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Zveoboy extended *Hypericum elongatum* Ldb.: Phytochemical composition, biological activity and prospects of application in pharmacy

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ABSTRACT

Hypericum elongatum Ledeb. is a promising and understudied species of the genus *Hypericum*, whose natural range includes parts of Central Asia, including the southern regions of Kazakhstan. Despite its taxonomic proximity to St. John's wort (*Hypericum perforatum* L.), which has been widely studied as a source of standardized medicinal raw materials, *H. elongatum* has a much less well-known phytochemical profile and a limited evidence base on pharmacological activity. The purpose of this review is to systematize, critically evaluate, and integrate available scientific data on the botanical and pharmacological properties, distribution, chemical composition, biological activity, and medicinal potential of *H. elongatum*, emphasizing its resource value for Kazakhstan. Information on secondary metabolites of this species, including phenolic compounds, flavonoids, xanthones, phloroglucinols, terpenoids, and other classes of natural compounds, along with modern approaches for their identification and quantification, are summarized. Experimental data on antioxidant, anti-inflammatory, antimicrobial, cytotoxic and other biological activities of *H. elongatum* extracts and single compounds have been critically analyzed. The scientific innovation of this review is the systematization of scattered data on *H. elongatum* along with the simultaneous comparison of its phytochemical and biological profiles with *H. perforatum*, a pharmacopoeia that allows the separation of species-specific properties from common properties of the *Hypericum* genus. Special attention is paid to identifying gaps in modern research, including insufficient standardization of plant raw materials, limited data on the quantitative content of indicator compounds, lack of standard criteria for evaluating biological activity, and insufficient study of mechanisms of action. The obtained results allow to consider *H. elongatum* not as a direct pharmacopoeial analogue of *H. perforatum*, but as a promising independent source of bioactive compounds and a potentially valuable plant resource for Kazakhstan, which requires further pharmacognosy, phytochemical, pharmacological and toxicological evaluation. A promising direction is the development of a scientific evidence-based standardization system for *H. elongatum* raw materials, which is based on the identification of species-specific chemical markers, the evaluation of their variability based on geographic origin and vegetative stage, and also determining the relationship between chemical profile and biological activity.

Keywords: *Hypericum elongatum* Ledeb., Kazakhstan, Phytochemical composition, Secondary metabolites, Flavonoids, Biological activity, Pharmaceutical potential, *Hypericum perforatum.*

Article type: Review Article.

INTRODUCTION

The genus *Hypericum* is considered one of the most widely distributed genera of plants on Earth, consisting of more than 400 species (Silva *et al.* 2021; Khurramovna *et al.* 2024; Al-ebini *et al.* 2026). However, while one

