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ANALYSIS OF THE INFLUENCE OF SOME SOIL MICRO ELEMENTS ON THE CONCENTRATION OF THE FLAVONOID RUTIN IN *TANACETUM VULGARE* (LINNEUS, 1753)

Actuality. *Flavonoids are used as part of medicines for the treatment of various diseases, and therefore investigating the influence of some environmental factors on the concentration of flavonoids will make it possible to understand which of these factors will positively or negatively affect the medicinal effect of the plant.*

The purpose of our study. *The article examines the effect of soil trace elements on the concentration of flavonoids in some medicinal plant materials, to reveal their inhibitory or activating properties.*

Material and methods. *Tanacetum vulgare (Linneus, 1753) was used as the research plant. The plant material, as well as the studied soil samples, were collected in different areas at the same time. The collection area is Chernihiv region, Nizhynskyi and Prylutskyi districts. Plant raw materials were dried and stored in accordance with the standards of the state pharmacopoeia. Extraction and measurement of the concentration of flavonoids was carried out according to the methodology of the state pharmacopoeia, medicinal plant raw materials section. The raw material was weighed in detail on laboratory scales, after which it was sent for extraction. After extraction in a water bath, the optical density of the solutions of the studied plant material was measured using a spectrophotometer, after which the concentration of flavonoids was measured as a percentage in terms of rutin according to the formula. The studied soil samples, after collection, were packaged in special containers and stored according to GOST (DSTU) standards. Soil microelements were studied by atomic emission spectrometry with inductively coupled plasma in a subsidiary laboratory. The following trace elements of the soil were studied: (B), (Co), (Cu), (Mg), (Mn), (Mo), (Zn).*

Research results. *After the obtained results, correlation tables and graphs of the dependence of each studied microelement of the soil were created. The conducted research made it possible to analyze the influence of soil microelements, to reveal the properties of each of them to inhibit or activate biological processes in plants to increase or decrease the concentration of flavonoids in medicinal plant raw materials, in particular rutin.*

Conclusion. *Based on the obtained results, it is possible to talk about recommendations for the introduction or removal of fertilizers that have the studied microelements.*

***Key words:** flavonoids, rutin, medicinal plant raw materials, biologically active substances, soil trace elements, Tanacetum vulgare.*

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АНАЛІЗ ВПЛИВУ ДЕЯКИХ МІКРОЕЛЕМЕНТІВ ҐРУНТУ НА КОНЦЕНТРАЦІЮ ФЛАВОНОЇДУ РУТИНУ В ПИЖМА ЗВИЧАЙНОГО (*TANACETUM VULGARE* LINNEUS, 1753)

Актуальність. *Флавоноїди використовуються у складі лікарських препаратів для лікування різноманітних хвороб, а тому дослідження впливу деяких чинників навколишнього середовища на концентрацію флавоноїдів дасть змогу зрозуміти, які саме із цих чинників позитивно або негативно вплинуть на лікувальний ефект рослини.*

Мета дослідження. *У статті досліджується вплив мікроелементів ґрунту на концентрацію флавоноїдів у деякій лікарській рослинній сировині для виявлення їхніх інгібуючих або акивуючих властивостей.*

Матеріали та методи дослідження. *Як досліджувану рослину було використано пижмо звичайне (Tanacetum vulgare Linneus, 1753). Рослинна сировина, як і досліджувані зразки ґрунту, були зібрані у різних районах в один і той самий час. Територія збирання – Чернігівська область, Ніжинський та Прилуцький райони. Рослинна сировина висушувалася та зберігалася відповідно до стандартів Державної фармакопеї України (ДФУ). Екстракцію та вимірювання концентрації флавоноїдів проводилося за методикою ДФУ, розділ «Лікарська рослинна сировина, пижмо звичайне». Сировину детально зважували на лабораторних вагах, після чого відправляли на екстракцію. Після екстракції на водяній бані вимірювали оптичну щільність розчинів досліджуваної рослинної сировини за допомогою спектрофотометра, після чого вимірювали за формулою концентрацію флавоноїдів у відсотках у перерахунку на рутин. Досліджувані зразки ґрунту після збирання фасували у спеціальні тари та зберігали згідно зі стандартами ГОСТ (ДСТУ). Мікроелементи ґрунту досліджувалися методом атомно-емісійної спектрометрії з індуктивно-зв'язаною плазмою у дочірній лабораторії. Досліджували такі мікроелементи ґрунту: бор (B), кобальт (Co), купрум (Cu), магній (Mg), манган (Mn), молібден (Mo), цинк (Zn).*

