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Research Article

Medicinal Application of the Iceland Poppy (*Papaver nudicaule* L.) in Traditional Mongolian Medicine

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ABSTRACT

In recent years, there has been a considerable focus on the utilization of natural medicinal substances, including plant-based medicines and formulations. While traditional medicine has been utilizing various medicinal plants to treat a wide range of diseases, there are still many medicinal plants and substances that have not been thoroughly studied at the scientific level. One such plant is the Iceland poppy (*Papaver nudicaule* L.) from the Papaveraceae family. Globally, the Papaveraceae family comprises 44 genera and 760 species of which 32 species, representing 7 genera, are identified within Mongolia. The Iceland poppy (*Papaver nudicaule* L.) is extensively distributed throughout Mongolia, with all parts of the plant, including its fruit and flowers. In addition, it has been traditionally employed in Mongolian medicine to treat a variety of ailments. However, systematic research on the practical applications and studies of the status of the local Iceland poppy in both modern and traditional Mongolian medicine remains poorly reported. Therefore, we aim to conduct a comprehensive and comparative study of the Iceland poppy (*Papaver nudicaule* L.) and its application in the Traditional Mongolian medicinal literature and internationally published studies. **Materials and Methods:** In this study, data was collected from a comprehensive review of the international and Traditional Mongolian medicine literature to understand the medicinal application of the Iceland poppy. Additionally, current study results were analyzed to assess its practical applications and efficacy in modern medicinal contexts. **Results:** "In a variant of Mongolian medicinal prescriptions, the Iceland poppy (*Papaver nudicaule* L.) is combined with the herb "Govo jad-5" Mongolian traditional prescription for treating surgical wounds, torn blood vessels, and both old and new wounds. Furthermore, the book 'Methods and Prescriptions for Using Medicinal Plants in Traditional Mongolian Medicine reports that Iceland poppy is part of a mixture of four types of poppies used to treat conditions such as diarrhea, intestinal inflammation, and dysentery, by boiling and administering the concoction. A study by Otgonpurev Sukhbaatar et al., (2018) determined that the optimal conditions for callus and suspension biomass production of *Papaver nudicaule* L. are 1 mg/L naphthalene acetic acid and 0.5 mg/L benzyl adenine in MS media. Additionally, Gerelt-Od Yadamsuren et al., reported that the alkaloids 8,14-dihydroamurin, 8,14-dihydroflavinantin, and flavinantin from *Papaver nudicaule* L. exhibit significant antiviral activity against human rhinovirus-14. **Conclusion:** Iceland poppy (*Papaver nudicaule* L.) has been used in traditional Mongolian medical practice for a long time. it has been historically widely used in Mongolian traditional medicine to treat wounds under the name of "wound healer". As reported by the scientific literature, the primary uses of these plants include inhibiting acetylcholinesterase enzyme, anti-cancer effects, as well as antioxidant and anti-inflammatory properties. Furthermore, regarding its chemical composition, researchers have conducted studies that confirm the presence of alkaloids in this plant, specifically isoquinoline alkaloids. These compounds are known for their diverse biological activities and potential therapeutic effects, which may contribute to the plant's traditional medicinal uses. In summary, the Iceland poppy (*Papaver nudicaule* L.) has been utilized in traditional medicine for treating a variety of illnesses; however, it suggests that more comprehensive research is necessary to scientifically substantiate these applications.

Keywords: Alkaloids, Medicinal plant, Nudicaulins, *Papaver nudicaule* L., Protopine, Traditional Mongolian Medicine.

INTRODUCTION

In recent years, significant attention has been given to the use of natural medicinal substances, plant-based medicines, and preparations. According to the report from the International Union for Conservation of Nature and the World Wildlife Fund, 50,000 to 80,000 species of flowering plants are used for medicinal purposes worldwide.[1,2] Furthermore, according to the World Health Organization (WHO), the global market for medicinal plants and traditional plant-based medicines is expected to continue growing globally in the coming years.[3,4]

In Mongolia, researchers identified approximately 900 species from about 70 families that contain biologically active compounds with medicinal properties and are capable of treating various diseases.

