Traditional medicine of ancient Kazakhs in the treatment of tuberculosis: folk methods in the context of modernity (Review)

Yelena Pozdnyakova

Correspondence

Yelena Pozdnyakova [1*]

[1]Department of Biomedicine, Karaganda Medical University, Karaganda, The Republic of Kazakhstan.

*Corresponding Author: nike_anteros@mail.ru

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Review

Abstract

Background: Tuberculosis remains a pressing global health issue, with millions affected each year despite ongoing efforts to control its spread. Kazakhstan, like many countries with ancient trade routes, encountered the problem of tuberculosis early in its history, leading to the development of unique and historically rooted treatment methods. This study investigates traditional Kazakh methods for treating tuberculosis, focusing on both historical and botanical sources. The purpose is to identify plants and traditional practices that may offer alternative or complementary treatments for tuberculosis.

Methods: The study involved a comprehensive literature review of ancient medical texts and modern databases like Google Scholar, Medline, Scopus, and PubMed. The research included botanical descriptions and analysis of plants' chemical compositions and medicinal properties.

Results: In the literature, 11 plant species were found that were historically used as anti-tuberculosis remedies. Significant anti-tuberculosis activity was identified in *Xanthium strumarium* L., *Achillea micrantha* Willd., *Juniperus communis* L., and *Anabasis aphylla* L.. Additionally, plants like *Illicium verum* Hook.f., *Scutellaria orientalis* L., and *Veronica arvensis* L. show promise for developing new antibacterial drugs. Further research is needed for *Cuscuta planiflora* Ten., *Euphorbia rapulum* Kar. & Kir., *Potentilla sanguisorba* Willd. ex Schltdl., and traditional remedies like Gulkand to explore their potential medical applications.

Conclusions: The findings highlight the relevance of traditional Kazakh medicine in contemporary contexts, especially in light of rising antibiotic resistance. The study suggests that further research into these plants could lead to innovative treatments for tuberculosis and other infectious diseases.

Keywords: Traditional Medicine, Tuberculosis, Kazakh Ethnobotany, Medicinal Plants, Antibiotic Resistance

Background

Tuberculosis is a highly infectious disease caused by the bacterium *Mycobacterium tuberculosis*. Primarily affecting the lungs, it can also spread to other organs (Moule *et al.* 2020).

Archaeological findings indicate that tuberculosis existed long before modern times, with traces found in the remains of ancient human populations (Pálfi *et al.* 2023). Research suggests that the origin of the tuberculosis bacterium occurred around 35,000 years ago in Central Africa (Iwai *et al.* 2010).

Evidence of the disease has been found in Egyptian mummies dating back to 2400 BCE (Zimmerman *et al.* 1979). The disease is also mentioned in Indian and Chinese medical texts, indicating its global spread facilitated by significant migrations, trade routes, and the great migration of peoples (Barberis *et al.* 2017; Prasad *et al.* 2002).

For instance, the Great Silk Road played a significant role in the spread of *Mycobacterium tuberculosis*. O'Neill (2019) highlights that *Mycobacterium tuberculosis* spread along trade routes, including the Silk Road, facilitating the pathogen's migration from East Africa and Southeast Asia. These historical trade routes linked various regions, accelerating the spread of tuberculosis and influencing its epidemiological characteristics across different cultures (O'Neill *et al.* 2019).

Maritime trade routes also played an essential role in the spread of tuberculosis. Research shows how Lineage 4 of *Mycobacterium tuberculosis* spread in Southern China under the influence of the Maritime Silk Road and the migration of the "Huguang Filling Sichuan" population. These trade routes facilitated the exchange of not only goods but also diseases like tuberculosis, spreading them to new territories and altering the epidemiological landscape (Wu *et al.* 2021).

The ancient Silk Road was a network of trade routes connecting East Asia with Europe. Its total length was about 7,000 kilometers, passing through the territories of 21 modern states. The ancient Silk Road traversed the territories of present-day China, Mongolia, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan, Afghanistan, Iran, Iraq, Syria, Turkey, India, Pakistan, and Lebanon. Caravans took three years to cover this distance (Sadikov 2008).

Over millennia, the Great Silk Road gained immense logistical importance. This network of roads connected the major centers of China, India, the Middle East, and Central Asia during antiquity and the early Middle Ages, up until the Great Geographical Discoveries of the 16th century (Kydyrali 2016). Merchants, travelers, and caravans passing through the cities along the Silk Road contributed to the spread of tuberculosis and other infectious diseases. The disease could be transmitted through close contact between people in caravans and trade settlements along the route (Wu *et al.* 2021).

Traditional methods of treating tuberculosis have been used for thousands of years in various cultures and regions. These methods were based on the use of resources such as herbs, minerals, and animal products. In ancient India, herbs like Tulsi (*Ocimum tenuiflorum* L.) and Neem (*Azadirachta indica* A.Juss.) were used to treat tuberculosis due to their remarkable antimicrobial properties (Nagasree *et al.* 2022, Shivarkar *et al.* 2023). In ancient China, herbs like *Botrychium lanuginosum* Wall. and *Peperomia dindygulensis* Miq. were used, as recorded in the Dongba Sutra, sacred texts of the Naxi people in southwest China. These texts include medicinal recipes that form part of the Naxi's shamanic and religious practices (Zhang et al. 2022). In Iraq, several plants have traditionally been used to treat tuberculosis, including *Apium graveolens* H.Wolff, *Cinnamomum cassia* (L.) J.Presl, *Commiphora molmol* (Engl.) Engl. ex Tschirch, *Cuminum cyminum* L. and others . These plants possess antimicrobial properties and could serve as a basis for developing new anti-tuberculosis drugs (Dheyab *et al.* 2019).

In modern Kazakhstan, where the Silk Road once passed, several ancient cities played key roles in trade and cultural exchange between East and West (Figure 1).

