Treatment of diarrhea and dysentery through ethnomedicinal plants in the Jaunpur Region of Garhwal Himalaya, India

Tarseem Lal, Lakhi Ram Dangwal and Minakshi Rawat

Correspondence

Tarseem Lal*, Lakhi Ram Dangwal and Minakshi Rawat

Herbarium and Plant Systematic Laboratory, Department of Botany, HNB Garhwal University, SRT Campus, Badshahi Thaul, Tehri Garhwal - 249199, Uttarakhand, India

*Corresponding Author: tarseemlal35527@gmail.com

Ethnobotany Research and Applications 28:44 (2024) - http://dx.doi.org/10.32859/era.28.44.1-14
Manuscript received: 24/10/2023 – Revised manuscript received: 22/02/2024 - Published: 24/02/2024

Research

Abstract

Background: Diarrhea and dysentery are leading causes of death and illness in rural areas of developing countries in worldwide and neighboring countries. Diarrhea ranking as the third most common cause of child mortality in India. It contributes to 13% of deaths in children under five years annually. Even at the present time, majority of the rural people of the country still rely on regional plants resources to treat many diseases, including diarrhea and dysentery. The aim of the present study was to document and record the utilization of ethnomedicinal plants and various herbal remedies for the management of gastrointestinal ailments, with a specific focus on combating diarrhea and dysentery in the rural area of Garhwal Himalaya, specifically the Jaunpur region in the study site.

Methods: Ethnobotanical investigation was carried out in 12 villages (namely Dhanaulti, Rautu ki Beli, Nainbagh, Kempty, Thatyur, Almas, Kyari, Pantwari, Devalsari, Teva, Naag Tibba, and Ontal) with traditional practices, interviewing 138 local informants (90 males and 48 females). The various methods (group discussions, meetings, and questionnaires) to gather ethnomedicinal knowledge for curing diarrhea and dysentery treatment. Furthermore, in this study, the informant's consensus factor (ICF), use value (UV), and fidelity index (FI%) were also discussed for each of the studied species.

Results: In this study, local informants utilized a total of 30 ethnomedicinal plant species (from 28 genera and 30 families) to treat diarrhea and dysentery. The percentage of plant species used for specific ailments was: diarrhea (32% spp.), dysentery (20%), digestive problems (14%), stomach problems (12%), gastroenteritis (8%), appetizers (6%), dyspepsia (4%), oral ulcers (2%), and flatulence (2%). The residents use specific plant parts for ethnomedicinal purposes, with the following distribution: bark (3% spp.), fruits (10%), flowers (3%), leaves (45%), rhizomes (7%), roots (13%), seeds (3%), stems (7%), twigs (3%), and whole plant (6%). The herbal preparations in use include decoction (56% spp.), infusion (20%), juice (12%), paste (8%), and powder (4%).

Conclusion: The present communication provides valuable insights into the indigenous utilization and availability of ethnomedicinal plants for treating diarrhea and dysentery. It underscores the importance of documenting and preserving this rich reservoir of knowledge passed down through generations for future research endeavors.

Keywords: Rural people, Child mortality, Gastrointestinal ailments, Herbal preparations, Tehri Garhwal

Background

Diarrhea and dysentery are some of the main reasons for death and illness, among all the age groups in rural communities. Worldwide, accepted as a significant hazard to human health problems. Every day the passage of more than three liquid or loose stools, or more often that is typical for the individual is known as diarrhea. Gastrointestinal illness is caused by bacteria, viruses and parasites. Infection can spread from one person to another through contaminated food and water as a consequence of unhygienic conditions (WHO 2013a). It kills the lives of about 2.2 million people annually especially children of developing countries (WHO 2013c). It is the second leading cause of death under the age of five years, 370,000 children lost their lives due to diarrhea (WHO 2019). Recently, a total of 7,74,925 acute watery diarrhea suspected cholera cases including 7,722 laboratory-confirmed cases. The suspected deaths (427) were reported from 8 countries in the eastern Mediterranean region (EMR) (WHO 2023). Diarrhea varies from moderate and publicly disturbing sickness before a dominant effect of hunger and food aversion in children in emergent nations (Mukherjee *et al.* 1998). Amoebic dysentery has a more hazardous effect on people's health than bacillary dysentery (Kar & Borthakar 2008; Krause *et al.* 2001). 15% deaths are happened due to dysentery (Jouret-Mourin & Geboes 2002). An estimated 75,000 deaths and 42 million cases of amoebic dysentery are reported worldwide each year (Jamil *et al.* 2003). Over the last few years, peculiar interest has been shown in alternative bio-remedies. It was utilized to treat the ailment due to its low cost, fewer or no negative impact, and productivity (Bonjar 2004). An ample part of the rural and folk communities in emergent nations still depend upon these medicines as their front line of defense in health protection. It considers the prior status of these indigenous medicines (Goleniowski *et al.* 2006).