In traditional Mongolian medicine, various plants have been utilized to treat a wide range of diseases. However, there are still many medicinal plants and substances that have not been fully studied at the scientific level. One such plant is the Iceland poppy (*Papaver nudicaule* L.) from the Papaveraceae family. Globally, the Papaveraceae family comprises around 44 genera and 760 species, of which 32 species from 7 genera are found in Mongolia.[5] The

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Iceland poppy (*Papaver nudicaule* L.) was first described by Swedish botanist, zoologist, and physician Carl Linnaeus in his 1753 work '*Species Plantarum*', and the type specimen of the poppy is preserved in London.[6]

In Tibetan medical texts, the plant referred to as *Mé-tog-ser-chen* (Mé-tog-ser-chen) is utilized by Traditional Tibetan medicine for its medicinal purposes. This plant is identified as *Ixeris sp.* (with the species unspecified), and its bitter roots from the aerial parts of the plant are used in medicine. However, traditional Mongolian medicine substitutes this with Iceland poppy (*Papaver nudicaule* L.), Orange poppy (*Papaver rubro-aurantiacum (Fisch.ex DC) Lundstr*), and the False pale poppy (*Papaver pseudocanescent* M. Pop.).[7] In addition, Traditional Tibetan medicine refers to wild-growing *Papaver* species as *Rya-men* (*Jamën*) and is utilized for medicinal purposes. This is mentioned in works by Mongolian scholar Jambaldorj Tsevegjav in *A Beautiful Eye Ornament*, Russian scholar A.F. Gammerman's *Dictionary of Medicinal Plant Terminology*, and the work *Herbal Medicine of Inner Mongolia* by Inner Mongolian scholar Yumjav.[7]

The medicinal application in Mongolian traditional medicine of Iceland poppy (*Papaver nudicaule* L.) has been mentioned in multiple traditional Mongolian books..[7,8,9,10,11]

According to these literature, Iceland poppy (*Papaver nudicaule* L.) has a bitter taste and cold properties which have been used for the treatment of diseases, such as reducing fever, detoxifying, and alleviating lung congestion due to its antibacterial effects.

The Iceland poppy (*Papaver nudicaule* L.) is widely distributed across Mongolia, all parts of the plant, including the flowers and fruits are used as medicinal raw material.[5,12] However, there has been limited research on medicinal applications and practical significance in Mongolia. Therefore, we conduct a study on the research status of the Iceland poppy (*Papaver nudicaule* L.), which has been relatively under-researched and serves as the basis for this research work.

Purpose of study

To study the research status and application of the Iceland poppy (*Papaver nudicaule* L.) in Mongolia by comparing information from ancient Traditional Mongolian medicines textbooks and other published review works.

MATERIALS AND METHODS

We conducted the study by reviewing the published research on Iceland poppy (*Papaver nudicaule* L.) medicinal plants found in Mongolia, using ancient books and databases such as PubMed and Medline for the literature review.

RESULTS

Physical Characteristics: The current review focused on the Iceland poppy (*Papaver nudicaule* L.) distribution, potency, effects, chemical composition, and utilization of traditional and modern medicines. Iceland poppy (*Papaver nudicaule* L.) has been reported in various names in different countries and their corresponding textbooks.

Mongolian name: Nutsgen namuu, Latin name: *Papaver nudicaule* L, Tibetan name: *Mé-tog-ser-chen* (Mé-tog-ser-chen), English name: Iceland poppy, Local names: Khurgan zasaa, wild poppy (sharkhnii shar), yellow *jamën*.[5]

The leaves are simple, feathery, gray-green in color, with broad segments. The leaflets are wide, with 2-3 large teeth or lobes, rough, bristly, and either upright or slightly bent. The inflorescence is large, white or yellowish woolly, and resembles the shape of a lamb's ear. For this reason, the plant is called "khurgan zasaa" (lamb's ear) by Mongolians. The flower stalk is upright, 15-50 cm tall, with white or brownish, slightly slanted, delicate, and woolly hairs.[8,13]

The flowers are 4-6 cm in diameter, light yellow, orange, and sometimes white. The petals are dry yellow, occasionally white, 4-7 cm in diameter, and drooping. The sepals are 10-15 mm long, 6-10 mm wide, elongated or somewhat barrel-shaped, narrowing at the base, with fine, pale, or yellowish bristly hairs on the outside, sometimes almost bare. The disc is slightly depressed, and the petals lack a membranous edge. The plant flowers from June to August and produces seeds from July to August.[8,13,14]