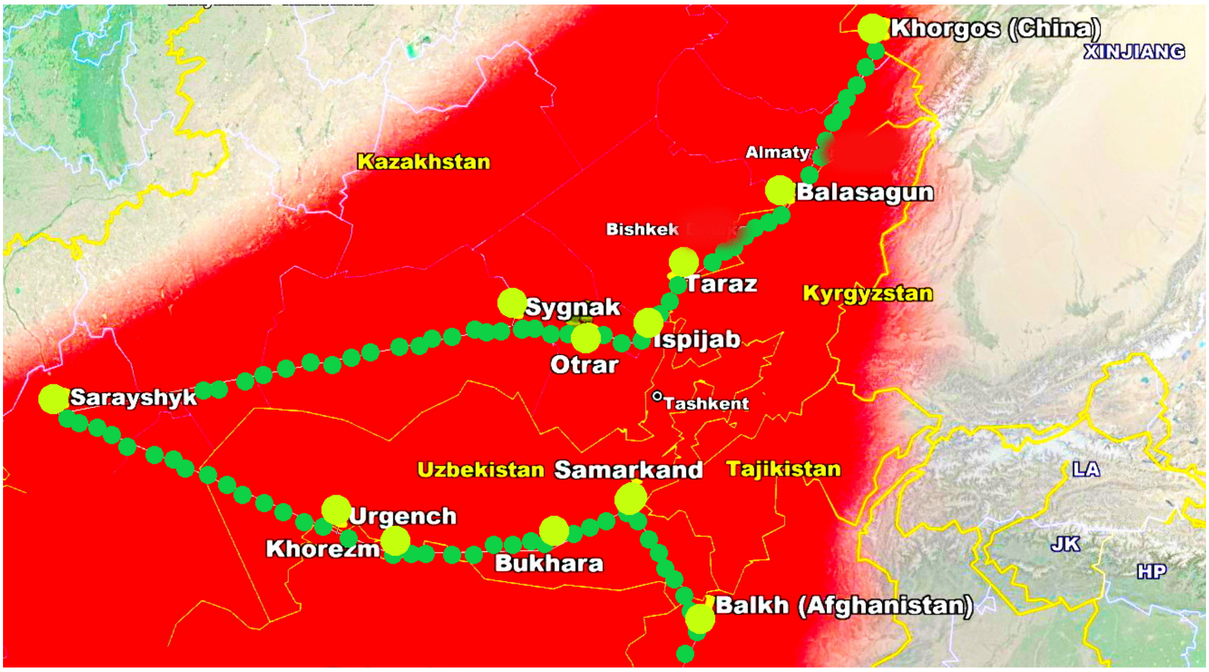

Figure 1. Cities of the ancient Great Silk Road on the territory of Kazakhstan

Turkestan – located in southern Kazakhstan, was a significant center on the Silk Road. The ruins of Sauran can still be found 40 km north of Turkestan. Otrar – between modern-day Turkestan and Shymkent, was a key trade hub, also known as Farab, but was destroyed by the Mongol invasion in the 13th century. Taraz – with its rich heritage, played a crucial role in trade and cultural exchange on the Silk Road. Isfijab (now a district of Shymkent) was known for its markets and craft workshops and served as an important trading center along the route. Balasagun – located in the Chu Valley in present-day Zhambyl district, was a major cultural and commercial hub. Sygnaq was another key point on the Silk Road, with its ruins now found in modern Kyzylorda region (Baipakov 1990; Zhetpysbayev 2020).

Dense populations in these trade settlements, along with poor hygiene and overcrowding in caravans, contributed to the spread of diseases. Climatic conditions, such as harsh winters and inadequate housing, also facilitated the spread of tuberculosis (Roberts & Buikstra 2003). The renowned Russian general, military publicist, and orientalist Dmitry Nikolayevich Logofet, in his book dedicated to the Bukhara Khanate, listed nine of the most common diseases among the local population, including malaria, gastrointestinal diseases, guinea worm disease, leprosy, goiter, syphilis, eye diseases, and tuberculosis (Logofet 1911).

Despite significant advances in modern medicine, the problem of tuberculosis treatment remains relevant, especially in the context of increasing antibiotic resistance (Liebenberg *et al.* 2022). This has led to a growing interest in studying traditional methods of tuberculosis treatment, which may offer alternative or complementary approaches to the disease (Fatima, 2020). The treatment traditions of the ancient Kazakhs, as a nomadic people, were closely linked to their lifestyle and surrounding nature. The Kazakhs developed a unique system of medicine based on the use of natural resources, knowledge passed down through generations, and deep respect for the forces of nature (Jumagalieva *et al.* 2020).

Therefore, the aim of this study was to conduct a literature review to identify traditional methods of tuberculosis treatment used by the Kazakh people.

Materials and Methods

The study of traditional Kazakh methods of treating tuberculosis was conducted through both manual reading of ancient medical texts and diaries of researchers in Kazakhstan. To explore the modern medical relevance of these traditional treatments, databases such as Google Scholar, Medline, Scopus, PubMed, eLibrary, and Cyberleninka were searched. The search was conducted using various keywords, including the Latin names of the identified plant species. Descriptions of the plants were obtained from the World Flora Online (WFO) database. (https://www.worldfloraonline.org/). Plant names are listed according to Plants of the World Online (http://www.plantsoftheworldonline.org/).

Results and Discussion

Treatment of tuberculosis in Kazakhstan using animal products

Traditionally, animal-derived products such as fats and kumis have been used in Kazakh folk medicine to treat tuberculosis, based on the belief in their healing properties (Ospan *et al.* 2017). Kumis, known in Kazakhstan since ancient times, has been proven effective against tuberculosis. An analysis of ancient pottery residues dating back to 3500 BCE found evidence of mare's milk processing in Northern Kazakhstan (Outram *et al.* 2009). The anti-tuberculosis effect of kumis was first described in 1861 by military doctor N. Zeland (Kudayarova *et al.* 2010).

In the late 19th century, Russian physician and researcher Valerian Kushelevsky wrote that tuberculosis (consumption) was treated with the same remedies as a cough, including goat and mare's milk, and chicken as food (Kushelevsky 1891). Staff physician Alphonse Yagmin, who served at the Iletsk Salt Mines from 1838 to 1843, praised the benefits of kumis for conditions such as neurosyphilis, pulmonary consumption (tuberculosis), dropsy, anemia, scurvy, and various digestive disorders (Yagmin 1845).

