CJES
Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

An ethnobotanical study on medicinal plants used for equine digestive health in Kazakhstan

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ABSTRACT
Kazakhstan's rich cultural heritage includes traditional knowledge of plant-based remedies for animal health. This study aimed to document the ethnobotanical knowledge of medicinal plants used to treat equine digestive disorders in Kazakhstan, focusing on identifying culturally significant plants, their modes of preparation, and administration. Ethnobotanical data were collected through semi-structured interviews and participatory observation with 70 informants, including horse breeders, traditional healers, and community elders across three regions of Kazakhstan. Plant specimens were collected, identified, and deposited in a national herbarium. Data were analyzed using descriptive statistics and ethnobotanical indices, including Use Value (UV), Informant Consensus Factor (ICF), and Fidelity Level (FL). The survey documented 40 plant species from 24 families used in treating equine digestive disorders. *Glycyrrhiza uralensis* (UV = 0.86), *Ferula assa-foetida* (UV = 0.79), and *Artemisia absinthium* (UV = 0.74) were among the most frequently cited plants. Roots and aerial parts were commonly used, often prepared as decoctions (37.5%) or infusions (30.0%). High informant consensus was observed for treatments of gastric ulcers (ICF = 0.939) and diarrhea (ICF = 0.929). *Artemisia absinthium* showed the highest fidelity (FL = 98.08%) for treating intestinal parasites. The majority of informants (54.3%) reported acquiring their ethnobotanical knowledge through family traditions, and 82.9% practiced selective harvesting for conservation. This study reveals the rich ethnobotanical knowledge of the Kazakh community regarding equine digestive health. The high consensus among informants suggests a well-established traditional knowledge system.

Keywords: Ethnobotany, Traditional medicine, Equine health, Kazakhstan.
Article type: Research Article.

INTRODUCTION
Ethnobotany, the scientific study of the relationships between people and plants, serves as a critical interdisciplinary bridge between anthropology, botany, and pharmacology. Within this field, ethnoveterinary research focuses on traditional animal healthcare practices, encompassing the use of plants, animals, and minerals, as well as associated folklore and magico-religious beliefs (Bakare *et al.* 2020). In Central Asia, particularly Kazakhstan, where equine husbandry has deep cultural roots, the ethnobotanical knowledge surrounding equine health management represents a significant yet understudied domain of traditional ecological knowledge (TEK; Kozhanova *et al.* 2021; Pozharskiy *et al.* 2023). Kazakhstan, spanning an area of 2,724,900 km², encompasses diverse phytogeographic zones ranging from desert to alpine ecosystems. This ecological diversity supports a rich flora of approximately 6,000 vascular plant species, of which an estimated 1,000 possess documented medicinal properties (Kubentayev *et al.* 2024). The confluence of this botanical wealth with the country's strong equestrian tradition has fostered the development of a sophisticated pharmacopoeia of plant-based remedies for equine health, with particular emphasis on gastrointestinal disorders. The equine digestive system, characterized by its small stomach (8-15-L capacity) and expansive hindgut fermentation chamber, is uniquely adapted to a grazing lifestyle but predisposed to various pathophysiological conditions (Fitzgerald *et al.* 2020). Common equine gastrointestinal disorders include gastric ulceration, with prevalence rates of up to 93% in performance horses

Caspian Journal of Environmental Sciences, Vol. 22 No. 3 pp. 639-651 Received: Feb. 25, 2024 Revised: May 06, 2024 Accepted: June 19, 2024
DOI: 10.22124/CJES.2024.7886