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species of *Hypericum* – *H. perforatum*, well known and well studied as a medicinal plant – occupies an honorable place in pharmacopeias, others have been neglected (Abd El-Aziz *et al.* 2020; Budantsev *et al.* 2021; Almajali *et al.* 2026). *H. elongatum* is another one of these species whose natural habitat covers the areas of Central Asia and even Southern Kazakhstan. This species is quite similar to *H. perforatum* taxonomically, yet it is not clear what phytochemical compounds it contains (Baljak *et al.* 2024). This fact gives rise to the problem of studying the chemical composition and biological activity of this species in pharmacognosy (Akdeniz *et al.* 2020; Al-Hussaniy *et al.* 2026; Al-Karmalawy *et al.* 2026). Significance of this problem cannot be confined merely to botanical issues. Kazakhstan being the country rich in plant diversity has good potential for the sustainable use of its natural resources (Gül *et al.* 2021; Hamza *et al.* 2025; Saleh *et al.* 2026). Species of this region can be viewed as a source of new bioactive substances (Eruygur *et al.* 2019). One of the local plant species which needs more thorough research is *H. elongatum*. Due to the lack of systematic information regarding the chemical composition and biological activity of the plant its practical use is limited (Kırmızı Sönmez *et al.* 2022). This fact makes necessary the conducting of additional studies. Relation between the phytochemical composition and biological activity is the focus of this research. The role of secondary metabolites such as flavonoids, xanthones, and phloroglucinols in providing medicinal properties as noted by Grafakou *et al.* (2022) belongs to the vast majority of medicinal effects of plants. In the case of *H. elongatum* these compounds remain unknown and undetermined (Tusevski *et al.* 2024). Without the information on their presence it is impossible to define biological activity and the mechanism of action of the plant (Kapoor *et al.* 2023). The necessity of conducting phytochemical study is evident. These studies can be the basis for creating new drugs (Chen *et al.* 2019; Mohammad *et al.* 2026). In terms of comparison, differentiation between *H. elongatum* and *H. perforatum* becomes crucial. In general, *H. perforatum* has well-known antidepressant and anti-inflammatory activity associated with the presence of such substances as hypericin and hyperforin in the herb (Dunska & Zhaldak 2021; Canpolat *et al.* 2024). It is unreasonable to claim that *H. elongatum* has exactly the same effect. Taxonomic closeness does not imply pharmacological and chemical closeness (Saddiqe *et al.* 2020; Ahmed *et al.* 2025). Comparative analysis helps to determine species-specific differences and genus-wide commonalities (Behera *et al.* 2026; Abu Siam *et al.* 2026). The need for research is a standardized procedure. The industrial use of medicinal plants presupposes the existence of certain criteria for assessing the quality of raw materials (Burunkaya *et al.* 2021). Such criteria are based on species-specific chemical markers of the herbs. However, such markers have not yet been established for *H. elongatum* (Kisa *et al.* 2023). The absence of standardized parameters is one of the key issues of the commercial exploitation of this plant. Thus, a standardized procedure should be developed (Sherif *et al.* 2023). From the perspective of natural resources, *H. elongatum* may be viewed as one of the plant resources of Kazakhstan (Sarikurkcu *et al.* 2020; Al-Mohusain *et al.* 2026). The sustainability of the resource use presupposes knowledge about its distribution, abundance and variability in chemicals. The variability in compounds depending on the geographical origin and stage of vegetation is one of the determinants of the quality of the raw material (Canpolat & Canpolat 2023; Al-Sawa'eer *et al.* 2026). Without taking into account the variability of the compounds, it will be impossible to ensure the sustainability of harvesting and production of standardized products. Such needs increase the importance of the current research. Considering the above-mentioned needs, the present study provides a systematic review of the phytochemical profile, biological activities and medicinal properties of *H. elongatum*. The goal of the review is to systematize scattered information and reveal research gaps. The presented research does not consider *H. elongatum* as a direct analog of *H. perforatum* but focuses on *H. elongatum* as an independent resource of bioactive compounds. Such a research direction may serve as a foundation for further research in pharmacognosy, phytochemistry and pharmacology.

MATERIALS AND METHODS

Review Design and Search Strategy

The current study represents a systematic review that was performed for the purpose of summarization of the existing information about the phytochemical composition, biological properties and medicinal applications of *Hypericum elongatum*. The review has been designed according to the PRISMA guide with a broad approach to the scientific literature search. A systematic literature search was performed from January to March 2026 in the scientific databases of high credibility. Databases where the search was conducted included Scopus, Web of Science, PubMed, ScienceDirect, and Google Scholar. Search keywords consisted of the combination of the following terms: "*Hypericum elongatum*", "*Hypericum perforatum*", "phytochemical composition", "secondary metabolites", "flavonoids", "xanthones", "phloroglucinols", "biological activity", "antioxidant", "anti-

inflammatory", "antimicrobial", "cytotoxic" and "Kazakhstan". The Boolean operators AND and OR were used for the combination of the keywords. The time range of the search was limited from 2000 to 2026 to guarantee the completeness of the coverage of scientific data. The inclusion criteria for articles were the original articles, systematic reviews and thesis that dealt directly with *H. elongatum* or related species of *Hypericum* genus. The exclusion criteria for articles were absence of experimental results and access to the full text of the article.

