DERRINGER’S FUNCTION FOR MULTIVARIABLE OPTIMIZATION IN ICP-AES ANALYSIS OF PLATINUM GROUP METALS

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It is well known that platinum group metals (PGMs), like platinum, palladium, rhodium, ruthenium, iridium and in addition gold exhibit increasing usage in anthropogenic activities, especially due to their catalytic and anticancer properties. Consequently, a sensitive multi-element method for the determination of these six analytes was developed and optimized. The Derringer’s function was employed for simultaneous multi-elemental optimization, for first time for this group of analytes by the ICP-AES technique. The employment of the desirability function limited the necessity to make compromise for simultaneous multi-elemental optimum settings, providing a reliable answer to this type of problem. Four parameters which affect the atomization process were studied, namely radiofrequency power, nebulizer gas flow rate, auxiliary gas flow rate and sample flow rate. Response Surface Methodology (RSM) (see figure) with a Central Composite Design (CCD) was used to evaluate the performance, construct prediction mathematical models and optimize, using the desirability function, the atomization conditions. Second order polynomials were constructed and their power for prediction was evaluated. Response surfaces and Pareto charts (see figure) revealed the effect that every selected parameter and their interactions have on the determination of the six analytes. Validation study was performed under optimized conditions including linearity, recovery, precision, limits of detection and quantification for all six elements. The method was applied on serum, wood pellets and roadside soil samples after digestion in stainless steel closed vessels.

Keywords: platinum group metals; optimization; experimental design; operating conditions; response surface methodology; derringer function;