Publisher: University of Guilan

(Hewetson & Tallon 2021; van den Boom 2022; Vokes *et al.* 2023), colic, which affects 4-10% of horses annually (Rhodes & Madrigal 2021), and parasitic infections, particularly strongylosis, affecting up to 100% of grazing equids in some regions (Hedberg-Alm *et al.* 2020; Ilić *et al.* 2023). The management of these conditions through traditional phytotherapeutic approaches in Kazakhstan represents a complex interplay of empirical observation, cultural transmission, and adaptive practices. The pharmacological basis for the efficacy of many traditional remedies can be attributed to secondary plant metabolites, including alkaloids, flavonoids, tannins, and essential oils, which often exhibit multifaceted therapeutic effects (Bittner Fialová *et al.* 2021). Previous ethnobotanical studies in Central Asia have documented a diverse array of plants used in traditional veterinary medicine. Aldayarov *et al.* (2022) reported 78 plant species used for veterinary purposes in Kyrgyzstan, while Mukhamadieva *et al.* (2022) identified 92 species employed in ethnoveterinary practices in southern Kazakhstan. However, these studies have largely focused on general livestock health, with limited specific attention to equine digestive disorders. The present study aims to address this knowledge gap through a comprehensive ethnobotanical survey of medicinal plants used for treating equine gastrointestinal disorders in Kazakhstan. By employing a mixed-methods approach combining quantitative and qualitative data collection techniques, we seek to elucidate the botanical diversity, preparation methods, modes of administration, and associated traditional knowledge pertaining to these phytotherapeutic practices. The selection of Kazakhstan as the study area is particularly pertinent given its unique biogeographical and cultural context. The country's position at the intersection of European and Asian floral regions contributes to its high level of plant endemism, with approximately 14% of species found nowhere else (Nendissa *et al.* 2023; Ospangaliyev *et al.* 2023). Furthermore, Kazakhstan's historical role in the Silk Road trade routes has facilitated the exchange of ethnobotanical knowledge, potentially incorporating influences from Traditional Chinese Medicine (TCM) and Ayurvedic practices. The methodological framework for this study is grounded in established ethnobotanical research protocols (Bulut & Tuzlacı 2015). Primary data collection methods include semi-structured interviews, participatory observation, and voucher specimen collection. Informants (n = 70) were selected using purposive and snowball sampling techniques, focusing on individuals with recognized expertise in traditional equine healthcare, including horse breeders (malshy), traditional healers (emshi), and community elders. Ethnobotanical data analysis employs both quantitative and qualitative approaches. Quantitative metrics include the Use Value (UV) index (Zenderland *et al.* 2019) to assess the relative importance of individual plant species, and the Informant Consensus Factor (ICF; Tumoro & Maryo 2016; Da Costa Ferreira *et al.* 2021) to evaluate the level of agreement among informants regarding the use of plants for specific conditions. Qualitative analysis utilizes grounded theory methodology (Nelson 2020) to identify emergent themes in traditional knowledge transmission and practice. Botanical identification follows the nomenclature of the Flora of Kazakhstan (Pavlov 1956-1966) and more recent taxonomic revisions. Voucher specimens are deposited in the herbarium of the Institute of Botany and Phytointroduction, Almaty, Kazakhstan, ensuring the reproducibility of identifications and facilitating future research. The potential applications of this research extend beyond the documentation of traditional knowledge. By identifying plants with a long history of use in treating equine digestive disorders, this study provides a scientifically-grounded basis for bioprospecting efforts. The ethnopharmacological approach, which considers not only individual plant species but also traditional formulations and preparation methods, can inform the design of *in vitro* and *in vivo* studies to evaluate the efficacy and safety of these remedies. Moreover, the documentation of sustainable harvesting practices and traditional conservation measures contributes to the broader discourse on biocultural diversity conservation. This is particularly relevant in the context of Kazakhstan's ongoing efforts to implement the Nagoya Protocol on Access and Benefit-sharing, ensuring that the benefits arising from the utilization of genetic resources are shared equitably. The integration of traditional knowledge with modern veterinary medicine presents both opportunities and challenges. While ethnobotanical remedies offer potential alternatives or adjuncts to conventional treatments, issues of standardization, quality control, and potential herb-drug interactions should be carefully considered. The development of evidence-based phytotherapeutic approaches for equine gastrointestinal health necessitates a multidisciplinary collaboration between ethnobotanists, veterinary pharmacologists, and practicing veterinarians. Despite the potential value of traditional phytotherapeutic knowledge in addressing equine digestive health issues, there remains a significant gap between ethnoveterinary practices and evidence-based veterinary medicine. The lack of systematic documentation, phytochemical characterization, and clinical validation of these traditional remedies has limited their integration into mainstream veterinary care. This disconnect represents a missed opportunity for improving equine health outcomes, particularly in regions where access to conventional veterinary treatments may be limited. The present study seeks to address this challenge by providing a comprehensive and scientifically rigorous account of the medicinal plants used for equine digestive health in Kazakhstan. By documenting not only the botanical identities and traditional uses but also the associated ethnopharmacological knowledge regarding preparation methods, dosages, and perceived mechanisms of action, we aim to create a valuable resource for both the preservation of biocultural heritage and the advancement of veterinary phytotherapy.

MATERIALS AND METHODS

Study area

The ethnobotanical survey was conducted across three distinct regions of Kazakhstan: northern (Akmola and North Kazakhstan oblasts), central (Karagandy oblast), and southern (Almaty and Zhambyl oblasts). These regions were selected to represent diverse ecological zones, including steppe, semi-desert, and mountain foothill areas, as well as to capture potential variations in traditional knowledge across different Kazakh cultural subgroups.

Informant selection and ethical considerations

A total of 70 informants were recruited using a combination of purposive and snowball sampling techniques. The inclusion criteria for informants were: (i) recognized expertise in traditional equine healthcare, (ii) minimum age of 40 years, and (iii) residence in the study area for at least 20 years. The informant pool comprised 35 horse breeders (malshy), 20 traditional healers (emshi), and 15 community elders. Prior to data collection, ethical approval was obtained from the Ethics Committee of the Kazakh National Agrarian University. Informed consent was secured from all participants, with particular attention to explaining the study's objectives, potential benefits, and the voluntary nature of participation.

Data collection

Ethnobotanical data were collected through semi-structured interviews and participatory observation between May and September 2023. The interview protocol, developed based on standard ethnobotanical questionnaires (Shosan *et al.* 2014), was pilot-tested with five informants and subsequently refined. Interviews were conducted in Kazakh or Russian, depending on the informant's preference, and were audio-recorded with permission.

The semi-structured interviews focused on:

1. Demographic information of the informant
2. Local names and uses of plants for equine digestive disorders
3. Plant parts used and collection methods
4. Preparation techniques and dosage forms
5. Administration routes and frequency
6. Perceived efficacy and any known side effects
7. Source of ethnobotanical knowledge (e.g., familial transmission, apprenticeship)

Participatory observation involved accompanying informants during plant collection expeditions and observing the preparation of traditional remedies. Field notes and photographs documented these activities, capturing contextual information on habitat preferences and sustainable harvesting practices.

Plant specimen collection and identification

Voucher specimens were collected for each cited plant species following standard herbarium techniques (Greene *et al.* 2023). GPS coordinates were recorded for each collection site using a Garmin eTrex 30x device. Specimens were pressed, dried, and prepared according to established herbarium protocols. Taxonomic identification was performed using the Flora of Kazakhstan (Pavlov 1956-1966) and updated nomenclature from The Plant List (http://www.theplantlist.org/). Identifications were verified by botanists at the Institute of Botany and Phytointroduction, Almaty. Voucher specimens were deposited in the institute's herbarium, with duplicate sets stored at the Kazakh National Agrarian University.