Результати дослідження. *Після отриманих результатів було створено кореляційні таблиці та графіки залежно від кожного досліджуваного мікроелемента ґрунту. Проведене дослідження дало змогу проаналізувати вплив мікроелементів ґрунту, виявити у кожного з них властивості інгібувати або активувати біологічні процеси у рослин для підвищення або зменшення концентрації флавоноїдів у лікарській рослинній сировині, зокрема рутину.* **Висновок.** *Спираючись на отримані результати, можна говорити про рекомендації щодо внесення або вилучення добрив, які мають досліджувані мікроелементи.*

Ключові слова: *флавоноїди, рутин, лікарська рослинна сировина, біологічно активні речовини, мікроелементи ґрунту, пижмо звичайне (Tanacetum vulgare).*

Introduction. Flavonoids are contained in many medicinal preparations. Such drugs are widely used in pharmacy for the treatment of various diseases and conditions, where flavonoids are the main active ingredient. The significant therapeutic effect of flavonoids has proven itself in therapy for the treatment of cardiovascular, gastrointestinal, nervous diseases and a number of other symptoms and syndromes. That is why there is a great prospect of researching the influence of the environment on the concentration of flavonoids in medicinal plant raw materials, which are used in the manufacture of medicines. Flavonoids are derivatives of phenolic compounds, they are plant pigments. The most famous flavonoids in phytotherapy are: rutin, hesperidin, hyperoside, quercetin (Georgievskyi, 1990, p. 101–107).

Topicality. The content of soil trace elements and their influence on the concentration of flavonoid rutin in medicinal plants is analyzed in the study. Some microelements can be part of enzymes that are catalysts of various biochemical processes in plants, they can suppress or activate these processes, which in turn can lead to a deterioration in yield, activation of diseases in plants, as well as changes in the chemical composition of biologically active substances, involved in pharmacy (Sereda, 2006, p. 28–38).

Flavonoids are those biologically active plant substances that can depend on the concentration of trace elements in the soil. So, for example, in the studies of V. M. Minarchenko, the influence of Nickel (Ni), Copper (Cu) and Lead (Pb) on the concentration of flavonoids in (Potentilla erecta Linneus, 1797) is described. Thus, the nickel content is observed in plants containing flavonoids, and the P. Erecta studied by the authors has the property to accumulate copper, which, in turn, affects the production of phenolic compounds in plants. It was stated that a large amount of lead can have a positive effect on plant photosynthesis, but, as the authors note, an excessive concentration leads to a toxic effect (Minarchenko, 2017, p. 76–81).

The general influence of soil microelements on flavones is described in the works of foreign scientists Hassan A. and Zengin M. In their works, the authors note that excessive application of Boron (B), Cobalt (Co), Molybdenum (Mo) leads to changes in the biological cycle of the plant, which contributes to suppression of flavone production (Zeggin, 2008; Hassan, 2012).

The purpose of our study was to analyze the content of a certain sample of soil trace elements and to investigate their influence on the concentration of flavonoids in common tansy (*Tanacetum vulgare* Linneus, 1753). The main task was to find out whether each investigated trace element affects the increase or, conversely, the decrease in the concentration of rutin during the cultivation of medicinal plant raw materials. This will allow us to find out how different microelements affect the concentration of rutin in tansy medicinal raw materials.