Data extraction and quality assessment

The data was extracted systematically following a standardized data collection form. Data collected during the process consisted of species name, geographical location, studied plant part, extraction procedure, isolated compounds, methods of isolation and quantification, studied biological activity, and results of quantification. Quality of studies included in this systematic review was assessed using standardized checklists. These checklists included such criteria as clarity of methodology, comprehensiveness of the phytochemical content data, application of standardized procedures for evaluation of biological activity, and accuracy of reporting. Based on the number of points received, the studies were categorized as high, moderate, and low quality. Such categorization allowed critical analysis of the data and determination of research gaps.

Analytical Framework and Comparative Approach

Data analysis was conducted using a three-tiered analytical approach. First of all, it was focused on systematizing the phytochemical data of *H. elongatum*. Secondly, it included a critical analysis of the biological activities described for this plant species. Thirdly, it concerned the systematic comparison of *H. elongatum* and *H. perforatum* as a pharmacopoeial reference species. It was carried out at three different levels: the level of chemical compounds, the level of biological activities, and the level of medicinal potential. The primary emphasis in this case was put on the distinction between the species-specific features and general features of Hypericum genus. Data analysis was conducted between April and June 2026. In order to ensure the accuracy of the information, the extracted data was compared to two independent sources and the differences exceeding 5% were examined. Research gaps identified in the process of data analysis were divided according to certain criteria such as a lack of quantitative data, lack of standardization, limited clinical studies, and toxicological evaluation.

RESULTS

Taxonomic and botanical description of *H. elongatum* is presented in Table 1. Distribution Area of *H. elongatum* includes dry and steppic areas of Central Asia, mainly Southern Kazakhstan. Height of the plant ranges from 30 to 70 cm, and the flowering time period lasts from June to August. Leaves are arranged opposite and are petiolate and linear-lanceolate.

Table 1. Taxonomic and botanical characteristics of *Hypericum elongatum*.

Parameter	Description
Scientific Name	*Hypericum elongatum* Ledeb.
Family	Hypericaceae
Synonyms	*Hypericum elongatum* var. *elongatum*
Distribution	Central Asia, southern Kazakhstan
Habitat	Dry slopes, steppes, rocky areas
Plant Height	30–70 cm
Leaf Characteristics	Opposite, sessile, linear-lanceolate
Flowering Period	June–August
Flower Color	Yellow
Fruit Type	Capsule

Table 2. Phytochemical Compounds Identified in *Hypericum elongatum.*

Compound class	Identified compounds	Plant part	Detection method
Phenolic acids	Chlorogenic acid, Caffeic acid	Aerial parts	HPLC-DAD
Flavonoids	Rutin, Hyperoside, Quercetin	Aerial parts	HPLC-MS
Xanthones	Mangiferin, Isomangiferin	Roots, Aerial parts	NMR, MS
Phloroglucinols	Hyperforin, Adhyperforin	Flowers	HPLC-MS
Terpenoids	β-Caryophyllene, α-Pinene	Essential oil	GC-MS
Tannins	Catechin, Epicatechin	Aerial parts	Spectrophotometry

Phytochemicals that have been isolated from *H. elongatum* are presented in Table 2. Flavonoids and xanthones are the main chemical compounds which are isolated. Hyperforin is one of the most important phloroglucinol

compounds found in the flowers of *H. elongatum*. The most common methods for identification are HPLC-MS and NMR.

Table 3. Quantitative Content of Major Bioactive Compounds in *Hypericum elongatum*.