Kumis, a fermented dairy product made from mare's milk, is known for its unique medicinal properties due to its composition. Studies show that mare's milk contains 2.8g of protein, 2.8g of lactose, and 1.6g of fat per 100g, making it similar in composition to human milk. This makes kumis not only nutritious but also easily digestible (Usupkozhoeva *et al.* 2018).

Kumis contains biologically active substances such as lactoferrin, angiogenin, and essential polyunsaturated fatty acids, and is rich in vitamins and minerals. Lactoferrin has anticancer, antiviral, and antibacterial properties, while angiogenin promotes blood vessel growth, which is important in heart diseases (Shepeleva *et al.* 2019, Musaev *et al.* 2021).

A study analyzing the treatment of 389 tuberculosis patients, half of whom received kumis as the sole therapeutic agent, showed that kumis increases the overall treatment efficacy and reduces allergic reactions to antibacterial drugs (Chepulis & Grishayenko 1978).

For instance, in Mongolia, kumis has traditionally been used to treat tuberculosis. At the Mongolian Medical Research Institute Siman, kumis treatment led to recovery in 60-91% of cases, as confirmed by X-rays and tuberculosis tests, highlighting its high therapeutic efficacy (Dong *et al.* 2015).

Today, Kazakhstan remains the world's largest producer of kumis (Siddiqui *et al.* 2023).

Treatment of tuberculosis in Kazakhstan using plants

An analysis of the literature identified 11 plant species from 9 different families traditionally used to treat tuberculosis (Table 1).

Table 1. Plant Species with anti-tuberculosis properties based on literature data.

Family	Plant species	Life form / plant part used	Type of tuberculosis
Asteraceae	*Achillea micrantha* Willd.	herbaceous plant / whole plant	Tuberculosis (type unspecified) "…The plant decoction is consumed for stomach diseases and bleeding; it is also taken as an anti-tuberculosis, anti-hemorrhoidal, and anti-fever remedy…" (Karomatov 2012).
Asteraceae	*Xanthium strumarium* L.	herbaceous plant / seeds	Tuberculosis of the glands "…The seeds are smoked in cases of glandular tuberculosis…" (Sakhobiddinov 1948).
Chenopodiaceae	*Anabasis aphylla* L.	herbaceous plant / root	Tuberculosis (type unspecified) "…The root decoction is used to treat tuberculosis…" (Lipisky 1907).
Convolvulaceae	*Cuscuta planiflora* Ten.	herbaceous vine / flowers	Pulmonary tuberculosis "… Use: for mental depression and for consumption [tuberculosis] …" (Monteverde & Gammerman 1927).

Cupressaceae	*Juniperus communis* L.	shrub / berries, needles	Pulmonary Tuberculosis "...A decoction of juniper roots is used in the treatment of bronchial asthma, tuberculosis, and kidney stones..." (Khodzhimatov 1989).
Euphorbiaceae	*Euphorbia rapulum* Kar. & Kir.	herbaceous plant / root	Pulmonary Tuberculosis "...The dried, crushed root is taken for pulmonary tuberculosis; the root is also considered a good laxative..." (Sakhobiddinov 1948).
Illiciaceae	*Illicium verum* Hook.f.	tree / fruits	Pulmonary tuberculosis This is imported raw material. The native region of Illicium verum is Southeast China. "... for tuberculosis. Take 300 g of fruits, crush them, pour 3 liters of water, boil for 30 minutes, drink 1/2 glass 3 times a day before meals for 40 days..." (Muravyeva & Gammerman 1991).
Lamiaceae	*Scutellaria orientalis* L.	herbaceous plant / whole plant	Pulmonary Tuberculosis "...A decoction of the entire plant is taken for pulmonary tuberculosis..." (Nosal 1958).
Rosaceae	*Cydonia oblonda* Mill. (Syn.: *Cydonia vulgaris* Pers.)	tree / fruits, juice	Pulmonary tuberculosis "...Fruits, cleansed of seeds, filled with cow's butter, and baked in ashes, were used for inflammatory diseases of the upper respiratory tract, chronic cough, and hemoptysis associated with tuberculosis..." (Sakhobiddinov 1948).
Rosaceae	*Potentilla sanguisorba* Willd. ex Schltdl.	herbaceous plant / whole plant	Tuberculosis (type not specified) "...The decoction is taken orally for diarrhea and tuberculosis..." (Sakhobiddinov, 1948).
Scrophulariaceae	*Veronica arvensis* L.	herbaceous plant / whole plant	Tuberculosis of the lungs "...A decoction of the plant is taken for throat inflammation, hemoptysis, tuberculosis, and rheumatism; externally, it is used for chronic skin diseases..." (Nosal 1958).

We also conducted an analysis using scientometric databases to determine the properties of the plants we identified and how they are used in modern medicine. The results are presented in Table 2.

Table 2. Literature reports on pharmacological and phytochemical properties of documented anti - tuberculosis plants.

Plant species	**Reported phytochemical constituents**	**Pharmacological activity reported**	**Anti-tuberculosis activity**
Achillea micrantha Willd.	Essential oils (cineole, camphor, thujone), flavonoids (apigenin, luteolin, quercetin, kaempferol), alkaloids, coumarins, tannins. (Hatam *et al.* 1992)	Antimycobacterial, antibacterial, antimicrobial. (Genatullina *et al.* 2020, Sampietro *et al.* 2016, Astafyeva *et al.* 2018)	Report available (Genatullina *et al.* 2020)
Anabasis aphylla L.	Alkaloids (anabasine, aphylline, aphillidin, lupinine), organic acids, carbohydrates, pectic acids, glycopyranosides, flavonoids. (Du *et al.* 2009, Yang *et al.* 2010)	Antibacterial, anti-tuberculosis, antimicrobial (Esmaeilzadeh Kashi *et al.* 2023, Sun *et al.* 2022, Du *et al.* 2009, Babaev *et al.* 2010)	Report available (Esmaeilzadeh Kashi *et al.* 2023)
Cuscuta planiflora Ten.	No reports	Antidepressant (Firoozabadi *et al.* 2015)	No reports

