Determination of Heavy Metals in Wine using simultaneous ICP-OES with Mini Torch

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Figure 1 : Grapes – the source of red wine

Introduction

Wine is one of the oldest cultural products in human history. Vines have been cultivated for over 8000 years. The oldest known archaeological evidence of winemaking is an 8000-year old wine- and fruit press found near Damascus. Awareness of the medicinal effects of wine also date back to this time. Hippocrates (460 – 377 B.C.) recommended wine diluted with water as a remedy against headaches and digestive disorders.

Winemaking is a rather simple process: freshly harvested grapes are crushed and the resulting juice (must) is collected. The must contains fermentable sugars and natural yeasts which, either by themselves or with the help of additional yeast cultures, start the fermentation process in which mainly ethyl alcohol and carbon dioxide are formed. The latter is a gas and escapes from the must. The fermentation process comes to a halt when all of the sugars are fermented or the alcohol concentration becomes too high and kills off the yeasts. At this point the must has turned into wine.

Spectroscopic methods for quality assurance

A meticulous quality control procedure is essential, and during each stage of the production process spectroscopic methods such as AAS-, ICP-, FTIR-, and UV-VIS spectroscopy are applied for quality assurance or for product characterisation. For the quantitative determination of essential elements such as potassium, sodium, calcium and magnesium, as well as heavy metals such as lead, arsenic, and cadmium, the ICP spectrometry is the method of choice, since a simultaneous instrument, such as the ICPE-9000 allows a fast and precise analytical procedure.

Quality Standards

The quality standards are fixed in the national wine regulations such as the German „Weinverordnung“ (Bundesgesetzblatt Teil 1 Nr. 32) from 22nd May 2002, which includes the classification of wines from different locations but also the production process, alcohol concentrations and the maximum allowable concentrations of the elements as listed in Table 1.

Element	Max. Concentration [mg/L]
Al	8,00
As	0,10
B	80,00
Cd	0,01
Cu	2,00
Pb	0,25
Sn	1,00
Zn	5,00

Table 1: Maximum allowable concentration of elements in wine

For quantitative determination of the elements in the required concentration range, ICP is the most preferable tool for quality control because of a high sensitivity, a wide dynamic range and a high sample throughput. Figure 2 shows the new simultaneous ICPE-9000 with CCD (charge-coupled device) detector, which has been used for all determinations. This system configuration is equipped with a unique optical system which sets new standards with respect to performance and speed and can be optimized for a wide variety of different applications. The vacuum systems allows precise analysis of elements in the lower UV range under extremely stable conditions.

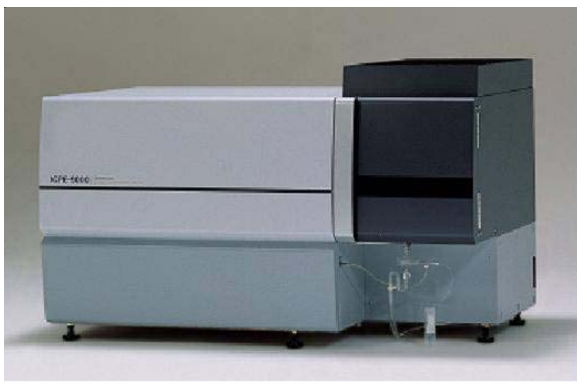

Figure 2: ICPE-9000 with Mini Torch

The system setup for determination of low concentration heavy metals in wine has been optimized using the mini torch and the ultrasonic nebulizer. The wine samples have been diluted 10 times, and aspirated in the same way as aqueous solutions in the cyclone chamber. The standard solutions have been prepared including ethanol in order to match the matrix.

Model	ICPE-9000
Radio frequency: Output:	1.2 (kW) (coaxial nebulizer) 1.0 (kW) (ultrasonic nebulizer)
Cooling gas: flow rate:	10 (L/min) (coaxial nebulizer) 8 (L/min) (ultrasonic nebulizer)
Plasma gas flow:	0.6 (L/min)
Carrier gas flow:	0.7 (L/min) (coaxial nebulizer) 0.6 (L/min) (ultrasonic nebulizer)
Sample: Introduction:	coaxial nebulizer ultrasonic nebulizer
Chamber:	Cyclone chamber

Table 2: Intensities of Cd and Fe at selected wavelengths

Conclusion

For the element analysis, ICP-OES is the „state of the art“ tool for the daily routine in quality control of wine samples. The ICPE-9000 is flexible enough to prepare the system configuration in order to achieve calibration ranges as low as 1 to 10 ppb.