Distribution and Growing Environment: The Iceland poppy (*Papaver nudicaule* L.) is indigenous to Central and Eastern Siberia, the Far East, Korea, China, and Central Asia. Within Mongolia, it is prevalent in various regions including: Khuvsgul (Shishkhid River, Ikh Uul), Khentii (Bogd Khan Mountain, Yeroo River), Khangai (Khan Khukh Mountain Range, Tarvagatai Mountain Range, Suvarga Khairkhan Mountain, Selenge River), Mongol-Daguur (Noyon Mountain, Shaamar, Onon River, Ereen Mountain Range), Khyangan Mountain Range, Khovd (Turgen River), Mongolian Altai Mountain Range (Dayan Lake, Sutai Khairkhan Mountain), Central Khalkh (Ugii Lake, Khugnu Khan Mountain), Eastern Mongolia (Khalkh River, Sumber), Gobi Altai (Gurvan Saikhan Mountain).

These species grow in a range of habitats including meadows, feather grass steppes, rocky areas, sandy riverbanks, gravelly areas, and shrublands.[5]

Preparation: The raw material of Iceland poppy (*Papaver nudicaule* L.) includes the aerial parts such as flowers, stems, and leaves, as well as the root system. The duration for preparing Iceland poppy (*Papaver nudicaule* L.) medicinal plant varies and depends on which part of the plant is being harvested. The level of biologically active substances contained in medicinal plants must be in the most abundant stages of the plant's development, which is why each plant should be harvested at a specific time. The aerial part of the Iceland poppy (*Papaver nudicaule* L.) is harvested and prepared at the end of July, during full blooming. When preparing the aerial parts of medicinal plants, they should be harvested and prepared after the morning dew has dried and during dry weather, when no precipitation has occurred. The harvested aerial parts of the Iceland Poppy (*Papaver nudicaule* L.) should be thoroughly cleaned of dirt and dried in a well-ventilated area such as on racks that allow air circulation. Any darkened or brown-colored parts of the plant should be discarded.[15]

Traditional Uses: The Iceland poppy (*Papaver nudicaule* L.) is also known as "Zunba-toin flower" and "Al shariin barigch" in traditional Mongolian medicine terminology. The plant has a root system, and in its youth, its flowers are a bright red color, but as it ages, they turn a bright yellow. The plant has five-petaled flowers and is called *Tibetan Jamën*; its leaves, stems, and capsules remain intact, but the flower petals are numerous and grow in clusters. The flowers come in colors such as white, yellow, red, and light red. In contrast, it is referred to as *Indian Jamën* in other contexts. *Jamën* is said to help treat anemia and chest pains.[7,16]

In Mongolia and Tibetan traditional medicine, the flowers and fruits of the plant are used to treat headaches, dysmenorrhea, dysentery, acute and chronic gastritis, and aches, as well as to reduce fever. A decoction of 1-2 grams of dried herb is typically brewed and consumed. Siberians, the people of the Trans-Baikal region, and Western Mongolians use the flowers for wound healing.[8]

It is included in the traditional preparation formulations for treating conditions such as dysentery, syncope, dysmenorrhea, hemorrhoids, acute and chronic gastritis, stomach ache, wounds, varicose veins,

Table 1: The chemical composition, traditional uses, and pharmacological effects of the Iceland poppy (*Papaver nudicaule* L.).

