Determination of calcium and magnesium by atomic absorption spectroscopy and flame photometry

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Abstract. The comparison of emission intensities of unknown samples to either that of standard solutions, the alkali and alkaline earth metals. Flame photometer has both quantitative and qualitative applications. Flame photometer with monochromators emits radiations of characteristic wavelengths which help to detect the presence of a particular metal in the sample. This help to determine the availability of alkali and alkaline earth metals. Simple direct analysis procedure calcium, magnesium, in test solution flow injection analysis using flame atomic absorption spectroscopy or flame photometry designed using a well-mixed dilution chamber to increase calibration range. Analysis results real samples correspond to those found in the flame batch atomic procedure. Using the dilution chamber allows possibility of calibration using a dilution profile a single concentrate standard for each element and an empirical dilution equation that can be used to all elements are defined in each sample.

1. Introduction
The atomic absorption spectrometry (AAC) method is highly sensitive for elements that are difficult to excite (having a high excitation energy), since there are much more non-excited atoms in the flame than excited ones. Highly excited elements in a high-temperature flame emit radiation efficiently, so they can be detected with greater sensitivity by emission spectrometry. Atomic spectroscopy is thought to be the oldest instrumental method for the determination of elements. These techniques are introduced in the mid of 19th Century during which Bunsen and Kirchhoff showed that the radiation emitted from the flames depends on the characteristic element present in the flame. The potential of atomic spectroscopy in both the qualitative as well as quantitative analysis were then well established. The developments in the instrumentation area led to the widespread application of atomic spectroscopy. Atomic spectroscopy is an unavoidable tool in the field of analytical chemistry [1]. It is divided into three types which are absorption, emission, and luminescence spectroscopy. The different branches of atomic absorption spectroscopy are Flame photometry or flame atomic emission spectrometry in which the species is examined in the form of atoms. Atomic absorption spectrophotometry, (AAS), inductively coupled plasma-atomic emission spectrometry. Photoelectric flame photometry, a branch of atomic spectroscopy is used for inorganic chemical analysis for determining the concentration of certain metal ions such as sodium, potassium, lithium, calcium, Cesium, etc. The basis of flame photometric working is that, the species of alkali metals (Group I) and alkaline earth metals (Group II) metals are dissociated due to the thermal energy provided by the flame source [2]. Due to this thermal excitation, some of the atoms are excited to a higher energy level where they are not stable. The absorbance of light due to the electrons
excitation can be measured by using the direct absorption techniques. The subsequent loss of energy will result in the movement of excited atoms to the low energy ground state with emission of some radiations, which can be visualized in the visible region of the spectrum. The absorbance of light due to the electrons excitation can be measured by using the direct absorption techniques while the emitting radiation intensity is measured using the emission techniques. The wavelength of emitted light is specific for specific elements. Atomic absorption spectroscopy has a difference from other spectroscopy methods, it has two additional requirements. These include a specially designed lamp to produce light of the desired wavelength and a burner to prepare the sample to absorb light radiation. The instrument also sprays the sample in a solution position over the atomizer (burner). This causes the solvent to evaporate and leaves a fine dry residue. This residue has neutral atoms in the ground state. The elements analyzed typically include sodium, potassium, magnesium, calcium, and zinc. For the determination of heavy metals such as iron, manganese, copper, zinc, mercury, lead, Nickel, as well as in urine and blood. This analysis is necessary in case of heavy metal poisoning. Determination of magnesium by atomic method, absorption was compared with standard methods using EDTA [3].

1. AAS "MGA-915MD" is a full automatic machine with automatic change of radiation sources and the installation of the corresponding resonance lines, there is a turret for 6 lamps (computer readjustment from one element to another without the need for manual adjustment). An autosampler with 55 sample cells is used to inject samples into the MGA-915MD figure 1. The principle of operation of the spectrophotometer is based on measuring the absorption of free atoms of elements of resonance radiation passing through a layer of atomic vapor arising from atomization of a sample in a graphite cell. For automatic correction of non-selective absorption, the method of Zeeman modulation polarization spectrometry with high-frequency modulation is used. Radiation modulated by polarization at a frequency of 50 kHz from a resonant source enters the atomizer, where the horizontal component perpendicular to the lines of the constant magnetic field is absorbed only by molecules and aerosols. As a result, a difference signal with a frequency of 50 kHz appears, which is proportional to the concentration of the element's atoms. The spectrometer consists of a resonant radiation source, elements of a polarization-modulation optical system, an atomizer, the main part of which is a graphite cell, a monochromator, a radiation receiver, and a signal processing system coming from a photomultiplier. The graphite cuvette is located in the air gap between the poles of a permanent magnet, the lines of magnetic induction of which are perpendicular to the optical axis of the spectrometer. Dosing of a liquid sample into a graphite cuvette of spectrometers is carried out using an autosampler or manually using variable volume microdispensers.

**Figure 1.** Appearance of the spectrometer of atomic absorption modifications "MGA-915 MD".

2. Flame photometry an optical method for quantitative elemental analysis by atomic emission spectra. To obtain spectra of analyte is converted into an atomic vapour in the flame. Thermal flame photometry - a kind of atomic emission spectral analysis.
3. Inductively coupled plasma atomic emission spectroscopy device for the determination of metals - the analytical method used for the detection of trace metals.

