ACTIVE EFFECTS OF LESS KNOWN BITUMINOUS ROCK ALGINITE ON THE BIOLOGICAL PROCESSES OF *Solanum lycopersicum* L.

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Abstract

Applied two preparations of alginite formed from natural bituminous rock alginite in 4 different variants into the soil (granular forms) and spraying on leaves (extracts) in 2 cultivars of *Solanum lycopersicum* L. resulted in reduced production traits on plants and fruits, increased or decreased accumulation of macro and microelements content in plants and fruits and by increasing the antioxidant activity of the fruits compared to the control variant without alginite.

Key words: alginite, bituminous rock, preparations, *Solanum lycopersicum*, fruits, macro- and microelements, antioxidant activity

Introduction

Alginite, as an organic-bituminous rock, originates mainly from the bodies of dead algae (from the Latin *algae*). It formed as a rock during various geological periods, especially those that gave algae optimal conditions for growth and reproduction. Post-volcanic crater lakes or swamps were sites where alginite arising [18]. The first research and its practical use with bituminous rock in the Gerge region is in Hungary. Alginite from Hungary became the subject of follow-up research [14]. An economically important deposit of alginite was also located in Slovakia in Maar near Pinciná village northeast of the town of Lučenec [18]. The exploitation of alginite from the deposit is only in the beginning stage. Nevertheless, alginite has become an important research object even in the conditions of Slovakia at the Geocomplex research workplace [12, 9, 10, 5], University of Veterinary Medicine and Pharmaceuticals in Košice, [13, 16], Technical University of Zvolen [6, 3], National Agriculture and Food Centre – Soil Science and Conservation Research Institute [2]; State Geological Institute of Dionýz Štúr [1]. Natural and modified alginite has unique effects on plants, animal organisms, soil, water and solving other current environmental problems [5].

Materials and methods

Object of the experiment – cultivar of tomato Denár (D) – late ripening of fruits, high yield of juice, used for manual and mechanized fruit picking, Odeon (O) – semi-early cultivar suitable for ketchup preparation.

Experimental location – Slovakia, Nitra; **Evaluated parts of plants** – plants, fruits.

Tested innovated alginite products in following variants: V1 – C (COO and COD) – control variant without alginite; V2 (KV1O1 – 3, and PV1D1 – 3) curative treatment with 0.2% AUZ solution (ultrasound-treated alginite); V3 (PK2O1-3, and PK2D1-3) preventive treatment with 0.4% AUZ solution (alginite treated with ultrasound); V4 (PV3O1-3 and PV3D1-3) AUZ powder treatment (ultrasonic treated alginite); V5 (PK4O1-3 and PK4D1-3) treated with ALGEX 4 (30ml.l⁻¹); **Application of alginite preparations** - curative (K) during plant vegetation.

Determination of macro and microelement content – AAS-AMA Atomic absorption spectrometry.

Determination of antioxidant analysis of fruits – DPPH method (Brand-Williams et al., 1995).

Results and discussions

The application of alginite preparations to tomatoes in all variants (V2-V4) resulted in a reduction in plant weight as well as a reduction in the average fruit weight compared to the control variant (Table 1). This effect can be considered both negative and positive.

Table 1. Comparison of applied preparations of alginite in the form of variants on plant weight and fruit weight of the cultivars *Solanum lycopersicum* L. LSD test, $\alpha = 0,05$

Variants	Weight of plant (g)	1	2	3	Variants	Weight of fruit (g)	1	2	3
V5	2236.942	****			V2	61.633	****		
V2	2624.657	****	****		V3	63.365	****		
V4	2688.788	****	****		V5	68.533		****	
V3	2896.000		****		V4	68.830		****	
V1	4618.813			****	V1	73.000			****

Table 2. Comparison of the determined lowest and highest contents of tested macro- and microelements in the dry matter of parts of plants of the cultivar Denar of *Solanum lycopersicum*