Cydonia oblonda Mill.	Sugars, organic acids, pectins, phenolic compounds, flavan-3-ols, derivatives of kaempferol and quercetin, Fe, Cu, mucilage, starch, and fatty oil. (Silva *et al.* 2004a, 2005b, Wojdyło *et al.* 2013, Rather *et al.* 2023, Oliveira *et al.* 2007)	Antiviral, immunomodulatory, antibacterial, antioxidant, anti-inflammatory, anticancer. (Ansari *et al.* 2020, Abed *et al.* 2022, Hindi *et al.* 2024, Alizadeh *et al.* 2013, Karar *et al.* 2014, Cerempei *et al.* 2016, Bystricka *et al.* 2017, Sabir *et al.* 2024, Muzykiewicz *et al.* 2018, Gubitosa *et al.* 2023)	No reports
Euphorbia rapulum Kar. & Kir.	No reports	No reports	No reports
Illicium verum Hook.f.	Essential oils (anethole, methyleugenol, anisaldehyde) (Skalicka-Woźniak *et al.* 2013). The seeds contain glycosides and fatty oils (Fujimatu *et al.* 2003). The fruits contain essential oils. (Miyagawa *et al.* 2014, Wu *et al.* 2016)	Antimicrobial, antibacterial, antiviral, anticancer, antioxidant, antidiabetic, bone-protective. (Boota *et al.* 2018, Yang *et al.* 2010, Muhsinah *et al.* 2021, Outemsaa *et al.* 2021, Li *et al.* 2022, Liu *et al.* 2020, Patra *et al.* 2020, Pahore *et al.* 2023)	No reports
Juniperus communis L.	Sugars, resin, wax, fatty oil, flavonoids, organic acids, essential oil (pinene, camphene, terpineol), rutin, quercetin. (Cabral *et al.* 2012, Mustafa *et al.* 2016)	Antimycobacterial, antibacterial, anti-inflammatory, antioxidant, antitumor (Carpenter *et al.* 2012, Gordien *et al.* 2009, Ivanova *et al.* 2021, Huang *et al.* 2021, Bais *et al.* 2017, Gao *et al.* 2019, Fernandez *et al.* 2016, Maurya *et al.* 2018, Elshafie *et al.* 2020, Najar *et al.* 2020, Khan *et al.* 2021)	Report available (Carpenter *et al.* 2012)
Potentilla sanguisorba Willd. ex Schltdl.	No reports	No reports	No reports
Scutellaria orientalis L.	Flavonoids (baicalein, wogonin, scutellarein), phenylethanoid glycosides. (Gharari *et al.* 2022)	Antimicrobial, antioxidant, tyrosinase-inhibitory. (Yilmaz *et al.* 2020, Zengin *et al.* 2019)	No reports
Veronica arvensis L.	No reports	Antibacterial, antiphytoviral, general tonic, antiscorbutic, diuretic. (Nazlić *et al.* 2023, Chopra *et al.* 1945)	No reports
Xanthium strumarium L.	Phenolic acids, tannins, anthocyanins, flavonoids, polyphenols, proteins, fiber, carotene, ascorbic acid, macro- and microelements, pectin substances, amino acids (Azimbaeva *et al.* 2020, Sidelnikova *et al.* 20182)	Antibacterial, anthelmintic, antifungal, antimicrobial, anti-inflammatory (Zazharskyi *et al.* 2024, Kurrey *et al.* 2020, Khuda, 2012 *et al.* Kim, 2014, Sharifi-Rad *et al.* 2016, Seo *et al.* 2019)	Report available (Zazharskyi *et al.* 2024)

***Cydonia oblonga* Mill.** (Syn.: *Cydonia vulgaris* Pers.) (Rosaceae)

Cydonia oblonga – is a small deciduous tree, typically growing to a height of 5 to 8 meters with a dense crown and a crooked trunk covered in pale gray bark. The leaves are simple, ovate, dark green on top with a whitish underside. The flowers are white to pale pink, blooming in late spring, and the fruit is pear-shaped, bright yellow when ripe, with a strong fragrance and hard, astringent flesh. Native to southwest Asia, quince has been cultivated for its edible fruit, which is used in cooking and traditional medicine.

Chemical composition: The fruits of *C. oblonga* contain up to 16% sugars, organic acids, pectins, and phenolic compounds (Silva *et al.* 2004, Silva *et al.* 2005). Additionally, 9 flavan-3-ols (including (-)-epicatechin, procyanidin B2, and derivatives) and various kaempferol and quercetin derivatives have been identified (Wojdyło 2013). The fruits are also rich in iron and copper salts. The seeds contain up to 20% mucilage, starch, fatty oil, protein, tannins, and the enzyme emulsin, along with amygdalin (Rather *et al.* 2023). The leaves contain caffeic acid, quercetin, and kaempferol (Oliveira *et al.* 2007).

Antibacterial properties. Recent studies have confirmed the antiviral and immunomodulatory activity of *C. oblonga*. A study on its role in traditional Unani medicine showed that extracts of this plant possess significant antiviral, anti-influenza, antitussive, and immunomodulatory activities (Ansari *et al.* 2020). The extract of *C. oblonga* also exhibited significant antibacterial activity against both Gram-positive and Gram-negative bacteria. It has been shown to inhibit adhesion and biofilm formation, making it potentially useful for treating bacterial infections (Hindi *et al.* 2024).

The antibacterial effect of *C. oblonga* extracts against *Klebsiella pneumoniae*, *Escherichia coli*, and *Enterobacter aerogenes* has been demonstrated, with ethanol extracts of the seeds being most effective, particularly against *E. coli*. These findings suggest that quince extracts could be beneficial for controlling infections caused by Enterobacteriaceae (Alizadeh *et al.* 2013). Polyphenols from quince fruits were studied using liquid chromatography-mass spectrometry (LC-MS) and demonstrated antibacterial activity against *E. coli*, particularly chlorogenic acid and its derivatives. Antibacterial activity was determined using agar diffusion assays (Karar *et al.* 2014).