N	Part Used	Chemical Compounds	Traditional Uses	Pharmacological Effects	Reference
1	Fruit flowers, and aerial parts	Alkaloids such as sanguinarine, protopine, amurine, amurensine, cryptopine, and flavonoids.	Dysentery, syncope, dysmenorrhea, stomach ache, injuries to blood vessels and tendons	-	Mendsaikhan Z, Ariunaa Z MP, et al.[7]
2	Flowers	Alkaloids flavonoids and others.	Surgical wounds, ruptured blood vessels, as well as both new and old wound conditions.	-	Ganbayar Ya, et al.[9]
3	Flower, fruit	Alkaloids containing amurine, amurensine, alborine, protopine, readine, muramine, oxysanguinarine, 13-oxysmuramine, papaverrubunes D and C, amurensinine, alpinine, cryptopine, nudarine, flavonoids.	Headache, caused by nervous disorders, hemi-headace, canteracted blood and bile, pulmonary fever, discharge of blood, dyspepsia, spermatorrhoea, painful menstruation, plentiful whites, ectropion of rectum, acuteand chronic inflammation of stomach, gastralgia	-	Ligaa U, et al.[10]
4	Flowers and leaves	Alkaloids and others	Blood disturbed fever, feels a stabbing pain in the chest, beneficialin roam stabbing pain	-	Boldsaikhan B, et al.[11]
5	Flowers and leaves	The leaves and flowers contain alkaloids such as amurine, amurolin, and sanguinarine. Additionally, they contain small amounts 5of flavonoids and essential oils	To stop pain, relieve, stop diarrhea, suppress shortness of breath, and stop coughing	-	Bold Sh et al.[16]
6	Aerial parts	Isoquinoline derivatives (-)-8,14-dihydropalmatine, amurensine, (-)-amurensinine, (-)-dihydroamuramine, (-)-*O*-methylthalizopavine, (-)-palmatine, (+)-amuramine, 8,14-dihydroamuramine, allocryptopine, amurensinine-α-N-oxide, amurensinine-β-N-oxide, and pseudoprotopine	-	-	Selenge Dangaa et al.[19]
7	Aerial parts	Isoquinoline alkaloids (+)-amuronine, pseudoprotopine, allocryptopine, (-)-dihydroamuronine, (-)-amurensinine N-oxide A and (-)-amurensinine N-oxide B	-	-	Gerelt-Od Yadamsuren et al.[20]
8	Aerial parts	Isoquinoline alkaloid protopine	-	-	Radka Vrancheva, et al.[21]
9	Aerial parts	Isoquinoline alkaloid protopine	-	-	Brian G, et al.[22]
10	Flower /basal and apical areas of petals, stamens, and capsules/	Gossypetin glycosides, kaempferol glycosides, nudicaulin	-	-	Bettina Dudek, Anne-Christin Warskulat, et al.[23,26]
11	Aerial parts	Flavonoid gossypitrin, kaempferol 3-O-beta-sophoroside and kaempferol 3-O-beta-sophoroside-7-O-*beta*-glucoside	-	-	Willibald Schliemann, Bernd Schneider, Victor Wray, et al.[24]
12	Flower	Flavonols and anthocyanins, nudicaulins	-		Evangelas C Tatsis, Bernd Schneider, et al.[25]
13	Aerial parts	Alkaloids 8,14-dihydroamuramine, 8,14-dihydrofavinanthine, and palmatine from the promorphinane	-	High anti-human rhinovirus-14 of the Picornaviridae family activity	Gerelt-Od Yadamsuren, et al.[33]
14	Flower	Isoquinoline alkaloids	-	Not only exhibited anti-inflammatory activity but also demonstrated strong antioxidant activity,	Kim H, et al.[28]
15	Aerial parts	Alkaloids such as cryptopine and protopine	-	Found to reduce the stroke volume and heart rate	Ellis G, et al.[32]
16	Aerial parts	Isoquinoline alkaloid protopine	-	Strong inhibitory effect on acetylcholinesterase, treating inflammatory diseases	Kim S, et al.[29]
17	Aerial parts	Macranthine and berberine	-	Anticancer	Recep Demirgan, Ali Karagöz, Murat Pekmez, et al.[34]
18	Aerial parts	Essential oil, nutrient and elements contents, biological activities	-	Antioxidant, antimicrobial, and anticancer	Falah Saleh Mohammed, Imran Uysal, Mustafa Sevindik, et al.[35]

dispels lymph disorders, alleviating empty heat, and injuries to blood vessels and tendons. In some cases, it is also used alone without any other ingredients.[7]

In the Mongolian medicinal recipe variants, Iceland poppy (*Papaver nudicaule* L.) is included in the five-ingredient formula known as "govo jad-5" Mongolian traditional prescription and is said to be useful for treating surgical wounds, ruptured blood vessels, as well as both new and old wound conditions.[9]