Research materials and methods. For the study, flowering inflorescences of common tansy were collected during their active flowering season, after which they were dried under the recommended conditions described in the state pharmacopoeia. Inflorescences were laid out on a flat, dry surface, without direct sunlight and with sufficient ventilation of the room. Drying was carried out for a month.

Quantitative representation of the amount of flavonoids in terms of rutin was carried out according to the methodology of the state pharmacopoeia. The dried plant was crushed so that the raw material passed through a 0.5 mm sieve. After that, the raw material weighed to 1 g (with an error of 0.002 g) is placed in a 150 ml flask, 30 ml of 50% ethyl alcohol is added, the flask is heated in a water bath for 30 minutes. The hot concentrate is filtered into a 100 ml flask so that the extracted plant material does not fall on the filter, after which 30 ml of 50% ethyl alcohol is added. Extraction is carried out 2 more times, filtering into the same volumetric flask (solution A). A Lomo SF-26 spectrophotometer was used for the measurement. 1 ml of solution A and 2 ml of 2% aluminum chloride were added with a pipette to a 25 ml flask. After 40 minutes, the optical density of the solution was measured at a wavelength of 415 nm in a cuvette with a thickness of 10 mm. The mass fraction of the sum of flavonoids in percent and conversion to rutin was determined by the formula: x = (D*m0*100*100*100)/(D0*m*100(100-w)) (State Pharmacopoeia, 1990, p. 247–251).

The investigated soil samples were collected at the same time from under the investigated plant. A total of 3 samples were collected from 3 different locations.

Sample 1: 3 soil samples were taken at the location (Chernihiv region, Nizhynskyi district, exit towards Berezanka)

Sample 2: 3 soil samples were taken at the location (Chernihiv region, Prylutskyi district, urban area 12, near non-working tracks)

Sample 3: 3 soil samples were taken at the location (Chernihiv region, Nizhyn city, Mykola Gogol Nizhyn State University, agricultural station)

The studied chemical elements of the soil: boron (B), cobalt (Co), copper (Cu), magnesium (Mg), manganese (Mn), molybdenum (Mo), zinc (Zn).

Determination of the content of elements (B, Co, Cu, Mg, Mn, Zn, Mo) was carried out by the method of atomic emission spectrometry with inductively coupled plasma (table 1).

Research results and discussion. The graphs presented below clearly demonstrate the dependence of the concentration of rutin on the concentrations of trace elements in the soil (fig. 1–7).

As can be seen from Fig. 1, boron suppresses the production of rutin in the studied plant. It should be noted that after the value of 0.24 mg/kg and up to the final value of 0.19 mg/kg, the concentration of rutin increases significantly, which gives reason to believe that boron is not a desirable trace element in the soil for the accumulation of flavonoids by plants.

From fig. 2 shows that cobalt, like boron, inhibits the accumulation of the flavonoid rutin in raw materials. This may be primarily due to the fact that this trace element, in these concentrations, can be toxic and affect the productive properties of plants. Based on this, there are reasons to consider cobalt as an undesirable trace element for growing plants containing flavonoids.

From fig. 3 shows that cuprum in these concentrations caused a decrease in the concentration of the flavonoid rutin in the studied plant. It should be noted that in some plants cuprum contributes to the accumulation of flavonoids, but perhaps for tansy such concentra-

Table

The concentration of rutin in Tanacetum vulgare L depending on the studied microelements of the soil

	Rutin concentration (1 sample) %	Rutin concentration (2 sample) %	Rutin concentration (3 sample) %	Error
The element under investigation	5.619	6.257	6.896	0.005
boron (B), mg/kg	1,04	0,24	0,19	0.01
cobalt (Co), mg/kg	0,27	0,18	0,05	0.01
copper (Cu), mg/kg	2,77	1,05	0,92	0.01
magnesium (Mg), mg/kg	1,5	0,14	0,22	0.01
manganese (Mn), mg/kg	20,81	27,18	31,33	0.01
molybdenum (Mo), mg/kg	0,12	0,08	0,02	0.01
zinc (Zn), mg/kg	19,22	31,1	21,06	0.01