A study on four varieties of *C. oblonga* revealed their high polyphenol content and antioxidant activity. Quince fruits have significant antibacterial, anti-inflammatory, and anticancer properties, with the "Konstantinopler Apfelquitte" variety showing the highest content of biologically active compounds and antioxidant activity (Bystricka *et al.* 2017).

Quince extracts have shown strong antioxidant and antibacterial activity against *Pseudomonas* aeruginosa and *Staphylococcus aureus*. These properties make quince a promising source of bioactive metabolites for use in medicine (Sabir *et al.* 2024).

In traditional Pakistani medicine, *C. oblonga* fruits are also used to treat cough, lung diseases, sore throat, and pneumonia (Rehman *et al.* 2023).

***Veronica arvensis* L.** (Scrophulariaceae)

Veronica arvensis L. is a low-growing annual herbaceous plant in the Plantaginaceae family, typically reaching a height of 5 to 20 centimeters. It has a sprawling habit with hairy stems and small, ovate, finely toothed leaves. The flowers are small, with blue or violet petals and a white center, and they are borne in clusters at the ends of the stems.

Chemical composition: No studies are available.

Antibacterial properties. In a study conducted by a team of authors, the antiviral and antibacterial activity of essential oils and hydrosol extracts from five species of Veronica, including *V. arvensis*, was evaluated. The results showed that the essential oils of *V. arvensis* exhibited significant antibacterial activity, particularly against *Listeria monocytogenes* and *Enterococcus faecalis*. The hydrosol extracts also showed antiviral activity against the tobacco mosaic virus (Nazlić *et al.* 2023).

According to Chopra and co-authors in the "Glossary of Indian Medicinal Plants," *V. arvensis* is traditionally used in medicine for its general strengthening, anti-scurvy, and diuretic properties. The plant is used to treat scurvy and as a remedy for healing skin lesions, burns, ulcers, and painful hemorrhoids (Chopra *et al.* 1945).

***Xanthium strumarium* L.** (Asteraceae)

Xanthium strumarium L. typically grows to a height of 30 to 120 centimeters and is characterized by its rough, hairy stem and broad, triangular leaves with serrated edges. The plant produces small, greenish flowers that develop into distinctive, spiny burs. These burs are covered in hooked spines, allowing them to cling to animal fur and clothing, facilitating seed dispersal. The plant is native to North America but has spread to various regions worldwide, often found in disturbed soils, fields, and along roadsides. *X. strumarium* is considered a weed in many areas due to its aggressive growth and tendency to outcompete native vegetation.

Chemical composition: the aerial parts of *X. strumarium* (leaves, stems) contain phenolic acids, tannins, anthocyanins, flavonoids, polyphenols, proteins, fiber, carotene, and ascorbic acid. It also has 10 macro- and microelements: copper, zinc, manganese, iron, cobalt, cadmium, lead, nickel, chromium, and potassium. The pectin content in the leaves is 3.1%, and in the stems, it is 5.7% (Azimbaeva *et al.* 2020). Seven compounds were identified in the water-alcohol extract of Xanthium strumarium, including epixanthanol, epi-isoxanthanol, p-methoxyphenylcaprinoate, and axillarin. Fractions with a high content of organically bound iodine were also discovered (Sidelnikova *et al.* 2018).

Antibacterial properties. In a study on the antibacterial and anthelmintic activity of *X. strumarium* extracts, extracts from various parts of the plant were tested on 13 bacterial species and larvae of three nematode species. Ethanol extracts from the fruits, leaves, shoots, and roots showed significant inhibition of the growth of several bacterial species, including *Staphylococcus aureus* and *Escherichia coli*, though anthelmintic activity was not observed (Zazharskyi *et al.* 2024).

Extracts from the leaves of *X. strumarium* demonstrated antibacterial activity against Escherichia coli and Bacillus subtilis. The study utilized various solvents for extraction and found that the extracts contained many phytochemical components, such as saponins and flavonoids, which may be used to develop medicinal drugs (Kurrey *et al.* 2020).

Research evaluated the antimicrobial potential of alcohol extracts and various fractions of *X. strumarium* and *Duchesnea indica* against different strains of bacteria and fungi. The chloroform fraction from *X. strumarium* showed significant activity against *Escherichia coli*, *Shigella flexneri*, *Bacillus subtilus*, and *Staphylococcus aureus*, with particular effectiveness against gram-positive bacteria. The fractions also exhibited antifungal activity against *Aspergillus flavus*, *Fusarium solani*, and *Microsporum canis*. These results indicate the potential of these plants as sources of antimicrobial compounds (Khuda *et al.* 2012).

Another study found that ethanol extracts of *X. strumarium* exhibit antimicrobial activity against oral microorganisms, including *Streptococcus mutans* and *Porphyromonas gingivalis*. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined for various bacteria, showing the potential of the extracts for use in oral care products (Kim *et al.* 2014).

The chemical composition and biological activity of *X. strumarium* essential oil were analyzed in another study. The essential oil, containing 34 components, including cis-β-guaiene and limonene, demonstrated antimicrobial activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Candida albicans*, and *Aspergillus niger*. It also showed scolicidal activity against *Echinococcus granulosus*, indicating its potential as a new chemotherapeutic agent (Sharifi-Rad *et al.* 2015).

***Anabasis aphylla* L.** (Chenopodiaceae)

Anabasis aphylla L. – is a common plant of the steppes and deserts of Central Asia, often found near groundwater, along lake and river shores. It is a perennial shrub, growing up to 50 cm in height, with a thick, woody root system that can extend up to 12 meters deep. The plant has woody stems, jointed, succulent, cylindrical, and leafless annual shoots. The flowers are small, white or pink, clustered at the ends of stems and branches. The fruit is berry-like. *A. aphylla* is highly toxic and not grazed by livestock.