In the book 'the methods and Prescriptions of Traditional Mongolian Medicine', Iceland poppy (*Papaver nudicaule* L.) is included in a four-ingredient formula "namuu-4" Mongolian traditional prescription for treating conditions such as diarrhea, intestinal inflammation, and dysentery. The mixtures are brewed and consumed for these ailments.[10]

Chemical Composition: The plant's leaves and flowers contain 0.94-1.36% alkaloids, the leaves contain 1.14-1.38%, the stems have 0.94-1.04%, and the roots contain 0.90-1.25% total alkaloids. The petals of the flowers contain approximately 5.5% of the dominant alkaloid, nudicauline. The seeds contain linamarin and lotaustraline, which are cyanogenic compounds. The roots contain alkaloids such as coptisine and sanguinarine, while the leaves contain cyanogenic glycosides.[17-18]

According to Selenge Dangaa et al.[19] 320 alkaloids were isolated and identified their structures from 30 medicinal plants in Mongolia. Among the identified alkaloids, Iceland poppy (*Papaver nudicaule* L.) contains the following compounds: isoquinoline derivatives (-)-8,14-dihydropalmatine, amurensine, (-)-amurensinine, (-)-dihydroamuramine, (-)-*O*-methylthalizopavine, (-)-palmatine, (+)-amuramine, 8,14-dihydroamuramine, allocryptopine, amurensinine-α-N-oxide, amurensinine-*β*-N-oxide, and pseudoprotopine.[19]

Researchers, Gerelt-Od Yadamsuren et al.[20] elucidated a structure of a new promorphinane alkaloid (-)-8,14-dihydroflavinantine that was isolated from the aerial parts of *Papaver nudicaule* L. (Papaveraceae) growing in Mongolia. Six known isoquinoline alkaloids (+)-amuronine, pseudoprotopine, allocryptopine, (-)-dihydroamuronine, (-)-amurensinine N-oxide A and (-)-amurensinine N-oxide B were isolated, too. Pseudoprotopine has been found for the first time in a plant of the family Papaveraceae. (-)-dihydroamuronine, (-)-amurensinine N-oxide A and (-)-amurensinine N-oxide B are new for the genus Papaver. All structures were established using spectral and physical data.[20]

Radka Vrancheva and colleagues (2013) studied the qualitative and quantitative identification of protopine in the medicinal plant fumitory (*Fumaria officinalis* L.) from the Papaveraceae family using the TLC method. [21]

In the study by Brian G and colleagues (1984), the alkaloids from cell suspensions of four different species of the *Papaveraceae* family and the effects of temperature stress were investigated. Protopine alkaloid was identified using TLC with two solvent systems, the Rf value for protopine was 0.87 and 0.10.[22]

Researchers, Dudek et al. [23] In this study, the occurrence of flavonoids in the basal and apical areas of petals, stamens, and capsules of four differently colored *P. nudicaule* cultivars was investigated using chromatographic and spectroscopic techniques. The results revealed the specific presence of gossypetin glycosides in the basal spot of all cultivars and demonstrated that kaempferol glycosides are the major secondary metabolites in the capsules. Contrary to previous reports, the yellow-colored stamens of all four *P. nudicaule* cultivars were found to contain carotenoids instead of nudicaulins. Furthermore, the presence of nudicaulins, pelargonidin, and kaempferol glycosides was confirmed in the apical petal area.[23]

Researchers Schliemann et al.[24] From the yellow petals of Iceland poppy, besides the known flavonoid gossypitrin, seven kaempferol derivatives were isolated. In addition to kaempferol 3-*O*-*beta*-sophoroside and kaempferol 3-*O*-*beta*-sophoroside-7-*O*-*beta*-glucoside, known from other plants, the mono- and dimalonyl conjugates of the latter were identified by MS and NMR spectroscopy. Structure analyses of a set of co-occurring pigments, the nudicaulins, revealed that they have identical acylated glycoside moieties attached to a pentacyclic indole alkaloid skeleton for which the structure of 19-(4-hydroxyphenyl)-10H-1,10-ethenochromeno[2,3-b]indole-6,8,18-triol was deduced from MS and NMR as well as chemical and chiroptical methods.[24]