Several national and international organization assists in conducting studies for curing diarrheal ailments by conventional approaches (Tona *et al.* 1998; Lin *et al.* 2002). It provides an effective source of medicine for diarrheal diseases (Mukherjee *et al.* 1998; Otshudi *et al.* 2001; Patel *et al.* 2008; Njume & Goduka 2012). A similar positive relationship between diarrhea and temperature has been reported in Latin America and Africa (Thiam *et al.* 2017). The rapid number of cases of diarrhea increased in China because speed up in relative humidity and temperature (Yang *et al.* 2021). The latest investigation assesses in Nepal, there is a 4.4% greater chance that a child under the age of five will develop diarrhea at 1°C higher in mean temperature (Dhimal *et al.* 2022). Additional factors including water availability and cleanliness, population density and socioeconomic position play a significant influence in predicting the occurrence of diarrhea. Much prior research primarily focused on weather variables (Gasana *et al.* 2002). Numerous research studies have discovered a connection between the death incidence of diarrhea and variations in temperature, precipitation, droughts, floods, and water scarcity (Saad-Hussein *et al.* 2023).

India is home to 427 tribal communities, and the population's tribal belt provides a fascinating insight into the ethnic diversity of this country (Dutta & Dutta 2005). Lots of studies were gone through by Indian researchers, to record and document the ethnomedicinal plants for curing or preventing diarrhea (Mohanty *et al.* 1998; Kar & Borthakur 2008; Panda *et al.* 2012). Utilization of seeds of *Mangifera indica* for antidiarrheal activity (sairam *et al.* 2003). Among the Koyas tribe's usage of ethnomedicinal plants to cure dysentery and diarrhea (Raju & Reddy 2005). The tribes and the local traditional practitioners of rural communities' dwell inside and surrounding the forest. The majority depend on the vegetation surrounding them to prevent and treatment of distinct ailments (Sen & Behera 2008; Laloo & Hemalatha 2011; Sarin & Bafna 2012).

Proficient and adequate knowledge regarding the proper usage of ethnomedicinal plants by aboriginal people of the Himalayan region is very minute despite that some new attempts were made (Gaur & Sharma 2011; Gaur *et al.* 2011; Sharma *et al.* 2011a; 2012a; 2013a; 2013b; Dangwal & Lal, 2020; 2021; 2023; Dangwal *et al.* 2021; 2022), to explore the ethnomedicinal plants. In India, sub-Himalaya is a peculiar region of Uttarakhand. The people of the Jaunpur region have a thorough understanding of natural herbal remedies that have been passed down through their ancestors for many years. Dysentery and diarrhea are common among the community members as a result of inadequate sanitation, adequacy of secure drinking water, surrounding is polluted and unhygienic. Recently, herbal medicine has been the sole option for healing ailments, because of limited availability, accessibility, and affordability choices for less known side effects. Generality, the locale of the distinct village in the Jaunpur region is wealthy in the knowledge of widely accessible herbal remedies, and various experienced conventional medicinal practitioners who cure diverse maladies. They have deep knowledge of herbal remedies for curing diarrhea and dysentery. The objective of the present communication pertains to documenting the ethnomedicinal plants are used to make herbal remedies for the management of gastrointestinal ailments, with a specific focus on combating diarrhea and dysentery in the rural area of Garhwal, Himalaya, India, specifically the Jaunpur region in the study site.

Material and Methods

Study Area

The present study was executed in the Jaunpur region of district Tehri Garhwal, of the sub-Himalayan region (Uttarakhand, India) (Figure 1). It encircles an area of 592.17 km per square and the geography of the region lies between 30° 17' 18.9132" N to 30° 38' 24.9828" N Latitudes and 77˚ 56' 13.506" E to 78˚18' 38.484" E Longitudes. The mountain ranges between 300 to 3,022 meters above sea level. The distance from this region to New Tehri, the district headquarters, is 41 kilometers. Sahaspur Block to the east and Dehradun Block to the southwest are its borders, and administrative point of view Jaunpur Block is partitioned into 261 villages (eUttaranchal 2023). The residents of the interior Jaunpur region is spoken *Jaunpuri* (local Language) which is a dialect of the Northern Indo-Aryan Language. Although, Hindi is generally utilized in urban areas, English and Hindi are blended around eco-tourism destinations, especially at Kempty Fall, Dhanaulti, and Nag Tibba due to the influx of visitors from across the country and the world. Approximately of the people practicing the Hindu religion in this region belonged to the Garhwali culture and *Jaunpuriya* sub-cultural group.