Chemical composition: *A. aphylla* contains up to 12% alkaloids, including anabasine, aphylline, aphyllidine, lupinine, pyridine alkaloid 1, N-methylanabasine, anabasamine, and isonicotine (Du *et al.* 2009). It also contains organic acids, such as oxalic and citric acids; carbohydrates; and pectic acids (Karomatov 2016). Other identified compounds include glucopyranosides, picein, isorhamnetin, quercetin, rutin, and isorhamnetin-3-rutinoside (Yang *et al.* 2010).

Antibacterial properties. A study by Esmaeilzadeh Kashi et al. (2023) evaluated the antibacterial, anti-tuberculosis, and cytotoxic activity of methanol-dichloromethane extracts of *A. aphylla* along with other plants. The study found that the extracts exhibit moderate activity against *Mycobacterium tuberculosis* and bacteria such as *Bacillus subtilis*. However, significant cytotoxic activity against cancer cells was not observed for this plant, unlike some other tested plants.

Another study identified and characterized chemical components from *A. aphylla*, including ten compounds such as anabasine and cytisine. These compounds were assessed for their antibacterial activity against various pathogenic microorganisms. Notably, 2-hydroxybenzoic acid demonstrated significant antibacterial activity against *Xanthomonas vesicatoria* and other bacteria, with a minimum inhibitory concentration as low as 10.0 μg/mL. The study also identified two new compounds, *A. aphylla* A and B, isolated from this genus for the first time (Sun *et al.* 2022).

Another study showed that phenolic compounds from *A. aphylla* possess antimicrobial activity. Specifically, the plant's alcoholic extracts demonstrated bactericidal effects, indicating their potential use as a topical antiseptic for treating skin infections, such as ringworm (Du *et al.* 2009).

Babayev et al. (2010) studied the synthesis and biological properties of phosphorylated derivatives of anabasine, one of the key alkaloids found in *A. aphylla*. These derivatives exhibited antibiotic, anti-enzyme, and anti-cholinesterase properties, suggesting their potential use in pharmacology for developing new therapeutic agents.

***Achillea micrantha* Willd.** (Asteraceae)

Achillea micrantha Willd. – is a perennial herbaceous plant typical of steppe and meadow habitats. It reaches a height of 30-60 cm, with an erect stem and pinnately dissected leaves with narrow segments. The small flowers are grouped in dense, umbrella-shaped inflorescences, usually white or pinkish.

Chemical composition: The plant contains essential oils (cineole, camphor, thujone), flavonoids (apigenin, luteolin, quercetin, kaempferol), alkaloids, coumarins, tannins, and resins (Hatam *et al.* 1992).

Antibacterial properties. Analysis of extracts from *A. millefolium* and *A. micrantha* revealed antimycobacterial activity against *M. lufu* and *M. tuberculosis*, with *A. micrantha* showing significant antibacterial activity comparable to rifampicin (Genatullina *et al.* 2020).

Further research demonstrated that *A. micrantha* extracts exhibit significant antibacterial activity. In ethanol extracts, 71 low-molecular-weight organic compounds were identified. Tests against bacterial strains such as *E. coli*, *St. aureus*, and *Ps. aeruginosa* showed a strong inhibitory effect, with a minimum inhibitory concentration (MIC) as low as 0.05 µg/mL, indicating a high antibacterial potential compared to other species like *A. millefolium* (Astafyeva *et al.* 2018).
Additional studies confirmed the presence of biologically active substances in *A. micrantha* with pronounced antimicrobial activity. The main components of the extracts include terpene compounds such as piperitone, carvone, and camphor, which make up 69.7% of the composition. These extracts demonstrated antimicrobial activity comparable to gentamicin and were more effective than *A. millefolium* extracts. This opens up prospects for using *A. micrantha* in developing new antibacterial drugs (Astafyeva *et al.* 2020).

***Scutellaria orientalis* L.** (Lamiaceae)

Scutellaria orientalis L. – is a perennial herbaceous plant found in temperate and subtropical regions, growing to a height of 15 to 50 cm. It has slender, branched stems with narrow, serrated leaves. The flowers are bright blue or violet, with a distinctive helmet-like shape, typical of the genus Scutellaria. The plant blooms during the summer months.

Chemical composition: Scutellaria orientalis contains flavonoids such as baicalein, wogonin, scutellarein, and their glycosides, as well as chrysin, tricin, skullcapflavone II, pinocembrin, and phenylethanoid glycosides like acteoside and verbascoside (Gharari *et al.* 2022).

Antibacterial properties. A study focused on the antimicrobial activity of methanolic extracts from various taxa of *S. orientalis* found that these extracts exhibit moderate to low antimicrobial activity compared to existing literature (Yilmaz *et al.* 2020).

***Juniperus communis* L**. (Cupressaceae)

Juniperus communis L. is an evergreen tree that can reach up to 25 meters in height, with spreading branches and a dense conical crown. The bark is reddish, and the shoots are highly branched, short, thick, and dark green. The tree has scale-like leaves that are elongated-lanceolate, and needle-like leaves that are thin and lanceolate. The fruit is a fleshy, berry-like cone with a bluish bloom, small, and contains three seeds.

Chemical composition: The fruits of various juniper species contain up to 40% sugars, resin, wax, fatty oil, flavonoids – biflavonoids (50%), scutellarein-7-O-glucoside (22%), and apigenin glycosides (14%), organic acids – malic, acetic, and formic acids (Cabral *et al.* 2012). All parts of the plant contain essential oil, which includes pinene, camphene, terpineol, borneol, juniper camphor, α-terpinene, α-phellandrene, vitamin C, chlorogenic, p-hydroxybenzoic, caffeic, ferulic, vanillic, rosmarinic, cinnamic acids, rutin, quercetin, and naringenin (Mustafa *et al.* 2016). The branches and needles of juniper contain quercetin-

3-O-(6"-O-acetyl)-β-D-glucopyranoside, hypolaetin-7-O-β-D-glucopyranoside, isoquercetin, 4-epi-abietic acid, β-sitosterol, and vitamin C (Taviano *et al.* 2011).

