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Metals interaction with DNA and its characterization by MALDI-TOF MS

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Introduction

The interaction between biomolecules and metals plays a very important in omics sciences (metallomics and metalloproteomics) and is related to other areas of research such as biochemistry, environmental sciences, and medicine. In this context, the combination of several techniques and methodological procedures can provide great information on the study of the interaction of metal with various types of biomolecules.[1] Viewed in this way mass spectrometric techniques are the most suitable for the development of analytical procedures that allow obtaining simultaneous information on the characterization and quantification of a molecule, which can be applied to studying metal-biomolecule interactions. Particularly, matrix-assisted laser desorption/ionization and electrospray mass spectrometry (MALDI-MS and ESI-MS) have been focused on the study of interactions of several metals with molecules of low (carbohydrate, lipids, and amino acids) and high (proteins, DNA, RNA, and polymers) molecular weight.[2] Generally, ESI-MS and MALDI-MS are suitable due to their high sensitivity and reproducibility, however, the use of MALDI-MS is preferred due to the possibility of simultaneous and automated analysis of many samples in a short time, which facilitates the study of the metal-biomolecule interactions.[3–5]

In general, the analysis of nucleic acids by mass spectrometry with MALDI ionization and time of flight how mass analyzer (MALDI-TOF MS) has been little studied compared with proteins, in this context, the DNA can be analyzed in positive and negative modes, although the negative mode is preferred due to the density of this charge on the surface of the DNA molecules. In this sense, MALDI-TOF MS has been employed extensively for oligonucleotide studies, which shows good performance for its detection. In this respect, Heetebrij et al.[6] have reported the typical sample amounts required are in the low picomole range, and laser vaporization of intact single-strand DNA molecules of ~100 bases. Furthermore, MALDI-TOF MS spectra of protein-DNA complexes have been reported by Ji et al.[7] Based on this, metal-oligonucleotide interactions, especially with the anti-tumoral cis-platinum complex, are of utmost importance. In this regard, Bruchert et al.[8] reported a study *in vitro* for the analysis of oligonucleotide-cisplatin interactions by MALDI-TOF MS; in this work, Bruchert et al.[8] proposes the use of MALDI-TOF MS as a complementary strategy to characterize the structure of the metal-adducts generated. Likewise, other MALDI-TOF MS applications, such as bacterial genotype analysis[9] and monitoring of DNA modifications, could allow the study of dysregulation of the replication DNA process.[10]

On the other hand, the binding modes of DNA-ruthenium complexes with MALDI-TOF MS were investigated by García-Fernandez et al; likewise, reaction products between Pt(II) complexes and DNA constituents, were also characterized by MALDI-TOF MS.[11] Three new Pt-complexes were recently obtained by reacting an alanine derivative (*Tiox-Ala*) with K_2PtCl_4; in this work, MALDI-TOF MS was used for the characterization of *Tiox-Ala*-based Pt(II)-complexes.[12]

Conclusion

Finally, compared to techniques such as UV spectrophotometry,[13] NMR spectroscopy, X-ray diffraction[14] and biochemical techniques analysis of the interactions of DNA with metals by mass spectrometry, mostly with MALDI-TOF MS, requires less time and smaller amounts of analyte. Also, MALDI-TOF spectra are acquired in a few seconds. Lastly, the desorption of intact monocharged DNA molecules by MALDI-TOF MS makes this analytical technique successful for studies of DNA-metal complexes.

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None.

Conflicts of interest

The author declared that there are no conflicts of interest.

References

1. Da Silva MA, Sussulini A, Arruda MA. Metalloproteomics as an interdisciplinary area involving proteins and metals. *Expert Rev Proteomics.* 2010;7(3):387–400.
2. Vladimir G. Zaikin, Borisov SB. Options of the main derivatization approaches for analytical ESI and MALDI mass spectrometry. *Crit Rev Anal Chem*. 2022;52(6):1287–1342.
3. Petković M, Kamčeva T. FAB, ESI and MALDI Mass Spectrometric methods in the study of metallo- drugs and their biomolecular interactions. *Metallomics*. 2011;3(6):550–565.
4. Lai YH, Wang YS. Matrix-assisted laser desorption/ionization mass spectrometry: mechanistic studies and methods for improving the structural identification of carbohydrates. *Mass Spectrom.* 2017;6(3):S0072.
5. Krasnići N, Dragun Z, Kazazić S, et al. Characterization and identification of selected metal-binding biomolecules from hepatic and gill cytosols of Vardar chub using various techniques of liquid chromatography and mass spectrometry. *Metallomics.* 2019;11(6):1060–1078.

6. Heetebrij RJ, de Kort M, Meeuwenoord NJ, et al. A versatile approach towards regioselective platinated DNA sequences. *Chemistry.* 2003;9(8):1823–1827.

7. Ji S, Shao H, Han Q, et al. Reversible DNA–Protein Cross-Linking at Epigenetic DNA Marks. *Angew Chem Int Ed Engl.* 2017;56(45):14130–14134.

8. Brüchert W, Krüger R, Tholey A, et al. A novel approach for analysis of oligonucleotide–cisplatin interactions by continuous elution gel electrophoresis coupled to isotope dilution inductively coupled plasma mass spectrometry and matrix-assisted laser desorption/ionization mass spectrometry. *Electrophoresis.* 2008;29(7):1451–1459.

9. Sauer S, Freiwald A, Maier T, et al. Classification and identification of bacteria by mass spectrometry and computational analysis. *PloS one.* 2008;3(7):e2843.

10. Bellido ML, Radpour R, Lapaire O, et al. MALDI-TOF mass array analysis of RASSF1A and SERPINB5 methylation patterns in human placenta and plasma. *Biol Reprod*. 2010;82(4):745–750.

11. Bugarčić ŽD, Soldatović T, Jelić R, et al. Equilibrium, kinetic and HPLC study of the reactions between platinum (II) complexes and DNA constituents in the presence and absence of glutathione. *Dalton Transactions*. 2004;22:3869–3877.

12. Riccardi C, Capasso D, Rozza GM, et al. Synthesis, antiproliferative activity, and DNA binding studies of nucleoamino acid-containing Pt(II) complexes. *Pharmaceuticals.* 2020;13(10):284.

13. Ali S, Chaspoul F, Anderson L, et al. Mapping fifteen trace elements in human seminal plasma and sperm DNA. *Biol Trace Elem Res.* 2017;175(2):244–253.

14. Kumari N, Mishra L. *Ruthenium Chemistry.* Approaching cancer therapy with ruthenium complexes by their interaction with DNA. 2018. pp. 45.

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