The alternation of climates in the study area, from subtropical to temperate throughout the year and its ranges vary from elevation zone. The highest peak of Jaunpur is Nag Tibba (3,022 m asl), which experienced snowfall in the winter along with other peaks. There are four distinct seasons in the area: summer, winter, rainy, and spring. At mid and upper elevations, where snowfall occurs most frequently in the winter, the climate is cheerful around the year. However, during the rainy season, residents are affected negatively by heavy rainfall, landslides, and occasionally even cloud bursts. The predominant vegetation in this region is evergreen conifer forests, which are dominated by *Pinus roxburghii* (at lower to mid-elevations) and Cedrus deodara (at higher elevation). Additionally, broad-leaved and conifer mixed forest stands are observed along the valleys and on the north-facing slopes.

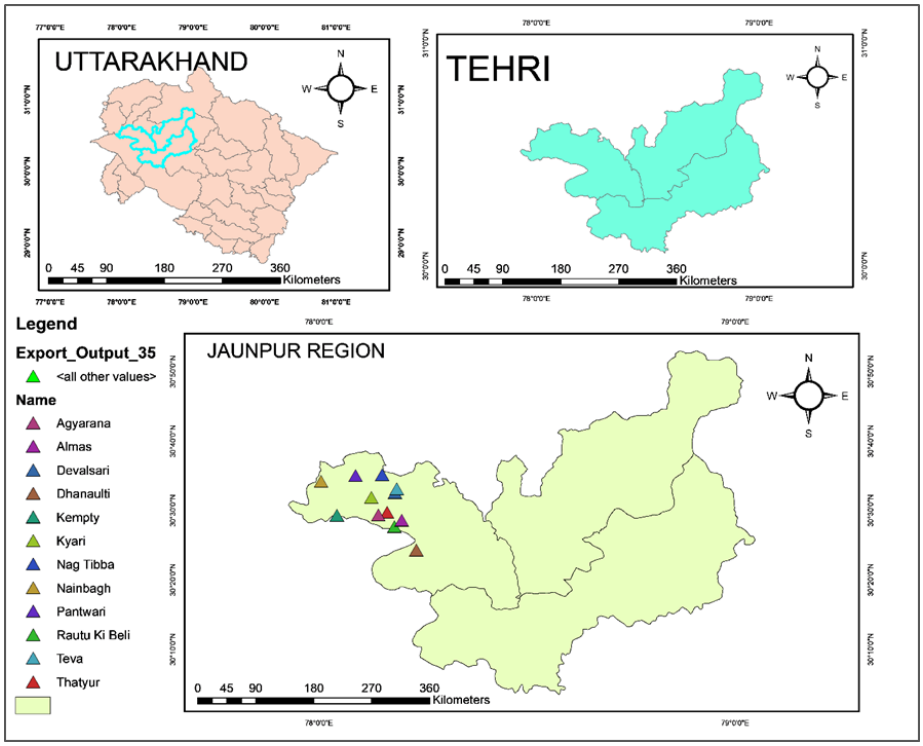

Figure 1. Map of the investigated area

Data collection

The comprehensive systematic ethnobotanical investigation was carried out during the period of September 2021 to July 2023 to gather information on varied ethnomedicinal plants being utilized by locale in distinct villages of the Jaunpur region. The investigation was done to identify the villages where traditional practices were common in the study region. The 12 representative villages viz., Dhanaulti, Rautu ki Beli, Nainbagh, Kempty, Thatyur, Almas, Kyari, Pantwari, Devalsari, Teva, Naag Tibba, and Ontal were selected (Figure 1). Frequently, field visits were made to conduct interviews, meetings, and group discussions with residents i.e., farmers, Vaidyas, shepherds, teachers, priests (pujari), laborers and housewives were used to gather data on the local uses of ethnomedicinal plants used for curing diarrhea and dysentery. After choosing the individuals, informal interviews were conducted to learn about their interests and proficiency for identification and usage.

