of multimembrane composites. Therefore, a contact of the test strip with the sample initiates all interactions. The given approach is successfully applied in the industry of meat products (mainly, to authenticate halal foodstuffs). However, limitations of its use for the identification of different species and quantitative estimation of meat composition are poorly characterized. In the present study, the use of skeletal troponin I, myoglobin, and immunoglobulins as species-specific biomarkers is considered and the developed ICAs are characterized and validated.

Materials and methods: The development of test strips included synthesis and characterization of conjugates between gold nanoparticles (AuNPs) as a label and specific antibodies, manufacturing multimembrane composites using different concentrations of reactants and immobilization conditions, and application of the optimized variants for testing raw and processed meat products. The assay results were assessed by scanning test strips and digital processing of the obtained images to estimate the intensity of bands' coloration.

Results: The combinations of antibodies with different specificity were selected for different tasks of authentication. Thus, the skeletal muscle protein troponin I was used as thermally stable and species-specific biomarker of mammalian muscle tissues. As a result of the developed sandwich ICA, it was demonstrated that the detection limit of troponin I was 25 ng/mL. The specificity of the used antibodies allowed distinguishing mammalian meat products (beef, pork, and lamb) from poultry (chicken, turkey, and duck) ones. The possibility of detecting beef additives in minced chicken down to 1% was demonstrated.

Chicken immunoglobulins Y were used as an efficient molecular identifier of poultry meat. They are present in tissues at high concentrations, can be easily extracted and allow the differentiation of poultry (chicken, turkey) and animal meat sources. The developed ICA can be completely implemented (including sample preparation) within 20 min. Its use to analyze meat foodstuffs demonstrated revealing an adulteration with up to 0.063% (w/w) sensitivity. Another test system based on porcine IgG biomarkers allowed revealing pork adulteration in beef with the detection limit of 0.1% (w/w). The developed test systems were characterized by high reproducibility; the RSD values did not exceed 14.7%. The assay protocols were successfully validated in testing raw meat and meat-based products, including various kinds of sausages and dumplings.

Conclusions: The developed techniques may be considered as an effective means of controlling the authenticity and quality of meat products.

This investigation was financially supported by the Russian Scientific Foundation (project No 19-16-00108).

Acknowledgements and Financial support statement: This investigation was financially supported by the Russian Scientific Foundation (project No 19-16-00108).