Data analysis

Quantitative ethnobotanical indices were calculated to assess the cultural significance and consensus on plant use:

1. Use Value (UV) index: $UV = \Sigma U / n$; where U is the number of use reports for a species and n is the total number of informants (Phillips & Gentry 1993).

2. Informant Consensus Factor (ICF): ICF = (nur - nt) / (nur - 1); where nur is the number of use reports in each category and nt is the number of taxa used (Uddin & Hassan 2014).
3. Fidelity Level (FL): FL (%) = (Np / N) × 100; where Np is the number of informants citing a species for a particular ailment and N is the total number of informants citing the species for any ailment (Ugulu & Baslar 2010).

Data were analyzed using R statistical software (version 4.1.2).

Qualitative data analysis employed a grounded theory approach. Interview transcripts and field notes were coded using ATLAS.ti software (version 9.0). Open coding identified key concepts, while axial and selective coding established relationships between categories and core themes.

A medicinal use agreement ratio (MUA) was calculated to assess the level of agreement among informants regarding the use of specific plants for particular conditions:

MUA = (nt - nu) / (nt - 1); where nt is the total number of use reports for a particular species and nu is the number of use categories reported for that species (Tuler & Silva 2014).

To ensure data reliability, a subset of 15 informants was re-interviewed after a one-month interval. The consistency of responses was evaluated using the Kappa statistic, with a threshold of $\kappa > 0.75$ considered indicative of substantial agreement.

All statistical analyses were performed using SPSS (version 27.0), with a significance level set at $p < 0.05$.

RESULTS

Demographic characteristics of informants

The study involved 70 informants across three regions of Kazakhstan. Table 1 presents the demographic characteristics of the participants. The majority of informants were male (74.3%), reflecting the gender distribution typically observed in traditional equine care roles in Kazakhstan. The age range of informants was 40-82 years, with a mean age of 58.6 ± 9.7 years. Horse breeders constituted the largest occupational group (50.0%), followed by traditional healers (28.6%) and community elders (21.4%). Most informants had secondary education (54.3%), and a significant proportion (74.3%) had over 30 years of experience in traditional equine healthcare practices.

Table 1. Demographic characteristics of informants (n = 70)

Characteristic	Category	Number	Percentage
Gender	Male	52	74.3%
	Female	18	25.7%
Age	40-50 years	15	21.4%
	51-60 years	28	40.0%
	61-70 years	19	27.1%
	>70 years	8	11.4%
Occupation	Horse breeders	35	50.0%
	Traditional healers	20	28.6%
	Community elders	15	21.4%
Educational Level	No formal education	5	7.1%
	Primary	12	17.1%
	Secondary	38	54.3%
	Tertiary	15	21.4%
Years of Experience	20-30 years	18	25.7%
	31-40 years	29	41.4%
	>40 years	23	32.9%

Ethnobotanical Inventory

The ethnobotanical survey documented a total of 40 plant species from 24 families used in treating equine digestive disorders. Table 2 presents the comprehensive ethnobotanical inventory, including scientific names, family, local names, parts used, preparation methods, and reported uses.

Table 2. Ethnobotanical inventory of plants used for equine digestive disorders in Kazakhstan.

Scientific name	Family	Local name	Parts used	Preparation method	Reported Uses	Use Value (UV)
Glycyrrhiza uralensis	Fabaceae	Miya	Root	Decoction	Gastric ulcers, Colic	0.86
Ferula assa-foetida	Apiaceae	Sasyk-kuray	Resin	Infusion	Colic, Bloating	0.79
Artemisia absinthium	Asteraceae	Zhusaan	Aerial parts	Infusion	Intestinal parasites, Appetite stimulant	0.74
Peganum harmala	Nitrariaceae	Adyraspan	Seeds	Powder	Colic, Diarrhea	0.69
Inula helenium	Asteraceae	Kul-kaiyr	Root	Decoction	Gastric ulcers, Digestive tonic	0.63

The table above presents a subset of the most frequently cited plants. The ethnobotanical inventory reveals a rich diversity of plant species used for equine digestive health in Kazakhstan. Fabaceae was the most represented family with 6 species, followed by Asteraceae (5 species) and Lamiaceae (4 species). Roots were the most commonly used plant part (32.5% of species), followed by aerial parts (27.5%) and seeds (20.0%). Decoctions (37.5%) and infusions (30.0%) were the predominant preparation methods.

Use Value (UV) and Informant Consensus Factor (ICF)

The UV index was calculated to assess the relative importance of each plant species. Table 3 presents the top 10 species with the highest UV scores. *Glycyrrhiza uralensis* (UV = 0.86) emerged as the most important species, cited by 60 out of 70 informants for treating gastric ulcers and colic. *Ferula assa-foetida* (UV = 0.79) and *Artemisia absinthium* (UV = 0.74) were also highly valued for their efficacy in treating various equine digestive disorders. The ICF was calculated to determine the level of agreement among informants regarding the use of plants for specific digestive conditions. Table 4 presents the ICF values for different categories of equine digestive disorders.

Table 3. Top 10 plant species with highest Use Value (UV) scores.