For the convenience of local informants' discussions were kept with them in their local language (Jaunpuri). This study intended to elaborate on conventional knowledge of ethnomedicinal plants. Total of 138 locals are the main key informants (females 48 and males 90), among the age group 25-100 years were interviewed, a group discussion, meetings, and questionnaire methods were used to collect information on these ethnomedicinal plants. The ratio of the female informants was less due to the social position of the study region which prevented them from interacting with outsiders. Below the age of 25-30, the local male informants interviewed were because they leave their villages to study or apply for jobs in cities (Bhatia *et al.* 2014). Entire local informants live in the backward area, where their primary jobs are farming and raising livestock. The gathered information from local inhabitants includes knowledge of common ailments occurring in humans, another ailment, no side effects of herbal medicine were observed for the treatment of diarrhea and dysentery. Botanical names, families, local names, life forms, parts used and ethnomedicinal uses (mode of administration, dosage pattern, and method of herbal preparation), given in (Table 1). The larger number of informants were farmers by vocation followed by Vaidyas, shepherds, teachers, and priests (pujari). The regional Flora, *Flora of the District Garhwal Northwest Himalaya* (Gaur 1999), and the herbarium, GUH (Herbarium of the Department of Botany, H.N.B. Garhwal University, Uttarakhand), were used to collect, process, and identify the plant specimens were submitted to the Herbarium of Plant Systematic Laboratory, Department of Botany herbarium at H.N.B. Garhwal University, S.R.T. Campus in Badshahi Thaul. The current (accepted botanical name of plant species were adopted using online database i.e., 'Plants of the World Online' (POWO 2024).

Analysis of data

Three quantitative indices Viz., use value (UV), informant's consensus factor (ICF), and fidelity level (FI%) were used to analyze the information gained through various frequent interviews with local informants. Estimation of relative significance through applied the use-value, and the importance of locale plant species is evaluated by quantitative indices (Phillips *et al.* 1994),

$$\boldsymbol{UV} = \sum \boldsymbol{U}/\mathbf{n}$$

Where 'n' denotes an entire number of local informants and 'U is the number of use reports mentioned by each informant for a particular species. Use value is maximum when the citation use report is high in number, and it is minimum when the citation use report is very small in number. Thus, high and low use value indicates the importance of ethnomedicinal plants. However, single and multiple uses of plants do not differentiate through use value (Musa *et al.* 2011).

The utilization of the informant consensus factor for examining the similarity of ethnomedicinal plant knowledge of use reports is analyzed when distinct ailments are categorized in the form of various groups (Heinrich *et al.* 1998). The ICF was determined to be:

$$\mathbf{Fic} = \frac{\mathbf{Nur} - \mathbf{Nt}}{\mathbf{Nur} - \mathbf{1}}$$

Where "Nt" denotes the total number of taxa utilized by all informants for a given use category, and "Nur" denotes the total number of use reports for a given use category. The value of factor informant consensus is low (close to 0), only when plants are selected randomly or among the informants there is no passage of information on plant usage, while the value of informant consensus factor is approach to one (1) only when there is clear-cut selection criterion in the community or among the informants there is passage of information of plant usage (Gazzaneo *et al.* 2005; Sharma *et al.* 2012). It is fascinating to determine the most selected species utilized for curing the specific illness, because of several plant species may be utilized in the same use category (Musa *et al.* 2011). This can be done using the fidelity level (FI%) (Friedman *et al.* 1986), which can be found here:

$$\mathbf{FI} = \frac{\mathbf{Np}}{\mathbf{N}} \times \mathbf{100}$$

Where "N" is the total number of use reports noted for any given species, and "Np" is the number of use reports cited for a given species for a specific illness. The fidelity index value is low for those ethnomedicinal plants, utilized for various distinct reasons while the high-fidelity index value (100%) of those ethnomedicinal plants, utilized for the same reason or the utilization pattern remains the same (Musa et al. 2011).