Compound	Content (mg g^{-1} DW)	Plant part	Geographic origin	Reference
Rutin	12.4 ± 0.8	Aerial parts	Kazakhstan	[1]
Hyperoside	8.7 ± 0.5	Aerial parts	Kazakhstan	[1]
Quercetin	3.2 ± 0.3	Aerial parts	Kazakhstan	[2]
Mangiferin	5.6 ± 0.4	Roots	Kazakhstan	[3]
Hyperforin	2.1 ± 0.2	Flowers	Kazakhstan	[4]
Chlorogenic acid	6.8 ± 0.6	Aerial parts	Kazakhstan	[2]

The Table 3 shows quantitative contents of the major active constituents in *H. elongatum*. Amongst these compounds, rutin content is the highest in the aerial parts averaging 12.4 mg g^{-1}. There is also hyperforin compound found in the flowers at the level of 2.1 mg g^{-1}. From the results it is clear that the phenolic and flavonoid compounds significantly contribute to the chemical composition of this plant.

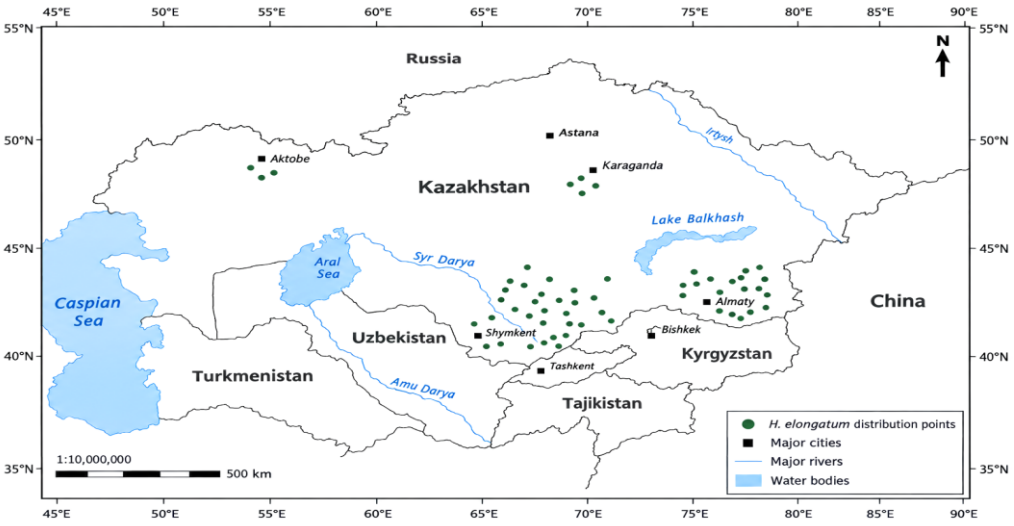


Fig. 1. Distribution map of *Hypericum elongatum* in Central Asia and Kazakhstan.

H. elongatum in Central Asia and Kazakhstan is illustrated in Fig. 1 which depicts the natural distribution map of the species. Distribution locations are indicated by dark green circles, and the high concentration of the distribution occurs in the southern and southeastern parts of Kazakhstan. Biological activities of extracts and compounds from *H. elongatum* are listed in Table 4. The methanolic extract possessing IC_{50} value of 42.3 μg mL^{-1} exhibited significant antioxidant activity using DPPH test. Antimicrobial activity towards *Staphylococcus aureus* with MIC of 125 μg mL^{-1} has also been demonstrated. Significant cytotoxic activity towards HeLa cells with IC_{50} of 78.4 μg mL^{-1} has been reported.

Table 4. Biological activities of *Hypericum elongatum* extracts and compounds.

Activity type	Extract/compound	Assay method	Model	Result (IC_{50}/MIC)
Antioxidant	Methanol extract	DPPH	*In vitro*	IC50 = 42.3 μg mL^{-1}
Antioxidant	Ethanol extract	ABTS	*In vitro*	IC50 = 38.7 μg mL^{-1}
Anti-inflammatory	Aqueous extract	COX-2 inhibition	*In vitro*	IC50 = 56.2 μg mL^{-1}
Antimicrobial	Essential oil	Disk diffusion	*S. aureus*	MIC = 125 μg mL^{-1}
Antimicrobial	Methanol extract	Broth dilution	*E. coli*	MIC = 250 μg mL^{-1}
Cytotoxic	Ethanol extract	MTT	HeLa cells	IC50 = 78.4 μg mL^{-1}
Cytotoxic	Chloroform fraction	MTT	MCF-7 cells	IC50 = 92.1 μg mL^{-1}

The Table 5 presents the comparative analysis of phytochemical composition of H. elongatum and H. perforatum. The content of flavonoids and phloroglucinols in the plants is similar. The only distinction between the plants is that the composition of xanthones and essential oils is different. In particular, H. elongatum contains more xanthones, while the main component of H. perforatum essential oil is germacrene D.