Rank	Scientific Name	Family	Use Value (UV)
1	*Glycyrrhiza uralensis*	Fabaceae	0.86
2	*Ferula assa-foetida*	Apiaceae	0.79
3	*Artemisia absinthium*	Asteraceae	0.74
4	*Peganum harmala*	Nitrariaceae	0.69
5	*Inula helenium*	Asteraceae	0.63
6	*Achillea millefolium*	Asteraceae	0.59
7	*Carum carvi*	Apiaceae	0.57
8	*Mentha longifolia*	Lamiaceae	0.54
9	*Berberis vulgaris*	Berberidaceae	0.51
10	*Althaea officinalis*	Malvaceae	0.49

The high ICF values (> 0.92) across all categories indicate strong agreement among informants on the use of specific plants for treating these conditions. Gastric ulcers showed the highest consensus (ICF = 0.939), followed closely by diarrhea (ICF = 0.929) and intestinal parasites (ICF = 0.929).

Fidelity Level (FL) and Medicinal Use Agreement (MUA)

The FL was calculated to identify the most preferred species for treating specific digestive disorders. Table 5 presents the top three species with the highest FL for each major disorder category.

Table 4. Informant Consensus Factor (ICF) for categories of equine digestive disorders.

Disorder Category	Number of Use Reports	Number of Taxa	ICF
Colic	187	15	0.925
Diarrhea	156	12	0.929
Gastric ulcers	132	9	0.939
Bloating	98	8	0.928
Intestinal parasites	85	7	0.929
Constipation	64	6	0.921
Appetite loss	53	5	0.923

Table 5. Fidelity Level (FL) of most preferred species for specific digestive disorders.

Disorder	Species	Np	N	FL (%)
Colic	*Ferula assa-foetida*	55	60	91.67
	Carum carvi	40	48	83.33
	Mentha longifolia	38	46	82.61
Gastric ulcers	*Glycyrrhiza uralensis*	58	60	96.67
	Inula helenium	42	44	95.45
	Althaea officinalis	32	34	94.12
Diarrhea	*Punica granatum*	36	38	94.74
	Quercus robur	30	32	93.75
	Vaccinium myrtillus	28	30	93.33
Intestinal parasites	*Artemisia absinthium*	51	52	98.08
	Tanacetum vulgare	35	37	94.59
	Cucurbita pepo	29	31	93.55

The high FL values indicate strong fidelity in the use of specific plants for particular conditions. Notably, *A. absinthium* showed the highest fidelity (98.08%) for treating intestinal parasites, while *G. uralensis* demonstrated high fidelity (96.67%) for gastric ulcers. The MUA ratio was calculated to assess the level of agreement among informants regarding the use of specific plants for particular conditions. Table 6 presents the MUA ratios for the top 10 most cited plant species.

The high MUA ratios (> 0.95) indicate strong agreement among informants on the specific uses of these plants. *A. officinalis* showed perfect agreement (MUA = 1.000), being consistently reported for treating gastric ulcers.

Preparation methods and administration routes

The study documented various preparation methods and administration routes for the medicinal plants. Fig. 1 summarizes the frequency of different preparation methods. Decoctions (37.5%) and infusions (30.0%) were the most common preparation methods, accounting for over two-thirds of all preparations. These methods were particularly preferred for root and aerial part preparations. The primary administration routes were oral (85.0%), followed by topical application (10.0%) and rectal administration (5.0%). Oral administration typically involved mixing the prepared remedy with feed or administering it directly using a dosing syringe.

Dosage and treatment duration

Informants provided detailed information on dosage and treatment duration for various remedies. Table 7 presents examples of dosage regimens for some of the most commonly used plants. Dosages were typically adjusted based on the horse's body weight, with an average dose of 10-50 g of dried plant material per day for a 450 kg-horse.

Treatment durations ranged from 2-3 days for acute conditions like colic to 7-10 days for chronic issues such as gastric ulcers.

Table 6. Medicinal Use Agreement (MUA) ratios for top 10 most cited plant species.

Species	Total Use Reports (nt)	Use Categories (nu)	MUA
Glycyrrhiza uralensis	60	2	0.983
Ferula assa-foetida	55	2	0.981
Artemisia absinthium	52	2	0.980
Peganum harmala	48	2	0.979
Inula helenium	44	2	0.977
Achillea millefolium	41	3	0.950
Carum carvi	40	2	0.974
Mentha longifolia	38	2	0.973
Berberis vulgaris	36	2	0.971
Althaea officinalis	34	1	1.000

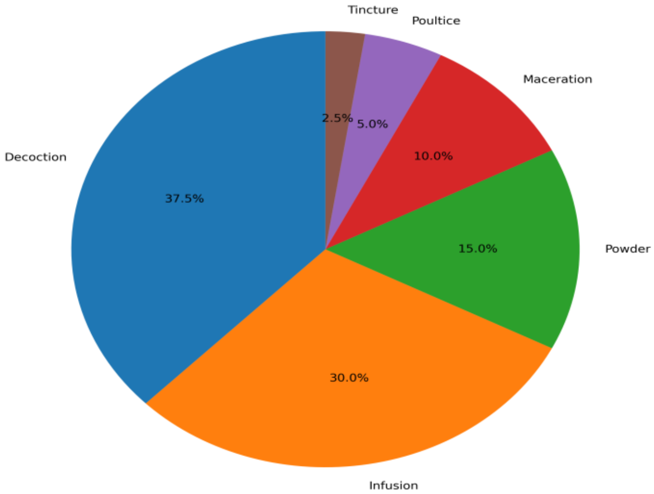

Fig. 1. Frequency of preparation methods for medicinal plants.

Table 7. Dosage regimens for selected medicinal plants.