Antibacterial properties. Research has identified antimycobacterial components in the aerial parts of *J. communis*, traditionally used by indigenous peoples of North America to treat tuberculosis. Methanol extracts of the needles and branches were fractionated to assess inhibitory activity against *Mycobacterium tuberculosis*, with isocupressic acid, communic acid, and deoxypodophyllotoxin demonstrating antimycobacterial activity (Carpenter *et al.* 2012).

The antimycobacterial activity of components extracted from the roots and aerial parts of *J. communis* showed significant effectiveness against *Mycobacterium tuberculosis* and drug-resistant strains, highlighting its potential as a source of new anti-tuberculosis drugs (Gordien *et al.* 2009). Additionally, the essential oils and berry extracts of *J. communis* have demonstrated notable antioxidant, antibacterial, and cytotoxic activities, particularly against gram-positive bacteria, fungi, and cancer cells, confirming their potential as natural antimicrobial and therapeutic agents for treating infections, autoimmune, and oncological diseases (Fernandez *et al.* 2016, Maurya *et al.* 2018, Elshafie *et al.* 2020, Najar *et al.* 2020, Khan *et al.* 2021, Esteban *et al.* 2023). Comparative analyses of various juniper species also supported these findings, suggesting the use of *J. communis* as a natural antimicrobial agent (Ivanova *et al.* 2023, Mërtiri *et al.* 2024).

***Cuscuta planiflora* Ten.** (Convolvulaceae)

Cuscuta planiflora Ten. – is a parasitic plant. It lacks its own green leaves and roots, drawing nutrients by attaching to host plants via specialized structures called haustoria. The plant typically has thin, thread-like stems that are yellowish or orange in color and small flowers. It is found in various regions with warm climates, where it parasitizes wild and cultivated plants.
Chemical composition: No studies available.

Antibacterial properties: No studies available.

One study assessed the efficacy of *C. planiflora* in treating severe depression. In a randomized, triple-blind controlled trial, 43 patients with severe depression were divided into three groups: one received *C. planiflora* capsules alongside standard treatment, another received Nepeta menthoides capsules with standard treatment, and the third received only standard treatment. After 8 weeks, significant symptom reduction was observed in patients taking the herbal treatments, indicating the potential effectiveness of *C. planiflora* as an accessible and safe treatment for depression (Firoozabadi *et al.* 2015).

***Illicium verum* Hook** (Illiciaceae)

I.llicium verum Hook – is an evergreen tree native to the southern regions of China and Vietnam. It can grow up to 10 meters tall and has lanceolate, dark green leaves. The flowers are yellowish-white with large petals, and the fruit is a distinctive star-shaped pod containing seeds with a strong aroma and sweet-spicy flavor.

Chemical composition: the fruits and leaves of star anise contain up to 6% essential oil, predominantly composed of anethole (up to 90%). Other compounds include methyleugenol, anisaldehyde, anisic ketone, anisic acid, linalool, terpinen-4-ol, α-terpineol, and foeniculin (Skalicka-Woźniak *et al.* 2013). The seeds also contain fatty oil, proteins, and several glucosides (Fujimatu *et al.* 2003). The star anise fruit contains 2.5% to 3.5% of aromatic, syrupy essential oil, with trans-anethole as the main component, along with other compounds like estragole and cisanethole (Miyagawa *et al.* 2014), and sesquiterpenoids like veranisatins A, B, and C (Wu *et al.* 2016).

Antibacterial properties. *I. verum* exhibits significant antimicrobial properties primarily due to the trans-anethole component. Studies have shown that the essential oils of *I. verum* are effective against various bacterial pathogens, including drug-resistant strains such as *Acinetobacter baumannii* and *Pseudomonas aeruginosa*. The antibacterial activity is linked to flavonoids like quercetin and shikimic acid, confirming its potential in combating bacterial infections (Boota *et al.* 2018, Yang *et al.* 2010, Muhsinah *et al.* 2021, Outemsaa *et al.* 2021).

I. verum also demonstrates significant antiviral activity. Studies have shown that compounds from I. verum, such as (-)-bornyl p-coumarate, outperform drugs like Tamiflu in combating the influenza *A virus*. *I. verum* extracts also effectively inhibit grouper iridovirus, making them a promising material for developing antiviral agents (Liu *et al.* 2020, Patra *et al.* 2020).

***Euphorbia rapulum* Kar. et Kir.** (Euphorbiaceae)

Euphorbia rapulum Kar. et Kir. – is a perennial plant with an upright stem, typically growing in rocky or sandy soils. It has characteristic fleshy leaves and a milky sap that can be toxic. This plant is found in Europe and Western Asia, preferring sunny, dry habitats.

Chemical composition: No studies are available.

Antibacterial properties: No studies are available.

***Potentilla sanguisorba* L.** (Rosaceae)

Potentilla sanguisorba L. – is a perennial herb characterized by an upright stem and pinnate leaves. Its small flowers are yellow or white and are clustered in inflorescences. *P. sanguisorba* is commonly found in meadows and forest edges in Europe and Asia, preferring sunny, well-drained soils.

Chemical composition: No studies are available.

Antibacterial properties: No studies are available.
In the reviewed literature, there is another folk remedy used as a treatment for tuberculosis, known as "Gulqand," a jam made from rose petals. This remedy cannot be attributed to a specific plant species, as different species of the Rosa genus (Rosaceae) or rose are used for its preparation.

"...To prepare Gulqand, freshly bloomed red rose petals with dew still on them are collected. The white stems are trimmed, and the petals are cleaned of stamens. The petals are then weighed and ground with sugar in a ratio of 1 pound of petals to 4 pounds of sugar or 3 pounds of crushed sugar. The petals and sugar mixture is ground thoroughly and placed in a glazed container with a tight lid. It is kept in the sun for 40 to 70 days, stirring the mixture every two days and then sealing it tightly again. The resulting thick, jam-like substance is consumed for side pain, left-sided pneumonia, approximately 6 grams per dose in the morning on an empty stomach and in the evening before bed. After the morning dose, nothing should be eaten for 2 hours. For pulmonary tuberculosis, Gulqand is taken in the prescribed doses in the morning for 6 months..." (Ershov 1970).