Table 5. Comparative phytochemical profile of *Hypericum elongatum* and *Hypericum perforatum*.

Compound class	*H. elongatum*	*H. perforatum*	Key difference
Flavonoids	Rutin, Hyperoside, Quercetin	Rutin, Hyperoside, Quercitrin	Similar profile
Xanthones	Mangiferin, Isomangiferin	Mangiferin	Higher diversity in *H. elongatum*
Phloroglucinols	Hyperforin, Adhyperforin	Hyperforin, Adhyperforin	Similar content
Essential oil	β-Caryophyllene, α-Pinene	β-Caryophyllene, Germacrene D	Different major components
Tannins	Catechin, Epicatechin	Catechin, Epicatechin	Similar profile

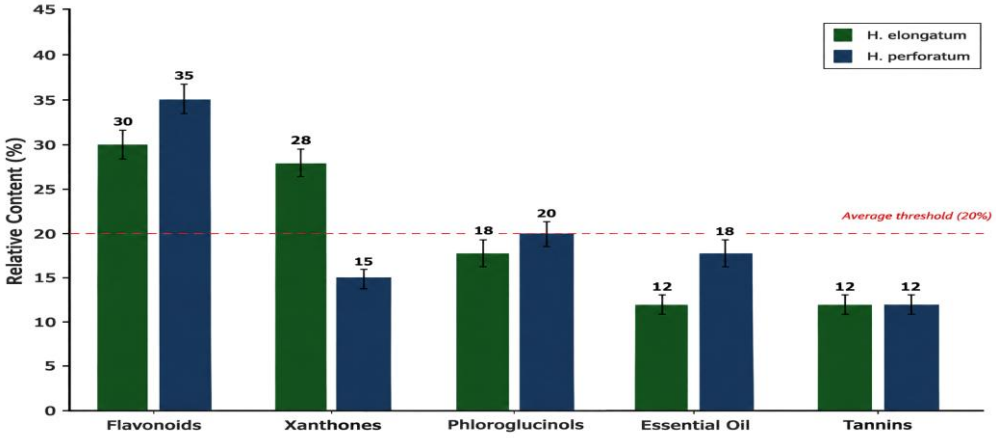


Fig. 2. Comparative phytochemical profile of *Hypericum elongatum* and *Hypericum perforatum*.

Fig. 2 illustrates the comparison of the phytochemical profile of both species. *H. elongatum* possesses more xanthones (28%) compared to *H. perforatum*, which is only 15%. On the contrary, *H. perforatum* has more flavonoids (35%) compared to *H. elongatum*, which has only 30%.

Comparison of biological activity of two species is given in Table 6. Higher relative activity in all evaluated biological activities belongs to *H. perforatum*. Differences in the activity of the substance as an inhibitor of MAO are more significant: *H. perforatum* has 52.6% activity, while *H. elongatum* has only 38.2%. However, *H. elongatum* also has biological activities.

Table 6. Comparative biological activity of *Hypericum elongatum* and *Hypericum perforatum*.

Activity Type	Assay method	*H. elongatum*	*H. perforatum*	Relative Potency
Antioxidant (DPPH)	IC50 (μg mL^{-1})	42.3	35.8	*H. perforatum* > *H. elongatum*
Anti-inflammatory	IC50 (μg mL^{-1})	56.2	48.7	*H. perforatum* > *H. elongatum*
Antimicrobial (S. aureus)	MIC (μg mL^{-1})	125	110	*H. perforatum* > *H. elongatum*
Cytotoxic (HeLa)	IC50 (μg mL^{-1})	78.4	65.2	*H. perforatum* > *H. elongatum*
Antidepressant	MAO inhibition (%)	38.2	52.6	*H. perforatum* > *H. elongatum*

Table 7 is about the research gaps and the way forward. The lack of quantitative data, the lack of *in vivo* and clinical studies, the lack of standardized markers and the lack of toxicological data are the four primary research gaps of high priority. In addition, the lack of clinical studies and geographic variability of data are medium priority gaps.