Additionally, Tatsis et al.[25] described petals from eight different Papaveraceae species. They were characterized by different color which was influenced by the presence of nudicaulins. In addition to their occurrence in yellow *P. nudicaule* flowers, nudicaulins I-VIII were detected and quantified in orange flowers of *P. nudicaule*, and in yellow and orange *Papaver alpinum* flowers. *Meconopsis cambrica* petals showed a divergent nudicaulin spectrum, with compounds having an attached 3-hydroxy-3-methyl-glutaryl group (HMG) instead of a malonyl unit at one of the glucose units. Flavonols and anthocyanins that accompany nudicaulins were identified.[25]

Dudek et al. [26] reported thet nudicaulins are derived from pelargonidin glycoside and indole and that they are products of the flavonoid and indole/tryptophan biosynthetic pathway, respectively. To gain insight into the molecular and chemical basis of nudicaulin biosynthesis, they combined transcriptome, differential gel electrophoresis (DIGE)-based proteome, and ultra-performance liquid chromatography-high-resolution mass spectrometry (UPLC-HRMS)-based metabolome data of *P. nudicaule* petals with chemical investigations. They identified candidate genes and proteins for all biosynthetic steps as well as some key metabolites across five stages of petal development.[26]

Pharmacological Effects:

According by Aalinezhad et al.[27] the genus *Papaver* L. includes 159 annual, biennial, and perennial species divided into 11 sections. Several studies on a few species in this genus have revealed that they have beneficial anti-microbial, anti-inflammatory, anti-cancer, and anti-depressant properties. In addition, they have analgesic and sedative effects to alleviate signs of various disorders such as pain, cough, and neurological problems. These beneficial properties have been shown to be primarily related to their alkaloids content. The majority of the alkaloids in the *Papaver* genus are aporphines, morphinanes, protoberberines, protopines, and simple benzylisoquinolines. Interestingly, studies on the pharmacological effects of their alkaloids, with focus on the structure–activity relationship, have revealed a number of biological activities, including effects on metabolic syndrome, neurodegenerative and psychiatric disorders.[27]

The number of studies on poppies is vast. Among the pharmacological effects some of the targets were also reported for *Papaver nudicaule.*

According to the study by Kim H (2021) and others, the anti-inflammatory and antioxidant activities of extracts from the Iceland poppy (*Papaver nudicaule* L.) and the Red Poppy (*Papaver rhoeas* L.) are investigated on the LPS-induced RAW264.7 cells. The results of the study showed that extracts from the Iceland poppy (*Papaver nudicaule* L.) and the Red poppy (*Papaver rhoeas* L.) not only exhibited anti-inflammatory activity but also demonstrated strong antioxidant activity, indicating the presence of alkaloids in the composition of these medicinal plants.[28]

Additionally, Kim S (1999) and others demonstrated that the methanol extract of plants from the Papaveraceae family had a strong inhibitory effect on acetylcholinesterase.[29]

Acetylcholinesterase (AChE) is a cholinergic enzyme primarily found at postsynaptic neuromuscular junctions, especially in muscles and nerves. It immediately breaks down or hydrolyzes acetylcholine (ACh), a naturally occurring neurotransmitter decomposed into acetic acid and choline. The primary role of AChE is to terminate neuronal transmission and signaling between synapses to prevent ACh dispersal and activation of nearby receptors. As organophosphates inhibit AchE, they are important components of pesticides and nerve targeting agents.[30]

Still in the same study Kim et al.[29] (1999) isolated the protopine alkaloid, a derivative of isoquinoline, and showed its dose-dependent inhibitory effect on the acetylcholinesterase enzyme. The dose that showed 50% inhibitory activity was 50 µg. Protopine exhibited therapeutic effects similar to that of velnacrine at the same concentration which is an alkaloid from Iceland poppy (*Papaver nudicaule* L.) there is potential for treating inflammatory diseases and introducing them into clinical practice.[29]

Next to the aforementioned activity of protopine alkaloids, their immunomodulatory action, regulation of the cytokines IL-6, IL-12, IL-1α, TNF-α, IL-1β, and IL-10 was also described. Moreover, flavonoids presented a similar portfolio of biological effects, including the antioxidant, anti-inflammatory, and immunomodulatory activities.[31]