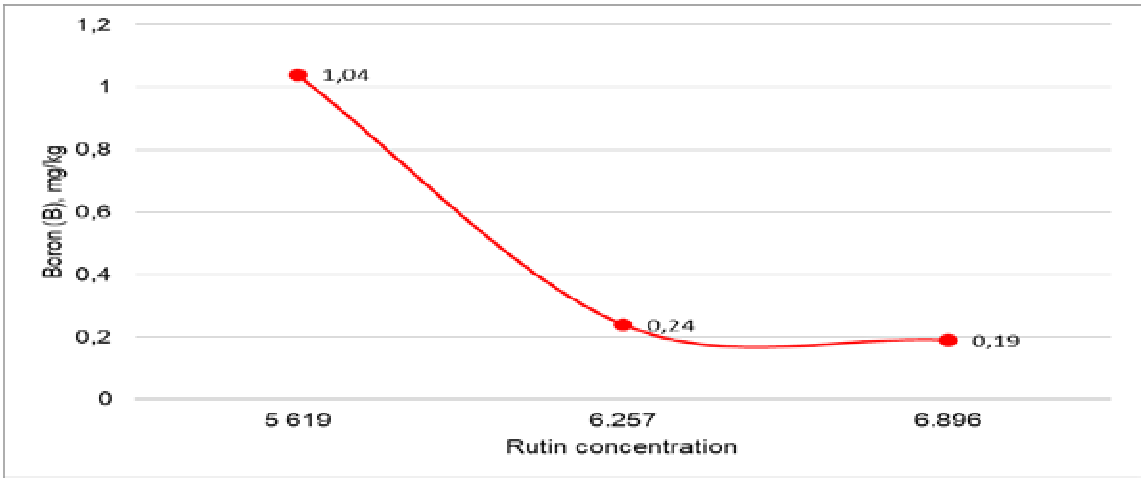

Fig. 1. Dynamics of rutin concentration depending on boron concentration

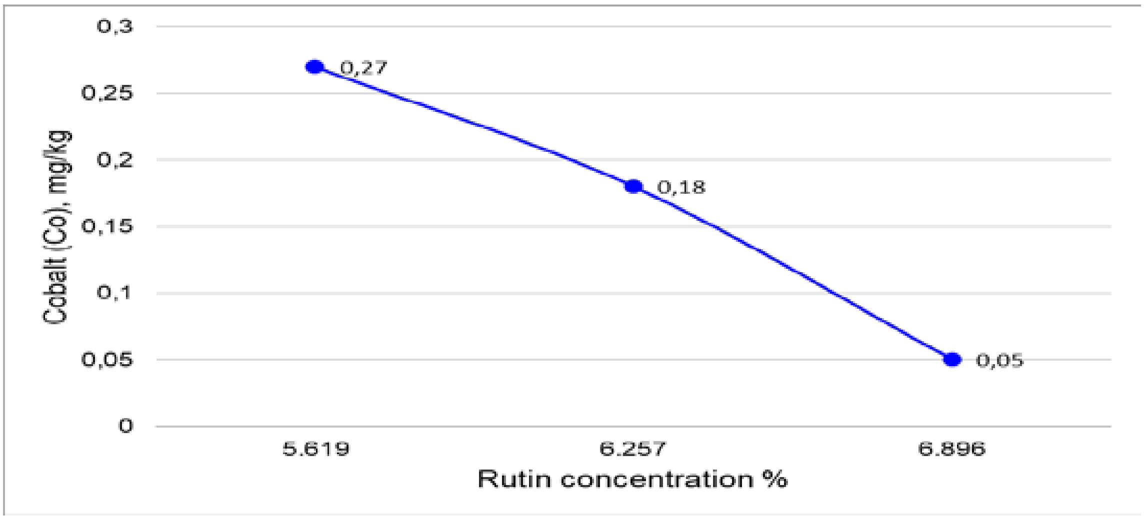

Fig. 2. Dynamics of rutin concentration depending on cobalt concentration

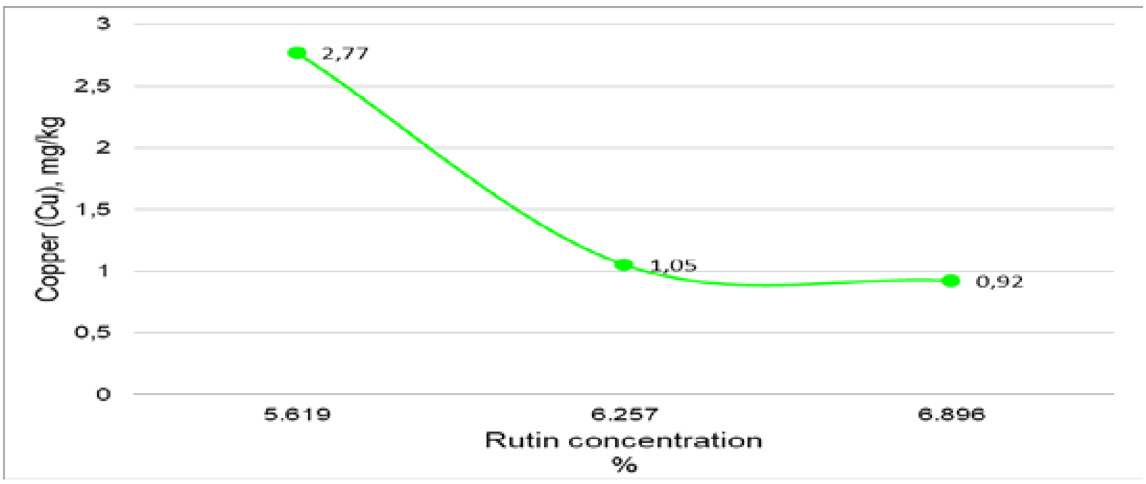

Fig. 3. Dynamics of rutin concentration depending on copper concentration

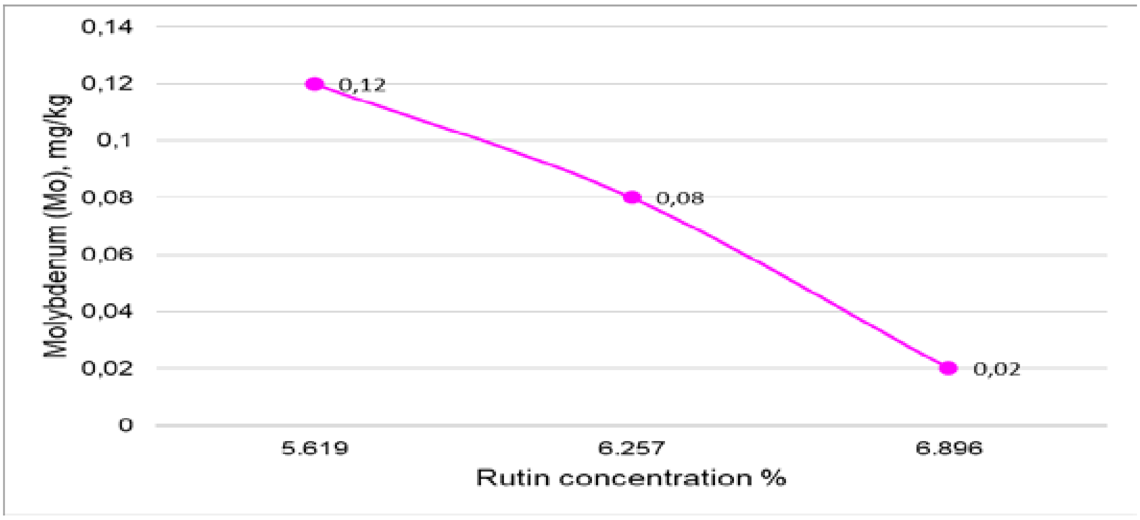

Fig. 4. Dynamics of rutin concentration depending on molybdenum concentration

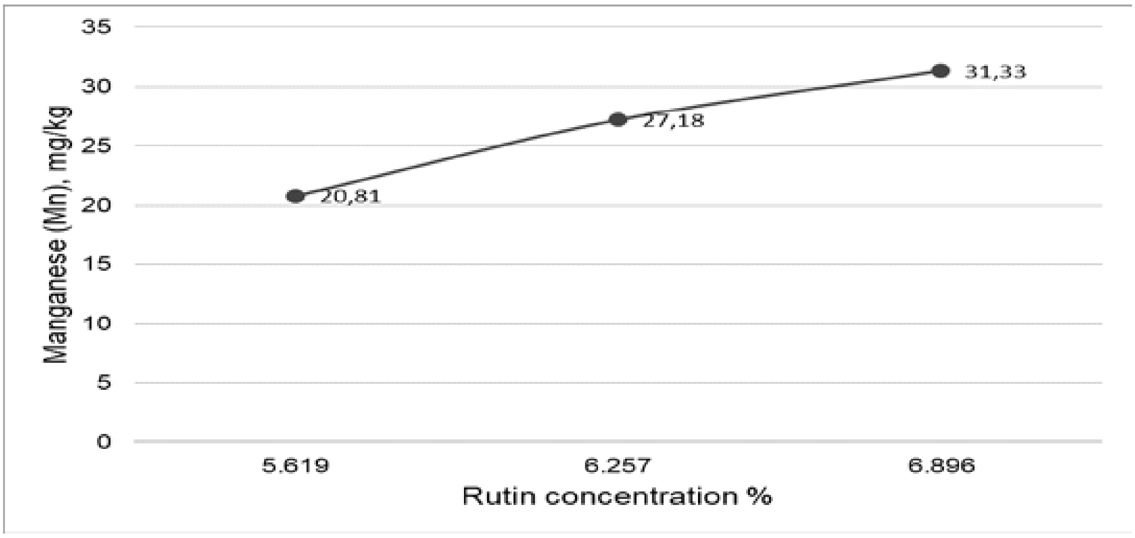

Fig. 5. Dynamics of rutin concentration depending on manganese concentration

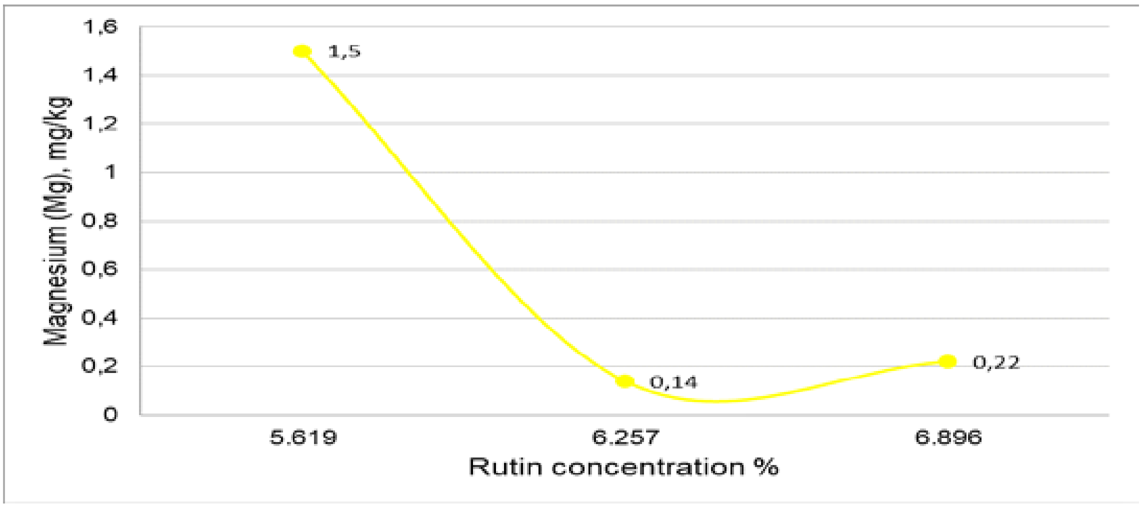

Fig. 6. Dynamics of rutin concentration depending on magnesium concentration

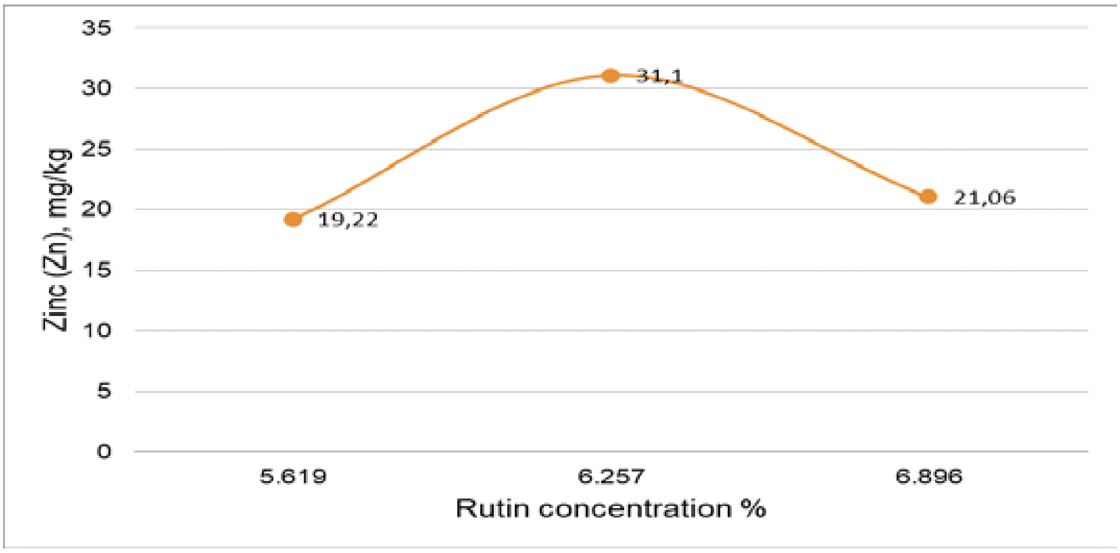