In a series of studies, the medicinal properties of *Rosa damascena* petals and other rose species were examined. In one study, an aqueous extract of *Rosa damascena* was tested for its antibacterial properties and adhesion to epithelial cells. The extract was found to be most effective at a concentration of 100 mg/ml, particularly against *Staphylococcus spp*., *Escherichia coli*, and *Klebsiella pneumoniae* (Alsafi *et al.* 2023). In another study, copper oxide nanoparticles (CuO NP) synthesized from rose petals showed significant antibacterial and antioxidant activity, especially in the case of *Rosa kardinal*, which was most effective in inhibiting bacterial growth and enzymes (Asghar *et al.* 2022).

Rosa damascena petal oil and aqueous extracts were also studied for their antibacterial and anti-trichomonad activities. The results showed that the aqueous-alcohol extract was more effective than rose oil, especially against methicillin-resistant *Staphylococcus aureus* and *Trichomonas vaginalis* (Saghafi *et al.* 2021). Extracts of *Rosa damascena* petals and rose geranium were also studied for their preservative properties. They showed significant antimicrobial and antiviral activity, particularly against *Escherichia coli* and *Salmonella enterica*, and were found to be non-toxic (Androutsopoulou *et al.* 2021). In a study on the antioxidant properties of *Rosa damascena* petals, it was found that methanol and ethyl acetate extracts have high antioxidant and antibacterial activity, especially against *Staphylococcus aureus* and *Bacillus cereus*, making them promising for clinical use (Ramdan *et al.* 2021).

Traditional healing methods, used for millennia across various cultures, have played a crucial role in the development of modern medicine (Yuan *et al.* 2016). These methods are based on extensive empirical knowledge of resources like plants, minerals, and animal products, and include complex practices such as Chinese medicine, Ayurveda, and shamanism (Pondomatti *et al.* 2024, Elendu *et al.* 2024). The study of traditional healing practices is essential for modern medicine because it helps discover new drugs, understand cultural aspects of health, and introduce alternative or complementary approaches to mainstream practice (Fabricant *et al.* 2001; Ven Murthy *et al.* 2010).

The activation of traditional knowledge through modern research opens up new opportunities for the pharmaceutical industry. It is important to note that such research is being conducted worldwide, covering all continents. For example, in Asia, Chinese medicine uses plants like *Artemisia annua* L., which served as the source for artemisinin – a key component of anti-malarial drugs (Wani *et al.* 2021). In Africa, research on plants such as *Prunus africana* (Hook.f.) Kalkman has led to the development of drugs for treating prostate diseases (Komakech *et al.* 2017). In South America, Amazon rainforest plants like *Croton lechleri* Müll.Arg. (dragon's blood) are used to produce anti-inflammatory and antibacterial drugs (Peres *et al.* 2023). In Europe, research on traditional herbs like Hypericum perforatum confirmed its antidepressant properties, and it is widely used in modern medicine (Barnes *et al.* 2001). For example, salicylic acid derived from willow bark became the basis for aspirin – one of the most widely used drugs in the world (Desborough *et al.* 2017).

In this context, our study focused on traditional methods of treating tuberculosis in Kazakhstan, making a significant contribution to modern and future treatments for this disease. The plants found in ancient medical books represent potential sources of active substances that could be used to develop new drugs against tuberculosis.

Promising plants with antibacterial activity include *Illicium verum* Hook.f., *Scutellaria orientalis* L., and *Veronica arvensis* L.. These plants could serve as the basis for new antibacterial drugs.

Plants such as *Cuscuta planiflora* Ten., *Euphorbia rapulum* Kar. & Kir., and *Potentilla sanguisorba* Willd. ex Schltdl., which did not show antibacterial properties in studies, remain potential candidates for further research.

Additionally, the use of kumis as a medicinal product highlights the importance of studying traditional foods in the context of their therapeutic properties. Kumis, which has been used in Kazakhstan for several thousand years, has proven effective in treating tuberculosis, making it an important component of both traditional and modern medicine.

Conclusion

In the course of studying the literature, ancient methods of treating tuberculosis in the territory of modern Kazakhstan were discovered. One of the methods included the use of kumis, which has proven its effectiveness over time, especially when combined with classical therapy. The search for plant-based treatments identified 11 species from 9 different families. Notable plants with significant anti-tuberculosis activity include *Xanthium strumarium* L., *Achillea micrantha* Willd., *Juniperus communis* L., and *Anabasis aphylla* L. Promising antibacterial plants include *Illicium verum* Hook.f., *Scutellaria orientalis* L., and *Veronica arvensis* L., which may serve as the basis for new antibacterial drugs. Plants such as *Cuscuta planiflora* Ten., *Euphorbia rapulum* Kar. & Kir., and *Potentilla sanguisorba* Willd. ex Schltdl., which did not demonstrate antibacterial properties in studies, remain potential candidates for further research as they may contain unique compounds for new medical treatments. Similarly, Gulqand (rose petal jam), used in traditional Kazakh medicine, requires further study as a possible source of biologically active compounds.

Thus, the exploration of traditional treatment methods opens new perspectives for developing innovative medicines, particularly in the context of growing antibiotic resistance. Plants that have not yet been thoroughly studied in modern laboratories represent a rich source of potential medicinal compounds, and their investigation could lead to significant breakthroughs in treating tuberculosis and other infectious diseases.

The study is subject to certain limitations, particularly regarding the accessibility and thorough examination of all potential sources that might contain information on traditional tuberculosis treatments in Kazakhstan. Not all relevant books and historical documents were available for review, which may have restricted the comprehensiveness of the research findings.

Declarations

List of abbreviations: Before Common Era (BCE), World Flora Online (WFO), Liquid Chromatography-Mass Spectrometry (LC-MS), Minimum Inhibitory Concentration (MIC), Minimum Bactericidal Concentration (MBC)

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Consent for publication: Not applicable

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Author contributions: Y.P. planned the study, designed the data collection tools, collected the data, analysed the data and wrote the manuscript.

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