In the study by Ellis G. et al.[32] the effects of alkaloids such as cryptopine and protopine on the cardiovascular system were similar to those of allocryptin. When administered intravenously at doses ranging from $4x10^{-6}$ to $2x10^{-5}$ mol/kg, the cryptopine alkaloid initially stimulated the cardiovascular system, but as the dose increased, it exhibited a depressant effect. When cryptopine was studied specifically on the heart, it showed a coronary vessel dilating effect comparable to that of papaverine and protopine. The alkaloids used in the experiment were found to reduce the stroke volume and heart rate in a dose-dependent manner, either alone or in combination. Additionally, protopine was found to have the least toxicity.[32]

The research by Gerelt-Od Yadamsuren and colleagues showed that the alkaloids 8,14-dihydroamuramine, 8,14-dihydrofavinanthine, and palmatine from the promorphinane group had a promising activity against anti-human rhinovirus-14 of the Picornaviridae family.[33]

In the study of Demirgan et al.[34] the effect of anticancer activity and cytotoxicity *in vitro* was evaluated on 13 poppy alkaloids (amurine, armepavine, berberine, isocorydine, isothebaine, macranthine, mecambrine, mecambridine, narkotine, orientalidine, oripavine, salutaridine, and thebaine) against the human cervical cancer cell line (HeLa) compared to the normal African green monkey kidney epithelial cell line (Vero) in a 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. Thus, two alkaloids, macranthine (SI = 12.42) and berberine (SI = 5.89) showed significant SI values. Therefore, macranthine and berberine are considered to have the potential for further exploration in the discovery and development of new anticancer agents.[34] The research by Falah Saleh Mohammed et al.[35] on *Papaver* species was related to the usage areas, essential oil, nutrient and elements contents, as well as the biological activities. This study has determined that *Papaver* spp. contain significant amounts of essential nutrients and minerals. Additionally, it has been found that poppies may serve as natural sources of antioxidant, antimicrobial, and anticancer compounds. The compounds identified in *Papaver* species have been observed to be potential sources of various biological activities. As a result, it has been concluded that *Papaver* species could be an important natural resource.[35]

The major information on the applicability of *P. nudicaule* in the traditional medicine and its proved pharmacological effects are listed in the 1.

Papaver rhoeas L. (*P. rhoeas*) was used as food and is exploited to treat several health problems. In one of the studies the anti-struvite, anti-inflammatory, analgesic, and antidepressant effects of the stem extract (SE) and flower extract (FE) were determined [36]. The former properties were proved with help of polarizing microscopy and Fourier transform infrared spectrometry (FT-IR). Later, the edema approach induced by the carrageenan molecule was used to study the anti-inflammatory impact of the extracts. The analgesic test was determined by calculating the number of abdominal contractions induced by the intraperitoneal (IP) administration of acetic acid. To evaluate the antidepressant effect of our extracts, we used the forced swimming test (FST). According to the results of the secondary metabolite extraction, both extracts contained high contents of secondary metabolites, while the results of the screening test showed that flavonoids, alkaloids, phenols, tannins, coumarins, saponins, and terpenoids were present.[36] This study confirms a broad spectrum of the applications of poppies that can be introduced to modern medicine practices.

CONCLUSION AND FUTURE PERSPECTIVES

Iceland poppy (*Papaver nudicaule* L.) has been used in traditional Mongolian medical practice for a long time. it has been historically widely used in Mongolian traditional medicine to treat wounds under the name of "wound healer". As reported by the scientific literature, the primary uses of these plants include inhibiting acetylcholinesterase enzyme, anti-cancer effects, as well as antioxidant and anti-inflammatory properties. Furthermore, regarding its chemical composition, researchers have conducted studies that confirm the presence of alkaloids in this plant, specifically isoquinoline alkaloids. These compounds are known for their diverse biological activities and potential therapeutic effects, which may contribute to the plant's traditional medicinal uses. In summary, the Iceland poppy (*Papaver nudicaule* L.) has been utilized in traditional medicine for treating a variety of illnesses; however, it suggests that more comprehensive research is necessary to scientifically substantiate these applications.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest in this research.

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