
# A STUDY OF THE MORPHOLOGICAL STRUCTURE AND PROPERTIES OF HYDROGELS ENRICHED WITH MINERAL FERTILISERS

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**ABSTRACT**

*In recent years, scientific research aimed at the efficient use of water and fertiliser resources in agriculture has intensified. In particular, hydrogel-based materials are distinguished by their high water absorption and long-term retention properties. Therefore, it is important not only to study the functional properties of hydrogels, but also to gain a deep understanding of their structural and compositional characteristics.*

In recent years, scientific research aimed at the efficient use of water and fertiliser resources in agriculture has intensified. In particular, hydrogel-based materials are distinguished by their high water absorption and long-term retention properties. Therefore, it is important not only to study the functional properties of hydrogels, but also to gain a deep understanding of their structural and compositional characteristics.

In this work, hydrogels enriched with ammonium polyphosphate and ammophos were synthesised based on hydrolysed polyacrylonitrile (GIPAN). When the mineral components were incorporated into the hydrogel, their interactions with the polymer matrix and structural changes were investigated. During the hydrogel synthesis, a three-dimensional polymer network was formed using formaldehyde.

The morphological structure of the hydrogels was examined using scanning electron microscopy (SEM). The analysis results revealed the presence of a micro- and macroporous structure on the hydrogel surface. These voids are formed as a result of mineral components being located between the polymer chains. Consequently, the hydrogel's internal structure becomes loosened and the formation of additional cross-links is restricted.

SEM images showed that ammonium polyphosphate and ammophos in the hydrogel are present not as separate phases but embedded within the polymer chains. This leads to the formation of pores in the hydrogel. It is precisely this porous structure that ensures the hydrogel's high water uptake and its retention over a prolonged period.

The compositional properties of the hydrogels were evaluated by elemental analysis. The results revealed the presence of phosphorus and nitrogen in the hydrogel, confirming the

successful incorporation of ammonium polyphosphate and ammophos into the polymer matrix. Furthermore, the detection of potassium, calcium and aluminium in the elemental analysis results indicates that these components originate from the mineral fertiliser composition.

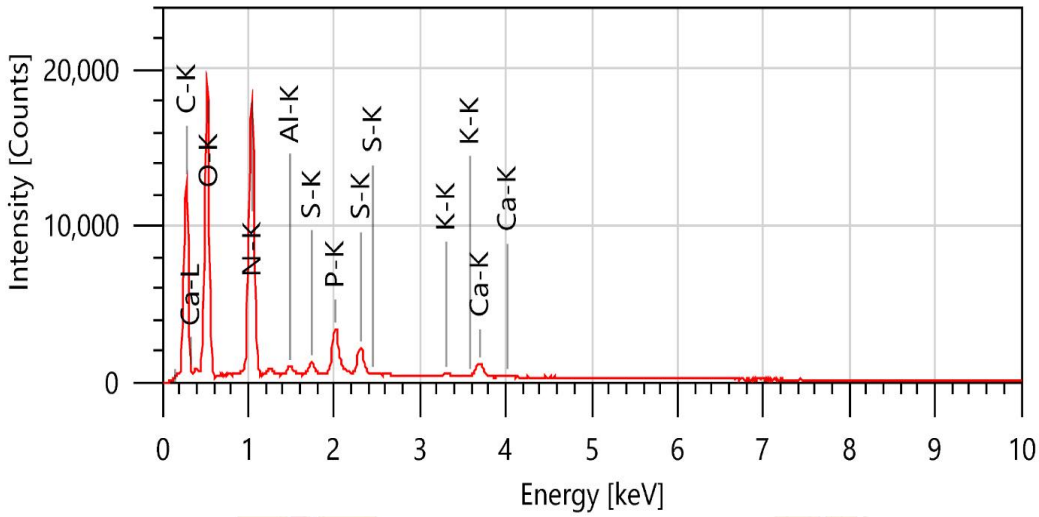


**Figure 1. Elemental analysis of hydrogel prepared on the basis of ammonium polyphosphate, ammaphos, hypane, formaldehyde and sulphuric acid**

**Table 1.**

| № | **Element** | **Line** | **Mass, %** | **Atom, %** |
|---|---|---|---|---|
| 1 | C | K | 38.56±0.13 | 48.44±0.16 |
| 2 | O | K | 42.12±0.20 | 39.72±0.19 |
| 3 | N | K | 14.08±0.08 | 9.71±0.05 |
| 4 | Al | K | 0.28±0.01 | 0.16±0.01 |
| 5 | S | K | 0.42±0.01 | 0.23±0.01 |
| 6 | P | K | 2.89±0.04 | 1.39±0.02 |
| 7 | K | K | 0.13±0.010 | 0.05±0.00 |
| 8 | Ca | K | 0.8±0.01 | 0.30±0.01 |
| 9 | **total** | | 100.00 | 100.00 |

The elemental composition results indicate that the hydrogel is a chemically complex system in which organic and inorganic components are interlinked. This confirms that hydrogels are not only water-retaining but also functional materials that gradually release nutrients.

The incorporation of mineral components into the hydrogel matrix significantly affects the structure of the polymer network. They are situated between the polymer chains, restricting additional crosslinking reactions and resulting in an elastic, porous structure. This enhances the hydrogel's mechanical and diffusion properties.

Based on the above results, it was determined that the morphological structure and elemental composition of the hydrogels are among the primary factors determining their functional properties. A porous structure and the uniform distribution of mineral components enhance the efficiency of the hydrogels.

In conclusion, a thorough study of the structure and compositional properties of mineral fertiliser-enriched hydrogels provides a crucial scientific basis for their effective application

in agriculture. Such hydrogels are regarded as a promising material for water conservation, efficient fertiliser utilisation and enhancing soil fertility..

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