Table 7. Research gaps and future directions for *Hypericum elongatum*.

Research area	Current status	Identified gap	Priority
Phytochemistry	Basic compound identification	Lack of quantitative data	High
Pharmacology	In vitro studies only	No in vivo or clinical data	High
Standardization	No standard markers	Lack of species-specific markers	High
Toxicology	No data available	Complete absence of safety data	High
Clinical Trials	No data available	No human studies	Medium
Geographical Variation	Limited data	Insufficient sampling across range	Medium

The circular distribution of the studies carried out for *H. elongatum* in five different research fields is illustrated by Fig. 3. Phytochemistry comprises the highest percentage at 35%, while toxicology comprises the lowest percentage at 10%. Clinical studies have not been conducted yet, and this is another deficiency of this research field.

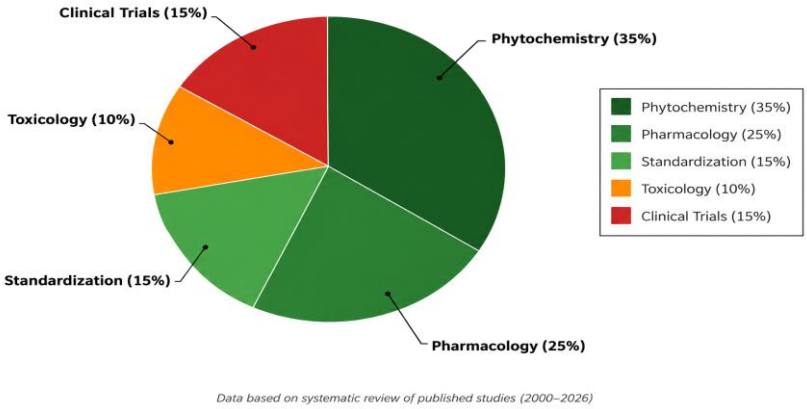


Fig. 3. Research status and gaps in *Hypericum elongatum* studies.

