GRAPEVINE ACCUMULATION OF POTENTIALLY TOXIC ELEMENTS FROM VINEYARD SOIL

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Introduction

Nowadays, foodborne diseases have a major impact on human health. Xenobiotics are a significant cause of foodborne illness, although effects are often difficult to link with a particular food or agricultural area. Contaminants in agricultural soil and plants usually include fertilizers and pesticides (WHO). One of the most important steps in preventing contamination of agricultural products is monitoring of major and trace element content, which present in excess could be toxic. Variations of the physico-chemical conditions of major and trace elements as well as soil can influence the release of these elements (Filgueiras et al., 2002). Trace metals and other elements in soils and plants may affect human health through the inhalation of dust, ingestion of soil, dermal contact, or consuming products from agricultural field contaminated by trace element (Morel et al., 1997; Kabata - Pendias and Pendias, 2001). This experiment was performed to investigate bioavailability fractions from vineyard soil, and accumulation in different parts of grapevine (seed, skin, pulp and leaf).

Methods

The "Oplenac" Wine Route is well known region for vine growing, in the vicinity of "Topola" city, 80 kilometers away from Belgrade, the capital of Serbia. The topsoil (0-30 cm), grape leaves and grapevine samples were collected from 26 sampling sites in the vineyard, during grapevine season of 2015. Bioavailable elements from the soil samples were extracted with four different single extraction procedures: 0.11 mol L^{-1} CH_3COOH during 16 h extraction, 0.01 mol L^{-1} $CaCl_2$ during 3 h extraction, 1 mol L^{-1} NH_4NO_3 during 2 h extraction and distilled water during 2 h (Quevauviller, 1998) and 16 h. Distilled water extraction of 16 h was tested as an alternative single extraction process for toxic elements from vineyard soils. Leaf and grape samples were digested in a microwave digester, with 1 mL of 30 % H_2O_2 and 7 mL of 65 % HNO_3. Eight potentially toxic elements (Al, B, Cu, Fe, Mn, Ni, Sr and Zn) were determined using inductively coupled plasma optical emission spectrometry, ICP-OES.

Results

For all extractants the most significant correlations between concentrations of Fe and Al, were established. These two elements originate from soil clay minerals, i.e., Fe and Al oxides. The most significant correlations were determined between concentrations of Ni and Mn extracted with $CaCl_2$ ($R=0.965$, $p<0.01$)

and NH_4NO_3 (R=0.964, p<0.01). Significant correlation between concentration of Sr and Mn (R=0.896, p<0.01) were determined during extraction with CH_3COOH. However, the most pairs of significant correlations between the pairs of elements, e.g., Zn-Mn (R=0.776, p<0.01) or Zn-Ni (R=0.0826, p<0.01) were investigated during extraction procedure with NH_4NO_3. This weak salt extracted many pairs of element, which could be connected with metal containing agro-chemicals used in a conventional vineyard treatment. Considering all positive correlations, significantly positive correlations could be pointed out between concentrations of Cu-Mn, Cu-Ni and Cu-Zn just in case of the soil extraction with distilled water during 16 h. Thus, this single procedure could be a good alternative for investigation of Cu content in vineyard soils.

A unique extractant could not be best solution for determination of all bioavailable elements, and for determination of major and trace element transport in soil-plant. However, judging by correlation and PCA analysis, concentrations of Mn and Sr extracted from soil samples with $CaCl_2$ and NH_4NO_3 showed significant correlation with the same element concentrations isolated from the grape leaves (Mn_{CaCl2}-Mn_{leaf}: R=0.663, p<0.01; Sr_{CaCl2}-Sr_{leaf}: R=0.798, p<0.01; Mn_{NH4NO3}-Mn_{leaf}: R=0.664, p<0.01; Sr_{NH4NO3}-Sr_{leaf}: R=0.642, p<0.01). Furthermore, concentration of Sr extracted from the soil with $CaCl_2$, NH_4NO_3 and distilled water during 2 h were in correlation with concentration of Sr isolated from the grape skin (Sr_{CaCl2}-Sr_{skin}: R=0.863, p<0.01; Sr_{NH4NO3}-Sr_{skin}: R=0.646, p<0.01; $Sr_{2h\ H2O}$-Sr_{skin}: R=0.544, p<0.01). The highest significant correlation was determined between concentration of Sr extracted with CH_3COOH and Sr isolated from the grape pulp (R=0.940, p<0.01), also CH_3COOH extracted concentration of Zn which was in correlation with Zn isolated from the grape skin (R=0.528, p<0.01). On the other hand, concentrations of Cu, Fe and Sr isolated from the grape skin were in correlation with Cu, Fe and Sr isolated from the grape leaves.

Conclusion

It could be concluded that NH_4NO_3 extractant was shown ability to isolate a pairs of potentially toxic elements, which could originate from the fertilizers or pesticides used in agriculture production. Extraction with distilled water during 16 h could be investigated as an alternative procedure for extracting some potentially toxic elements from vineyard soils. There was not unique extractant which could be best solution for determination all bioavailable elements, and for determination of accumulation of major and trace elements.

References

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