Title
The complete relevant inorganic spectrum of wine. First results on sources of the stable isotope cesium-133 in red wine as an experiment in metabolic environmental ecology

I want to submit an abstract for:
Conference Presentation

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Keywords
Red wine, MH-ICP-MS, inorganic elemental analysis, cesium-133, nuclear power plants, vineyard, geogenic and anthropogenic sources.

Research Question
To explore the contributions of elements such as stable isotope of cesium-133 in wine that derive from various environmental related sources such as closeness of vineyard to nuclear power plants.

Methods
Wine samples were diluted 1:10 with with ultrapure-water. All prepared samples, standards, and controls were acidified and internal standards Li:Ge:Rh:Th were added. All measurement were performed using MH-ICP-MS.

Results
Results show that the vicinity of vineyards and wineries to nuclear power plants renders higher concentrations of the stable isotope of Cs-133 in red wines examined.

Abstract
INTRODUCTION: Most elements of the elemental periodic table are contained in wine. The purpose of our comprehensive ongoing project is to explore the contributions of elements in wine that derive from various environmental related sources and/or from production procedures performed by the wine grape grower and the
wine maker. In general, there are various sources such as soil, climate, grape variety, and water of, for instance, metals in wine [1]. Quality of produced wine can be affected by two main sources i.e. geogenic - due to natural phenomena - and anthropogenic, i.e. human-made activities. To date more than 1500 wines representing more than 900 producers, 100 grape varieties, and 34 countries have been sampled. They include a variety of wines incorporated into Constellation Brands, E&J Gallo, Pernod-Ricard, The Wine Group, and Treasury Wine Estates, and hundreds of family and corporate-owned wineries from around the world. All sampled wines are accompanied by wine name, rating, average price, whether red or white varietal, appellation, county, district, province (or US state), winery, vintage, alcohol content, GPS coordinates (vineyard and/or winery), geological information, fermentation/storage information, organic certification, and biodynamic farming practices. The resulting data will inform environmental sustainability and health practices. In this study, the focus was directed only toward the stable isotope of cesium-133 (Cs-133) in red wine to investigate, for example, the concentrations of cesium-133 in red wine produced by wineries located in the vicinity of nuclear power plants as evidence of the relationship that the local environment has to vineyard ecology. Cesium is a metal located in the first group and the 6th period of the elemental periodic table, and while it has several isotopes, only Cs-133 is stable, yet is a byproduct nuclear power plant activities.

MATERIALS AND METHODS: To obtain the absolute total concentrations of numerous inorganic elements quantitatively and simultaneously, a Mattauch–Herzog inductively coupled plasma - mass spectrometer (MH-ICP-MS) was used. Red wine samples: 214 red wine samples were collected from their original wine bottles produced in France (133), Chile (32), Argentina (28), Brazil (9), Mexico (7), Uruguay (4), and Peru (1). 10-14 mL of wine were transferred into 15 mL previously acid cleaned with 2% (v/v) Suprapur® 65% HNO3 (analytical-reagent grade, Merck, Germany) conical centrifuge tube (high-density polyethylene (HDPE) tubes from Fischer Scientific) and stored in a fridge at 4°C prior to analysis using MH-ICP-MS. Red wine samples preparation: Considering an average of 12% alcohol content in red wines, all samples were diluted 1:10 with ultrapure water (18.2 MΩ cm; ELGA, Purelab®Ultrapure Water Purification Systems, Buckinghamshire, UK). All prepared samples, calibration standards, and controls were acidified to 2% (vol/vol) using Suprapur® 65% HNO3 and mix of four internal standards of 6Li (enriched lithium), Ge, Rh, and Th (all from Inorganic Ventures, Christiansburg, VA, U.S.A) at the concentration of 100, 50, 20, and 20 µg/L, respectively were added as well. To matrix match of calibration standards and controls to the wine samples, ethanol was added at the concentration of 1.2% (vol/vol). MH-ICP-MS Analysis: Our recent developments in MH-ICP-MS, its calibration standards, and methods was used to determine the total concentrations of ~ 65 inorganic elements simultaneously in red wine samples. To realize this innovation, there were numerous obstacles to overcome, the methodological details of which have already been described and published [2]. The methods were developed further [3] to permit measurements of concentrations of ~ 65 elements across the complete inorganic spectrum, from lithium to uranium, with high sensitivity from small sample volumes (less than 750 µL), in seconds, and at lower costs than conventional technologies. To take possible variability of the ICP-MS conditions into account while performing wine samples analysis, four internal standards were used for various mass ranges [3]. MH-ICP-MS was optimized and tuned each time for its performance within the entire breadth of the chemical periodic table, i.e., from Li to U using 1:500 diluted of Merck VI multi-element standard solution (Merck, Darmstadt, Germany) to achieve maximum sensitivity. To check the repeatability of analyses, in addition to spiked solutions, various single and multi-element standard solutions were analyzed in the beginning and after every six samples in each set of samples run.

As a measure of precision, a correlation coefficient greater or equal to R2 = 0.996 was achieved for results to be accepted. Readings of the blank and at least two calibrations standards were plotted, and the influence of potential interferers were also factored in. Mean values of three consecutive MH-ICP-MS measurements, standard deviation, and relative standard deviation were recorded for the analyzed element. All samples were introduced to the MH-IPC-MS via a programmable Cetac Autosampler (ASX-560, Teledyne Cetac Technologies, U.S.A) to avoid errors in manual introduction.

RESULTS AND DISCUSSION: Obtained results show that in some cases the distance of the vineyard and winery to nuclear power plants is correlated with the concentration of Cs-133 in the analyzed red wines. A range of 10.2 – 77.0 µg/L was observed for elevated concentration of cesium-133 where the vineyards were located at the maximum distance of approximately 150 km from nuclear power plants. While, this range was decreased to 0.52 – 9.47 µg/L for the wines produced by winery located at more far away from these power plants. The average
The concentration of Cs-133 from all analyzed red wine samples was 5.66 µg/L. The results of this pilot study showed that how wine is sensitive to its environment. Although some issues such as gastrointestinal distress, hypotension, syncope, numbness, or tingling of the lips were reported in relation to cesium toxicity, this element is relatively safe. However, concentrations do represent extraordinary sensitivity of grape vines to their local environment. Cs in Czech wine [4] ranged 0.02–59.3 µg/L with an average of 6.3 µg/L was reported. In another study of South African wines, Cs ranged 0.30 – 6.71 µg/L with an average of 1.53 µg/L was reported based on 120 analyzed wine samples [5]. In other cases we have observed, vineyard distances from nuclear power plants is not related to Cs-133, but is rather attributed to fallout and hydrological and soil conditions.

CONCLUSION: Elemental signature in wines produced from vineyards in the vicinity of nuclear power plants was observed for the stable isotope of cesium-133. The possibilities inherent in having knowledge of the complete inorganic spectrum in environmental chemistry and toxicology can be employed by biomedical and ecological researchers as an approach they can apply to their own fields.

REFERENCES:

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