Dry matter of stems					
a) The lowest values of the content of evaluated macro and microelements were determined for the variants					
KOD (5)	KV1D (4)	KV2D (1)	KV3D (4)	KV4D(3)	KV5D (3)
P-Al-Cu-Sn-Zn	K-Hg-Cr-Ni	Se	Ca-Na-S-Mn	Co-Fe-Sb	Mg-Si-N
b) The highest values of the content of evaluated macro and microelements were determined for the variants					
KOD (3)	KV1D (1)	KV2D (11)	KV3D (2)	KV4D(2)	KV5D(2)
Na-K-Co	Se	Ca-Mg-S-P-Al-Cu-Fe-Mn-Cr-Ni-N	Hg-Si	Hg-Zn	Sb-Sn
Dry matter of leaves					
a) The lowest values of the content of evaluated macro and microelements were determined for the variants					
KOD (2)	KV1D	KV2D	KV3D (3)	KV4D (5)	KV5D (11)
S-Cu	–	–	Ca-Mg-N	Na-K-Se-Zn-Pb	P-Al-Co-Fe-Hg-Li-Mn-Sc-Si-Cr-Ni
b) The highest values of the content of evaluated macro and microelements were determined for the variants					
KOD (1)	KV1D (14)	KV2D (1)	KV3D	KV4D (3)	KV5D (2)
Hg	Mg-Na-P-Al-Co-Cu-Fe-Li-Mn-Zn-Sc-Cr-Ni-Pb	Si	–	Ca-S-Se	K-N
Dry matter of fruits					
a) The lowest values of the content of evaluated macro and microelements were determined for the variants					
KOD (4)	KV1D (6)	KV2D (1)	KV3D	KV4D(2)	KV5D (4)
Cu-Mn-Sn-Zn	Mg-Na-K-S-P-N	N	–	Al-Si	Ca-Fe-Sn-Ni
b) The highest values of the content of evaluated macro and microelements were determined for the variants					
KOD (1)	KV1D (2)	KV2D (3)	KV3D (2)	KV4D (1)	KV5D (6)
Si	Ca-Sn	Al-Zn-Ni	Fe-N	P	Mg-Na-K-S-Cu-Mn

Figure 1. Comparison of dependences between aluminium and chromium content expressed by correlation coefficients according to Pearson's correlation analysis of innovated alginite products in individual plant parts of tested cultivars Odeon and Denár within evaluated variants.

Figure 2. Comparison of dependences between silicon and aluminium content expressed by correlation coefficients according to Pearson's correlation analysis of innovated alginite products in individual plant parts of tested cultivars Odeon and Denár within evaluated variants.

Figure 3. Antioxidant activity of preventively (P) treated fruits of tomato cultivars Odeon and Denar in aqueous extract after application of various developed alginite products (PV1 – PV4).

Improves seed germination, plant growth and development <i>Kovár et al., 2021; Tužinský et al., 2015</i>	Stabilization of probiotic preparations <i>Styková et al., 2016</i>	Increases the yield and production of plant parts <i>Kádár et al., 2015</i>
It allows the retention of water in the soil and the gradual supply of water to plants <i>Bublinec and Gregor, 1997</i>		It degrades the decomposition of pesticide and drug residues in water <i>Guhl et al., 2018; Kropp et al., 2021</i>
Improves fertility and microbiological properties of soils <i>Gömöryová et al., 2009</i>	Retains nutrients in the soil <i>Wass et al., 1997</i>	Stabilizes microorganisms in animal organisms <i>Strompfová et al., 2018</i>

Figure 4. Summary of some determined effects after application of natural or modified alginite according to the literary data.

The results of the experiment showed that the application of alginite preparations significantly and specifically affected the accumulation of macro- and microelements in the roots, stems, leaves and fruits (Table 2). Compared to the control variant (V1), the accumulation of the content of some macro- and microelements was significantly reduced, and in some cases increased.

By evaluating the correlation dependence between the content of tested macro- and microelements in tomato plants, we also determined significant differences. The results indicate a very interesting correlation between the silicon and aluminium content (Figure 2) and the aluminium and chromium content (Figure 1). We do not provide further results.

The application of alginite preparations was proved by an increase in antioxidant activity in aqueous extracts, which is also documented in the presentation in Figure 3.

The reduction in biomass production is significant with a reduction in nutrient depletion from the soil. The formation of lower weight fruits results in an improvement in their quality (Figure 3).

The knowledge obtained from the experiment contributes and complements the knowledge of other authors about the significant effects on the production and quality of plants, the improvement of water, soil and the solution of many other current problems.

Conclusions

By applying the formed preparations from natural bituminous rock alginite to tomato plants, the effects on reducing the weight of plants and fruits were confirmed in experiments. Other effects were manifested by a significant change in the accumulation of macro and microelements in the roots, stems, leaves and fruits. Application with alginite resulted in an increase in the antioxidant activity of the fruit. It is very difficult to justify the determined effects of the application of alginite to tomato in this experiment as well as many other significant effects determined by other authors on other plant species and in other areas.

It is very likely that these effects of alginite are manifested due to its content of more than 70 macro and microelements in its composition. A positive component of alginite is also the favourable content of humates. A priority feature of natural alginite is also the high binding of water, which plants can grad-

ually take in dry conditions. The least knowledge is about the content and composition of the organic component alginite, which requires many further experiments.

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