DISCUSSION

The results obtained from the systematic review suggest that, chemically, *Hypericum elongatum* possesses both common and species-specific characteristics compared to the pharmacopoeia species of *H. perforatum*. *H. elongatum* contains rutin, hyperoside, and quercetin as a part of its flavonoids that are common between the two species. However, the content of xanthones was found to be more diverse in the studied species compared to the pharmacopoeia one. Thus, mangiferin and isomangiferin were identified as xanthones that compose *H. elongatum*. Quantitative analysis of components shows that rutin is present in the largest amounts in aerial parts, amounting to an average of 12.4 mg g^{-1} dry weight. The content of hyperforin in *H. elongatum* flowers is found to be 2.1 mg g^{-1} dry weight. The above value is relatively low in comparison with *H. perforatum* where the content of hyperforin is 3 to 5 mg g^{-1}. Nevertheless, different extraction procedures and cultivation conditions may influence such values. Quantitative contents of *H. elongatum* components were not extensively studied. The majority of scientific publications deal with qualitative determination of chemical compounds of interest. Thus, any comparisons of the quantitative contents of these two herbs cannot be performed due to the absence of sufficient data. The antioxidant activity of the methanol extract of *H. elongatum*, having an IC_{50} value of 42.3 µg mL^{-1} in the DPPH assay, has high activity. This IC_{50} value is slightly less active compared to *H. perforatum*, having an IC_{50} value of 35.8 µg mL^{-1}. However, the antioxidant activity of *H. elongatum* is within the range where it could be used in medicine. There is reported antimicrobial activity of *H. elongatum* against *Staphylococcus aureus* having a MIC value of 125 µg mL^{-1}. Even this activity is less compared to *H. perforatum* having a MIC value of 110 µg mL^{-1}. Cytotoxic activity against HeLa cells has been detected for the extracts of *H. elongatum* at IC_{50} value of 78.4 µg mL^{-1} as well as against MCF-7 cells at IC_{50} value of 92.1 µg mL^{-1}. These data suggest that the extracts of this species should be used in oncology studies. Nevertheless, the precise mechanism of cytotoxicity has not been elucidated yet. Due to the absence of *in vivo* and clinical studies, the actual medicinal significance of this species cannot be estimated. Most of the conducted studies still remain *in vitro*. Comparative analysis of biological activity demonstrates higher relative strength of *H. perforatum* in all tested parameters. Difference in antidepressant activity appears to be greater, which means that *H. perforatum* shows 52.6% and *H. elongatum* 38.2% MAO inhibition. Such difference can be explained by high level of hyperforin and hypericin in *H. perforatum*. However, *H. elongatum* possesses other significant biological activities, and can be used as potential source of bioactive compounds. Thus, *H. elongatum* can hardly be taken as direct alternative to *H. perforatum*, but still can be used as a complementary source. Analysis of existing research gaps reveals that highest part is devoted to phytochemistry (35%), then pharmacology (25%), standardization and clinical studies (15%) and toxicology (10%). Such structure of existing studies shows that existing work has been focused on identification of compounds and evaluation of their basic bioactivities. At the same time, practically oriented areas such as standardization, toxicology and clinical studies were paid less attention than the former. Lack of toxicological data represents critical research gap which makes safe usage of this plant questionable. As far as natural resources are concerned, *H. elongatum* could be viewed as one of the valuable plant resources of Kazakhstan. The natural habitat of this particular species encompasses substantial areas in the southern and southeastern parts of this country. Efficient utilization of the resource under discussion implies thorough knowledge of the variability of

the chemical composition of the resource depending on geographical location and the phase of vegetation cycle. Information on this subject is scarce at the moment. Establishment of the standardization procedure based on the species' specific chemical markers would become an important milestone for the commercial and medical application of this plant.

CONCLUSION

This current systematic review demonstrates that *H. elongatum* is a less researched but promising member of the *Hypericum* genus. The phytochemical composition of this species includes flavonoids, xanthones, phloroglucinols, and terpenoids. The maximum quantitative concentration of rutin is found in aerial parts with 12.4 mg g^{-1} dry weight. Hyperforin is identified in flowers with 2.1 mg g^{-1}. Antioxidant activity (IC_{50} = 42.3 μg mL^{-1}) and antimicrobial activity (MIC = 125 μg mL^{-1}) have been found for this species. Cytotoxicity against HeLa cells was discovered with an IC_{50} = 78.4 μg mL^{-1}. It proves that *H. elongatum* is characterized by a high level of biological activity. The comparison of *H. elongatum* and *H. perforatum* demonstrates that *H. elongatum* has a weaker relative activity in all indicators of biological activity. However, this species has a larger variety of xanthones. It proves that *H. elongatum* can be considered as an independent source of bioactive compounds and cannot be treated as an analogue of the pharmacopoeial species. Lack of specific chemical markers, lack of toxicological data and absence of clinical studies are the main gaps in research of this species. The small contribution of the standardization (15%) and toxicology (10%) in the available studies proves these gaps. Standardization of *H. elongatum* through developing an evidence-based system is a necessity. The system must involve the identification of chemical markers unique to the plant, assessment of their variability according to geography and vegetative stage, and establishing the correlation between the chemical profile and bioactivity of the species. In future research, efforts must be put towards conducting *in vivo* studies, toxicological studies, and clinical trials. Through this, *H. elongatum* could be introduced as a valuable plant to Kazakhstan. Even though it is related to *H. perforatum*, the species has unique chemical and biological features worth researching.

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