

An experiment for undergraduate students: Element analysis of dietary supplements using a nitrogen microwave inductively coupled atmospheric-pressure plasma optical emission spectrometer (MICAP-OES)

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Quantitative analyses are a major part of analytical chemistry in academia, public service, and industry. Incorrect analyses can end in false conclusions in research, losses of production or for example incorrect drug compositions and therefore may have severe health consequences, respectively. Thus, laboratory experiments for quantitative analyses should be a part of academic education in chemistry and related sciences and train student in matters of related theory and practice.

A large portion of the considerable running costs of ICP-OES are caused by the required supply of argon as plasma gas, whereas the use of a nitrogen-based microwave inductively coupled atmospheric-pressure plasma optical emission spectrometer (MICAP-OES)[1,2] is more affordable and well-suited for lab courses in undergraduate education.

Some educational activities were presented in which nitrogen plasmas sources have already been presented for element analyses: Ricca et al. used a microwave plasma to identify cereal brands based on their element composition[3] and Muna reported on soil analyses using microwave plasma atomic emission spectroscopy.[4]

We present a new laboratory experiment in which students use a N₂MICAP-OES to determine several elements in dietary supplements and other consumer products. In contrast to most other lab experiments carried out in typical analytical lab courses, this experiment was designed so that students could and should follow their own approach to the task. Experimental details were not provided to the students in advance. Appropriate procedures included dissolving the sample and acid digestions that students could perform within the given time frame of 4 hours. We also show various ways in which the experiment can be adapted to provide different emphases on samples, sample preparation, calibration, the use of internal standards, and spectral interference. An evaluation revealed that this experiment was well received by students, but they asked for a more detailed handout.

- [1] A.J. Schwartz, Y. Cheung, J. Jevtic, V. Pikelja, A. Menon, S.J. Ray, G.M. Hieftje, *J. Anal. Atom. Spectrom.*, **2016**, *31*, 440-449, doi: 10.1039/C5JA00418G.
- [2] H. Wiltsche and M. Wolfgang, *J. Anal. Atom. Spectrom.*, **2020**, *35*, 2369-2377, doi:10.1039/DOJA00293C.
- [3] J.G. Ricca, B.G. Duersch, T.S.S. Plaza, J.E. Haky, *J. Chem. Educ.*, **2022**, *99*, 994-999, doi: 10.1021/acs.jchemed.1c00745.
- [4] G.W. Muna, *J. Chem. Educ.*, **2021**, *98*, 1221-1226, doi: 10.1021/acs.jchemed.0c01326.