In this study we used two metals from group (II) magnesium and calcium. The group (II) elements are the alkaline earth metals and all of them are metals. The alkaline earth metals are high in the reactivity series of the metals, however not high as alkali metals of Group (I) [4]. We will use just two metals from group (II) however we have six elements in periodic table, in group(II): Beryllium, magnesium, calcium, strontium, barium, and radium. Group (II) metals are very important in chemistry and in some other subjects. Especially chemists use them when they do a lot of practical chemistry classes. For the detection of magnesium, atomic absorption spectrometry is used table 1, and calcium is detected using flame photometry table 2, and for both of them, inductively coupled plasma atomic emission spectroscopy is used [5].

As a secondary messenger, calcium is involved in transmitting the signal received by the cell to the genome. As a result, many enzymes are activated – dehydrogenases, amylases, phosphatases, kinases, lipases. Its action is based on participation in the formation of the Quaternary structure of the protein, creating bridges in the enzyme-substrate complexes. It is for calcium that the function of neutralization in plants is recognized oxalic acid. This element plays a large role as an antagonist of other cations. By delaying the excess intake of some elements into the cell, it also stimulates the absorption of others. Calcium plays an important role in restoring and maintaining soil balance a solution that provides a normal supply of mineral nutrition elements to the root system [6].

Magnesium activates carboxylase, phosphokinase, ATPase, enolase, Krebs cycle enzymes, pentose phosphate pathways of alcoholic and lactic fermentation, and a number of others enzyme system. It also activates the DNA-and RNA-polymerases and processes of electron transport with phosphorylation. This element participates in the photochemical decomposition of water during photosynthesis. Magnesium catalyzes the formation of ATP, helping to conserve energy.

2. Methods and results

To study solutions for the content of calcium and magnesium using flame photometry:

- five standard solutions of calcium should be prepared using 0 to 100 mg dm$^{-3}$, using deionized water whose absorption is zero, and set the maximum value of the absorption reading near one hundred using the most concentrated standard. Using different standard solutions of calcium starting from 100 ppm, different values of the absorption readings and the data obtained were entered in the table.

- The main ions that are contained in soil waters are elements of the I and II groups of the main subgroup. The content of calcium and magnesium determines water hardness, salinity can be expressed as the concentration of sodium and potassium, and the absorption coefficient of sodium. An important parameter from an agricultural point of view is determined from the ratio between the concentration of sodium and calcium plus magnesium, they can be determined by atomic absorption spectrometry (AAS) or flame photometry (FP) after significant dilution of samples [7-9]. Automation of routine flow injection analysis procedures ensures reduced sample and reagent consumption, minimizes sample manipulation, and enables research in analytical chemistry in recent years. In atomic spectroscopy, FIA methods make it possible to obtain preliminary concentration of samples and preliminary processing of samples in real time [10].

To determine the main elements by analysis using flame atomic spectroscopy a large sample dispersion is required to obtain their adequate dilution due to the high sensitivity of atomic spectroscopy methods. Pipette, pipet filler, five laboratory bottles, Ca$^{2+}$, Mg$^{2+}$, de-ionised water. Flame photometry for Calcium, Atomic absorption spectrometry for Magnesium and Inductively coupled plasma atomic emission spectroscopy device for determination of metals. In the beginning of the experiment were prepared five standard solutions of Calcium using 0 to 100 mg dm$^{-3}$.

Then, by using de-ionized water sout the absorbance zero.

In the next step, have to set the reading absorbance maximum near to one hundred using from the most concentrated standard. In this experiment they started from 100 ppm using our different standard
solutions of calcium and have the different absorption readings also. Then, writing down all our readings from 100 to 20 ppm by inserting the table.

Table 1. Changing indicator values magnesium on an atomic absorption spectrometer on the concentration.

| Sample Concentration (mg dm$^{-3}$) | Absorbance reading |
|-------------------------------------|-------------------|
| 0                                   | -0.0033           |
| 5                                   | 0.1062            |
| 10                                  | 0.2033            |
| 15                                  | 0.3034            |
| 20                                  | 0.3846            |
| Unknown Exceeded range of analysis  |                   |
| Unknown diluted (1:3)               | 17.3280           |

Table 2. The value of calcium absorption on the flame photometry device as a function of concentration.

| Sample concentration (ppm) | Absorbance reading |
|---------------------------|--------------------|
| 20                        | 26                 |
| 40                        | 41.5               |
| 60                        | 65                 |
| 80                        | 83                 |
| 100                       | 100                |
| Unknown                   | 61                 |

3. Conclusion
In conclusion, noted that in this experiment were used elements of group (II), conducting an experiment with calcium and magnesium, as well as devices for determining elements and metals. For example: flame photometry, atomic absorption spectrometry. Mineral nutrition of plants—a set of processes of absorption, movement and assimilation of chemical elements obtained from the soil in the form of mineral salt ions. Magnesium (Mg$^{2+}$) is responsible for the production of green foliage, and is its Central molecule.

Calcium (Ca$^{2+}$) provides elasticity of stem and fruit cells (components of the cell membrane). Salts, like water, are absorbed by living cells of the primary root bark and root hairs, then pushed with water by root pressure into vessels, carried by a transpiration current to other parts of the plant and again accepted by living cells of the stem and leaf. In the living cells of the root, the first selection of substances allowed inside the plant takes place. The participation of living cells in the acceptance of substances determines the selective ability of the plant, due to which different substances are absorbed in different quantities. Since the receipt is highly dependent on consumption. The plant accepts at different stages of development some salts, then others. The closer the root touches the parts of the mat. The more developed the root system and the more complete the absorption of salts. In addition, the roots have a
dissolving ability. There is no doubt that a powerful, highly branched root system contributes to better nutrition of the plant.

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