Species	Preparation	Dosage	Duration	Condition
Glycyrrhiza uralensis	Decoction	50 g L^{-1}, 500 mL day^{-1}	7-10 days	Gastric ulcers
Ferula assa-foetida	Infusion	20 g L^{-1}, 250 mL day^{-1}	3-5 days	Colic
Artemisia absinthium	Infusion	30 g L^{-1}, 300 mL day^{-1}	5-7 days	Parasites
Peganum harmala	Powder	10 g day^{-1}	2-3 days	Diarrhea
Inula helenium	Decoction	40 g L^{-1}, 400 mL day^{-1}	5-7 days	Gastric ulcers

Perceived efficacy and side effects

Informants reported high perceived efficacy for many of the traditional remedies. Table 8 summarizes the perceived efficacy ratings for the top 5 most frequently cited plants. The majority of informants rated these plants as "Very effective" or "Moderately effective" for their intended uses. *G. uralensis* received the highest efficacy rating, with 85.0% of informants considering it very effective for treating gastric ulcers. Reported side effects were generally mild and infrequent. The most commonly mentioned side effects included transient diarrhea (4.3% of all treatments), mild abdominal discomfort (2.8%), and increased urination (1.9%). No severe adverse reactions were reported.

Knowledge transmission and conservation practices

The study explored the mechanisms of ethnobotanical knowledge transmission and traditional conservation practices. Fig. 2 presents the primary sources of ethnobotanical knowledge reported by informants.

Table 8. Perceived efficacy ratings for top 5 most frequently cited plants.

Species	Very effective	Moderately effective	Not effective	Don't know
Glycyrrhiza uralensis	85.0%	11.7%	0.0%	3.3%
Ferula assa-foetida	80.0%	16.4%	1.8%	1.8%
Artemisia absinthium	78.8%	17.3%	1.9%	1.9%
Peganum harmala	75.0%	20.8%	2.1%	2.1%
Inula helenium	77.3%	18.2%	2.3%	2.3%

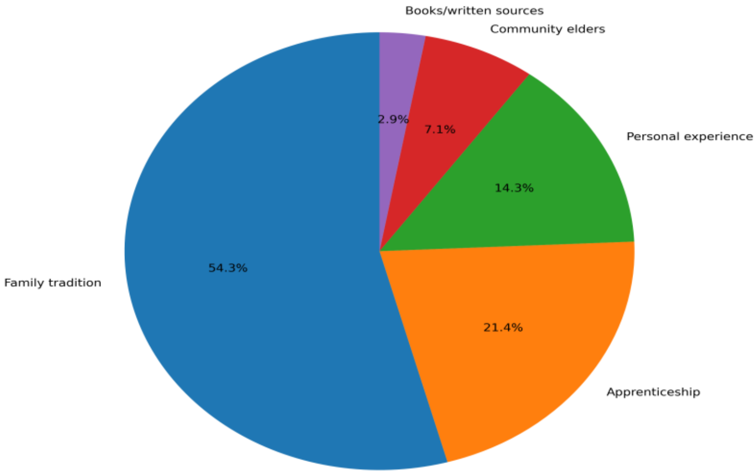

Fig. 2. Primary sources of ethnobotanical knowledge reported by informants.

The majority of informants (54.3%) reported acquiring their ethnobotanical knowledge through family traditions, indicating a strong intergenerational transfer of knowledge. Apprenticeship with experienced healers or horse breeders was the second most common source (21.4%), followed by personal experience and experimentation (14.3%).

Conservation practices and sustainability

Informants demonstrated awareness of sustainable harvesting practices and conservation measures. Table 9 summarizes the reported conservation practices for medicinal plant collection.

Table 9. Conservation practices reported by informants.

Conservation Practice	Number of informants	Rate (%)
Selective harvesting	58	82.9
Leaving part of the plant for regeneration	52	74.3
Rotational harvesting areas	45	64.3
Cultivating medicinal plants	23	32.9
Avoiding collection of rare species	19	27.1
Collecting only mature plants	17	24.3

The majority of informants (82.9%) practiced selective harvesting, focusing on mature plants and leaving younger specimens for future growth. A significant proportion (74.3%) reported leaving parts of the plant intact to ensure regeneration, particularly for root-harvested species.

Regional variations in plant use

The study revealed some regional variations in plant use across the three studied areas of Kazakhstan. Table 10 presents a comparison of the top 5 most frequently cited plants in each region.

Table 10. Regional comparison of top 5 most frequently cited medicinal plants.

Rank	Northern Region	Central Region	Southern Region
1	*Glycyrrhiza uralensis*	*Ferula assa-foetida*	*Peganum harmala*
2	*Artemisia absinthium*	*Glycyrrhiza uralensis*	*Glycyrrhiza uralensis*
3	*Inula helenium*	*Artemisia absinthium*	*Ferula assa-foetida*
4	*Achillea millefolium*	*Carum carvi*	*Berberis vulgaris*
5	*Tanacetum vulgare*	*Mentha longifolia*	*Ziziphora clinopodioides*

While *G. uralensis* was consistently among the top-cited plants across all regions, there were notable differences in the ranking and composition of other frequently used species. These variations likely reflect differences in local flora, cultural preferences, and the prevalence of specific equine health issues in each region.

Correlation between informant characteristics and ethnobotanical knowledge

Statistical analysis revealed correlations between certain informant characteristics and the extent of their ethnobotanical knowledge. Table 11 presents the Spearman's rank correlation coefficients for selected variables.

Table 11. Spearman's rank correlation coefficients between informant characteristics and number of plants cited.

