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Comparison, limitations and uncertainty of wet chemistry techniques, loss on ignition and dry combustion in soil organic carbon analysis

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Soil organic carbon (SOC) has an important role in natural processes (carbon cycle, global climate change and plant growth), agriculture, soil protection and biodiversity. Determination of SOC is usually based on the oxidation of soil organic matter (SOM). Many methods are available, each with advantages and disadvantages in terms of accuracy, costs, convenience and repeatability. Therefore, it is necessary to make a comprehensive overview in order to select appropriate method with the purpose of accurate SOC determination. Most errors in SOC stocks assessment and SOC monitoring occur due to differences in analytical approaches and procedures. This can be a key factor in making incorrect conclusions.

The purpose of this research was to compare methods for SOC determination and highlight the strengths and weaknesses of individual methods. The research was conducted on soil samples collected from different soil types and different land uses of temperate region. The concentration of SOC in every sample was determined by the following methods: Tyrin's method, Tyrin's method without addition of AgSO4, Kotzmann's method, loss on ignition (LOI) method, Walkley-Black method, dry combustion by CHN analyzer with pretreatment with HCl and subtraction of volumetrically determined soil inorganic carbon (SIC) from dry combustion by CHN analyzer without pretreatment.

Each of the applied methods demonstrated specific limitations. The average SOC concentration determined by different methods ranged from 16.1-28.5 g kg-1. It has been established that different methods for the determination of total SOC recovered 76-157% of SOC compared to the reference dry combustion method by CHN analyzer. The correlation coefficients between applied methods ranged from 0.74-0.98. The Tyrin's method without addition of AgSO4 can be recommended as the most suitable method for the determination of SOC, with mandatory use of the correction factor 1.14. For the purpose of reducing the difference between results obtained by CHN analyzer and other applied methods, linear regression equations for the recalculation of SOC concentration were developed.