Fig. 7. Dynamics of rutin concentration depending on zinc concentration

tions exceed the permissible norm, which causes such an effect.

Molybdenum in high concentrations can be toxic to many plants. In fig. 4, we see how even small concentrations of molybdenum suppress the production of rutin in the plant. Considering the data, it is recommended to avoid the use of fertilizers that can use this trace element when growing tansy as a medicinal plant.

As can be seen from fig. 5 manganese activates the production of rutin in the studied plant. This can be explained by the fact that manganese improves metabolic processes in plants, and these concentrations are sufficient not to cause a toxic effect, considering that manganese is the recommended trace element for growing plants containing flavonoids.

From fig. 6-7 it can be seen that the concentration of flavonoids has an unstable dependence on the concentration of the microelement of the soil that was studied, which indicates a more significant influence of secondary microelements on the concentration of rutin.

Conclusions. The obtained data make it possible to analyze the possible influence of some microelements in the soil on the concentration of flavonoids, but there are exceptions, such as Zinc and Magnesium, which do not fully provide a general and final confirmation of the significant influence of these elements on the concentration of rutin in common tansy (Tanacetum vulgare L.), therefore it is important to continue the study with the involvement of a larger number of studied plants to create correlation tables.

However, indicators of other trace elements (boron, cobalt, copper, manganese, molybdenum) show a direct effect on the concentration of the flavonoid rutin. So, boron, cobalt, cuprum, molybdenum suppress the production of flavonoid rutin in the studied plant, which gives reasons not to recommend the use of fertilizers with this trace element. And the study of the effect of manganese concentration on the concentration of rutin, on the contrary, showed an increase in the production of flavonoids, which gives reasons to recommend the use of substances with this trace element, from which it is possible to conclude about the priority of introducing this element to obtain better results in the future.

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