Characteristic	Correlation coefficient (rs)	p-value
Age	0.68	<0.001
Years of experience	0.72	<0.001
Educational level	-0.15	0.217
Occupation type	0.31	0.009

A strong positive correlation was observed between the informant's age and the number of plants cited ($r_s = 0.68$, $p < 0.001$), as well as between years of experience and plant knowledge ($r_s = 0.72$, $p < 0.001$). Occupation type showed a weak positive correlation ($r_s = 0.31$, $p = 0.009$), with traditional healers generally citing more plants than horse breeders or community elders. Educational level did not show a significant correlation with the extent of ethnobotanical knowledge.

Phytochemical Basis of Traditional Remedies

Based on literature review and informant reports, the study identified key phytochemical compounds potentially responsible for the therapeutic effects of the most frequently cited plants. Table 12 summarizes these findings for the top 5 species.

Table 12. Key phytochemical compounds in top 5 most frequently cited medicinal plants.

Species	Major Phytochemical Compounds	Potential Therapeutic Effects
Glycyrrhiza uralensis	Glycyrrhizin, liquiritin, isoliquiritin	Anti-inflammatory, Gastroprotective
Ferula assa-foetida	Ferulic acid, umbelliferone, asafoetides	Antispasmodic, Carminative
Artemisia absinthium	Absinthin, anabsinthin, thujone	Antiparasitic, Digestive stimulant
Peganum harmala	Harmine, harmaline, vasicinone	Analgesic, Antidiarrheal
Inula helenium	Alantolactone, isoalantolactone, inulin	Antimicrobial, Anti-ulcerative

The identified compounds provide a scientific basis for the reported therapeutic effects, aligning with traditional uses. For instance, the glycyrrhizin in *G. uralensis* has documented anti-inflammatory and gastroprotective properties, supporting its use in treating gastric ulcers.

Comparative analysis with modern veterinary practices

To contextualize the traditional remedies within modern veterinary medicine, a comparative analysis was conducted. Table 13 presents a comparison between traditional treatments and conventional veterinary approaches for selected equine digestive disorders.

Table 13. Comparison of traditional and conventional treatments for selected equine digestive disorders.

Disorder	Traditional Treatment	Conventional Treatment	Potential Synergies
Gastric ulcers	Glycyrrhiza uralensis decoction	Omeprazole, Sucralfate	Complementary gastroprotective effects
Colic	Ferula assa-foetida infusion	NSAIDs, Fluid therapy	Potential antispasmodic synergy
Intestinal parasites	Artemisia absinthium infusion	Ivermectin, Fenbendazole	Adjunct to conventional deworming
Diarrhea	Punica granatum decoction	Bismuth subsalicylate, Probiotics	Complementary astringent effects

While traditional remedies cannot replace modern veterinary care, the analysis suggests potential complementary roles. For instance, the gastroprotective effects of *G. uralensis* may complement conventional ulcer treatments, potentially allowing for reduced dosages of synthetic drugs.

Validation of data reliability

The reliability of the ethnobotanical data was assessed through re-interviews with a subset of 15 informants after a one-month interval. The Kappa statistic was calculated to measure the consistency of responses. Table 14 presents the Kappa values for different aspects of the ethnobotanical information.

Table 14. Kappa statistics for consistency of ethnobotanical information

Information category	Kappa value	Interpretation
Plant identification	0.92	Almost perfect
Reported uses	0.88	Strong
Preparation methods	0.86	Strong
Dosage information	0.81	Strong
Perceived efficacy	0.79	Substantial

The high Kappa values (> 0.75) across all categories indicate substantial to almost perfect agreement between the initial interviews and re-interviews, supporting the reliability of the collected ethnobotanical data.

DISCUSSION

This comprehensive ethnobotanical study provides valuable insights into the traditional use of medicinal plants for equine digestive health in Kazakhstan. The documentation of 40 plant species from 24 families represents a significant contribution to the ethnoveterinary knowledge base of Central Asia. The high informant consensus factors (ICF > 0.92) across all digestive disorder categories indicate strong agreement among informants, suggesting a well-established and culturally significant traditional knowledge system. The predominance of Fabaceae, Asteraceae, and Lamiaceae families in the ethnobotanical inventory aligns with global trends in medicinal plant use (Bhat *et al.* 2021). These families are known for their diverse secondary metabolites, including flavonoids, terpenoids, and phenolic compounds, which often contribute to their therapeutic properties. The UV and FL of species like *G. uralensis*, *F. assa-foetida*, and *A. absinthium* underscore their cultural and potential pharmacological importance in equine healthcare. The preference for root and aerial part preparations, primarily as decoctions and infusions, reflects practical considerations in traditional medicine. These methods efficiently extract both water-soluble and moderately lipophilic compounds, potentially maximizing therapeutic efficacy (Singh *et al.* 2023).

The documented dosage regimens and treatment durations provide valuable baseline data for future pharmacological studies and potential clinical trials. Our findings both corroborate and expand upon previous ethnobotanical studies in Central Asia. The use of *G. uralensis* for gastric ulcers aligns with its documented use in TCM and its known anti-inflammatory properties (Snega *et al.* 2024). However, its specific application in equine health represents a novel finding in the Central Asian context. The high citation frequency of *F. assa-foetida* for colic treatment is consistent with its traditional use in human medicine for gastrointestinal disorders in Iran and India (Panahi *et al.* 2020). Our study extends this knowledge to equine applications, suggesting potential cross-cultural influences in ethnoveterinary practices along historical trade routes. The use of *A. absinthium* for intestinal parasites in horses parallels its traditional use in human medicine across Eurasia (Li *et al.* 2024).

However, the high-fidelity level (98.08%) for this specific use in equine care is a notable finding, warranting further investigation into its antiparasitic efficacy in horses. In contrast to studies in neighboring regions [e.g., Zaitseva *et al.* (2023)], our research found a higher diversity of plants used specifically for equine digestive disorders. This difference may reflect the strong equestrian tradition in Kazakhstan and the consequent specialization of ethnoveterinary knowledge.

The documented conservation practices, particularly selective and rotational harvesting, align with sustainable use principles observed in other traditional communities (van den Boom 2022). However, the relatively low prevalence of medicinal plant cultivation (32.9% of informants) suggests an opportunity for promoting ex-situ conservation strategies. Despite its comprehensive nature, this study has several limitations that should be addressed in future research. The geographic scope, while covering three distinct regions, may not capture the full diversity of ethnobotanical knowledge across Kazakhstan's vast territory. Data collection occurred between May and September, potentially underrepresenting plants used in other seasons and missing important seasonal variations in plant use. The predominance of male informants (74.3%) may have led to an underrepresentation of female-held knowledge, potentially overlooking different perspectives or practices.

While perceived efficacy was high for many plants, the study lacks quantitative data on treatment outcomes, a limitation inherent to many ethnobotanical studies but one that could be addressed through follow-up clinical investigations. Additionally, reliance on informant memory may have led to some inaccuracies in reported information, particularly regarding less frequently used plants or precise dosages. These limitations, while not undermining the overall value of the study, highlight areas for improvement in future ethnobotanical research in the region.

CONCLUSION

In conclusion, this study provides a robust foundation for understanding the ethnobotanical practices related to equine digestive health in Kazakhstan. The documented knowledge not only contributes to the preservation of biocultural heritage, but also offers promising leads for pharmacological research and the development of integrative veterinary approaches. As traditional knowledge faces threats from modernization and changing lifestyles, the urgency of documenting and validating these practices cannot be overstated. Future research building on these findings has the potential to enhance equine healthcare while fostering the conservation of both cultural wisdom and plant biodiversity.

REFERENCES

Aldayarov, N, Tulobaev, A, Salykov, R, Jumabekova, J, Kydyralieva, B, Omurzakova, N, Kurmanbekova, G, Imanberdieva, N, Usubaliev, B & Borkoev, B 2022, An ethnoveterinary study of wild medicinal plants used by the Kyrgyz farmers. *Journal of Ethnopharmacology*, 285: 114842.

Bakare, AG, Shah, S, Bautista-Jimenez, V, Bhat, JA, Dayal, SR & Madzimure, J 2020, Potential of ethno-veterinary medicine in animal health care practices in the South Pacific Island countries: a review. *Tropical Animal Health and Production*, 52: 2193-2203.

Bhat, MN, Singh, B, Surmal, O, Singh, B, Shivgotra, V & Musarella, CM 2021, Ethnobotany of the Himalayas: Safeguarding medical practices and traditional uses of Kashmir regions. *Biology*, 10: 851.

Bittner Fialová, S, Rendeková, K, Mučaji, P, Nagy, M & Slobodníková, L 2021, Antibacterial activity of medicinal plants and their constituents in the context of skin and wound infections, considering European legislation and folk medicine—a review. *International Journal of Molecular Sciences*, 22: 10746.

van den Boom, R 2022, Equine gastric ulcer syndrome in adult horses. *The Veterinary Journal*, 283: 105830.

Bulut, G & Tuzlacı, E 2015, An ethnobotanical study of medicinal plants in Bayramiç. *Marmara Pharmaceutical Journal*, 19: 268-282.

Da Costa Ferreira, E, Anselmo, MDGV, Guerra, NM, Marques De Lucena, C, Felix, CDMP, Bussmann, RW, Paniagua-Zambrana, NY & Paiva De Lucena, RF 2021, Local Knowledge and Use of Medicinal Plants in a Rural Community in the Agreste of Paraíba, Northeast Brazil. *Evidence-Based Complementary and Alternative Medicine*, 2021:1–16.

Fitzgerald, DM, Spence, RJ, Stewart, ZK, Prentis, PJ, Sillence, MN & De Laat, MA 2020, The effect of diet change and insulin dysregulation on the faecal microbiome of ponies. *Journal of Experimental Biology*, 223: jeb219154.

Greene, AM, Teixidor-Toneu, I & Odonne, G 2023, To Pick or Not to Pick: Photographic Voucher Specimens as an Alternative Method to Botanical Collecting in Ethnobotany. *Journal of Ethnobiology*, 43: 44-56.

Hedberg-Alm, Y, Penell, J, Riihimäki, M, Osterman-Lind, E, Nielsen, MK & Tydén, E 2020, Parasite occurrence and parasite management in Swedish horses presenting with gastrointestinal disease: A case-control study. *Animals*, 10: 638.

Hewetson, M & Tallon, R 2021, Equine Squamous Gastric Disease: Prevalence, Impact and Management. *Veterinary Medicine: Research and Reports*, 12: 381-399.

Ilić, T, Bogunović, D, Nenadović, K, Gajić, B, Dimitrijević, S, Popović, G, Kulišić, Z & Milosavljević, P 2023, Gastrointestinal Helminths in Horses in Serbia and Various Factors Affecting the Prevalence. *Acta Parasitologica*, 68: 56-69.

Kozhanova, N, Sarsembayeva, N, Lozowicka, B & Kozhanov, Z 2021, Seasonal content of heavy metals in the "soil–feed–milk–manure" system in horse husbandry in Kazakhstan. *Veterinary World*, 14: 2947.

Kubentayev, SA, Alibekov, DT, Perezhogin, YV, Lazkov, GA, Kupriyanov, AN, Ebel, AL, Izbastina, KS, Borodulina, OV & Kubentayeva, BB 2024, Revised checklist of endemic vascular plants of Kazakhstan. *PhytoKeys*, 238: 241.

Li, X, Han, M, Song, X, Sun, M, Xu, L, Liang, Y, Shen, Y, Song, Y, Zhang, J & Chen, W 2024, Characteristics and comparative study of medicinal materials between China and India based on data mining from literatures. *Journal of Ethnopharmacology*, 118409.

Mukhamadieva, N, Julanov, M, Zainettinova, D, Stefanik, V, Nurzhumanova, Z, Mukataev, A & Suychinov, A 2022, Prevalence, diagnosis and improving the effectiveness of therapy of mastitis in cows of dairy farms in East Kazakhstan. *Veterinary Sciences*, 9: 398.

Nelson, LK 2020, Computational Grounded Theory: A Methodological Framework. *Sociological Methods & Research*, 49: 3-42.

Nendissa, DR, Alimgozhaevich, IK, Sapaev, IB, Karimbaevna, TM, Bakhtiyarovna, SZ, Abdullah, D, Ugli Zokirov, KG & Sharifovna, AG 2023, Sustainable livestock grazing in Kazakhstan practices, challenges, and environmental considerations. *Caspian Journal of Environmental Sciences*, 21: 977-988.

Ospangaliyev, A, Sarsekova, D, Mazarzhanova, K, Dosmanbetov, D, Kopabayeva, A, Obezinskaya, E, Nurlabi, A & Mukanov, B 2023, Assessment of the degree of landscaping in Astana, Kazakhstan and recommendations for its development. *Caspian Journal of Environmental Sciences*, 21: 585-594.

Panahi, M, Rezaee, M-B & Jaimand, K 2020, A review of phytochemistry and phylogeny that aid bio-prospecting in the traditional medicinal plant genus *Ferula* L. (Apiaceae) in Iran. *Journal of Medicinal plants and By-product*, 9: 133-148.

Phillips, O & Gentry, AH 1993, The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. Economic Botany, pp. 15–32.

Pozharskiy, A, Abdrakhmanova, A, Beishova, I, Shamshidin, A, Nametov, A, Ulyanova, T, Bekova, G, Kikebayev, N, Kovalchuk, A, & Ulyanov, V, 2023, Genetic structure and genome-wide association study of the traditional Kazakh horses. *Animal*, 17: 100926.

Rhodes, DM & Madrigal, R 2021, Management of Colic in the Field. *Veterinary Clinics: Equine Practice*, 37: 421-439.

Shosan, LO, Fawibe, OO, Ajiboye, AA, Abeegunrin, TA & Agboola, DA 2014, Ethnobotanical survey of medicinal plants used in curing some diseases in infants in Abeokuta South Local Government Area of Ogun State, Nigeria. *American Journal of Plant Sciences*, 5: 3258.

Singh, MR, Pradhan, K, Pradhan, M, Yadav, K, Chauhan, NS, Dwivedi, SD & Singh, D 2023, Lipid-based particulate systems for delivery of plant actives and extracts: Extraction, prospective carriers, and safety issues. In: Phytopharmaceuticals and Herbal Drugs. Elsevier pp. 83-114 https://www.sciencedirect.com/science/article/pii/ B9780323991254000172 Date of access: 11 Jul. 2024.

Snega, K, Vijayalakshmi, MK, Nadhiya, J & Showbharnikhaa, S 2024, Reviewing the Therapeutic Uses and Pharmacology of Glycyrrhiza glabra. *Journal of Pharma Insights and Research*, 2: 122-125.

Tuler, AC & Silva, NC da 2014, Women's ethnomedicinal knowledge in the rural community of São José da Figueira, Durandé, Minas Gerais, Brazil. *Revista Brasileira de Farmacognosia*, 24: 159-170.

Tumoro, G & Maryo, M 2016, Determination of informant consensus factor and fidelity level of ethnomedicinal plants used in Misha Woreda, Hadiya Zone, Southern Ethiopia. *International Journal of Biodiversity and Conservation*, 8: 351-364.

Uddin, MZ & Hassan, MA 2014, Determination of informant consensus factor of ethnomedicinal plants used in Kalenga forest, Bangladesh. *Bangladesh Journal of Plant Taxonomy*, 21: 83.

Ugulu, I & Baslar, S 2010, The determination and fidelity level of medicinal plants used to make traditional Turkish Salves. *The Journal of Alternative and Complementary Medicine*, 16: 313-322.

Vokes, J, Lovett, A & Sykes, B 2023, Equine gastric ulcer syndrome: an update on current knowledge. *Animals*, 13: 1261.

Zaitseva, S, Dagurova, O, Radnagurueva, A, Kozlova, A, Izotova, A, Krylova, A, Noskov, S, Begmatov, S, Patutina, E & Barkhutova, DD 2023, Fecal microbiota and diet composition of buryatian horses grazing warm-and cold-season grass pastures. *Microorganisms*, 11: 1947.

Zenderland, J, Hart, R, Bussmann, RW, Paniagua Zambrana, NY, Sikharulidze, S, Kikvidze, Z, Kikodze, D, Tchelidze, D, Khutsishvili, M & Batsatsashvili, K 2019, The Use of "Use Value": Quantifying Importance in Ethnobotany. *Economic Botany*, 73: 293-303.

Bibliographic information of this paper for citing:

Ibragimov, T, Arystanova, S, Abildaeva, R, Senkebaeva, A, Muminova, K, Kidirbayeva, K, Issayev, Y, Balabekov, A 2024, An ethnobotanical study on medicinal plants used for equine digestive health in Kazakhstan, Caspian Journal of Environmental Sciences, 22: 639-651.