Table 1. Treatment of diarrhea and dysentery through ethnomedicinal plants

Botanical Name (Family)	Local name/Common name	Life forms	Part used	Ethnomedicinal uses	Total citation/ Use value
Achyranthes aspera L. (Amaranthaceae)	Latjiri/Chaff-flower	H	Lf, Tw	100ml decoction of twigs along with leaves and added 20ml of honey was given orally to a person about 2 teaspoons thrice a day for curing the diarrhea (78) and dysentery (32).	110/0.79
Aegle marmelos (L.) Corrêa (Rutaceae)	Bel/Bael Tree	T	Fr	250 ml juice of the fruit pulp is orally given 3 times every day after meal to get relief from diarrhea (37), dysentery (22), and stomach problems (32). It also increases the appetite (34).	125/0.90
Agrimonia eupatoria L. (Rosaceae)	Agrimony, Sticklewort	H	Lf	10ml decoction of leaves is given to the patient thrice after meal to treat digestive tract problems (6), internal wounds (24), digestive system (36), and urinary infections (16).	82/0.59
Agrimonia pilosa Ledeb. (Rosaceae)	Lesukuria/Hairy Agrimony	H	Lf	Crushed leaves added with water to make a paste, it is administrated orally twice a day after meal in the morning and evening for curing the diarrhea (28) and dysentery (15).	43/0.31
Ainsliaea aptera DC. (Asteraceae)	Kauru/Wingless Ainsliaea	H	Rt	2–3-gram powder of dried root is added with 20 ml hot water and given orally after breakfast and dinner to cure stomachache (24) and diarrhea (88).	112/0.81
Amaranthus spinosus L. (Amaranthaceae)	Chulai/ Prickly Amaranth	H	Lf	Infusion of leaves is utilized for curing the stomach problems (12), diarrhea (52), and anemia (6), it increases digestion (16), and cures the peptic ulcer (8).	94/0.68
Arenaria serpyllifolia L. (Caryophyllaceae)	Thyme-Leaved Sandwort	H	Lf	5 ml decoction of leaves is given orally 3 times a day to cure the diarrhea (64) and dysentery (13).	77/0.55
Bergenia ciliata (Haw.) Sternb. (Saxifragaceae)	Patharchur /Paakhanbhed	H	Rz	10-15 ml decoction of rhizome is taken orally thrice each day after meal for curing stomach problems (84) and fever (14).	98/0.71
Bergera koenigii L. (Rutaceae)	Kadhipatta/ Curry Leaf	T	Lf	5 ml infusion of leaves is taken orally an empty stomach once a day, to cure gastroenteritis (23), it increases appetite (102).	125/0.90
Brucea javanica (L.) Merr. (Simaroubaceae)	Deshmeel/ Sumac	S	Fr	The fruit juice is taken orally up to 50 ml thrice a day to cure the diarrhea (76).	76/0.55
Bryophyllum pinnatum (Lam.) Oken (Crassulaceae)	Life Plant	H	Lf	The paste of leaves is utilized to cure stomach problems (13).	13/0.094
Curculigo orchioides Gaertn. (Hypoxidaceae)	Kali Musli	H	Rz	20-30 ml decoction of the rhizome is taken orally once a day for 20 days to cure the diarrhea (16).	16/0.11
Cynoglossum zeylanicum (Sw.ex Lehm.) Thunb. ex Brand (Boraginaceae)	Lichkura/Ceylon Hound's Tongue	H	Rt	8-12 ml root decoction is administrated orally twice a day in the morning and evening before meal to cure the digestive problems (33) and dyspepsia (42).	75 /0.54

Duchesnea indica (Andrews) Teschem. (Rosaceae)	Bhiun-Kaphal	H	Wp	Whole plant decoction is orally taken three times each day after meal for curing the diarrhea (73) and dysentery (52).	125/0.90
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita (Rosaceae)	Gand- Kaphal	H	Lf	50 ml infusion of leaves is taken orally once a day after 15 minutes of lunch to treat the diarrhea (95).	95/0.68
Leucas lanata Benth. (Lamiaceae)	Bis-Kapra/ Woolly Leucas	H	Lf	Cooked leaves are eaten to get comfort from body aches (15) and gastroenteritis (54).	69/0.5
Micromeria biflora (Buch. - Ham. ex D.Don) Benth. (Lamiaceae)	Ban-ajwain /Lemon Savory	H	Lf	Infusion of leaves added with 10 ml honey, and milk is administrated orally after meal 3 times a day for 21 days to cure gastroenteritis (65).	65/0.47
Moringa oleifera Lam. (Moringaceae)	Sunara/Drumstick Tree	T	Lf	2 to 3 teaspoons of leaves decoction is administrated orally thrice a day for minimum 14 days to cure gastroenteritis (23) and high blood pressure (64).	87/0.63
Myrica esculenta Buch. - Ham. ex D.Don (Myricaceae)	Kaphal/Box Myrtle	T	Fr	Juice of fresh fruit given daily after one hours of lunch to get relief from digestive problems (122).	122/0.88
Oxalis corniculata L. (Oxalidaceae)	Khati-Buti/Indian Sorrel	H	Wp	3-5 ml decoction of the whole plant is taken orally 3 times a day to cure diarrhea (76), dysentery (12), and fever (5).	93/0.67
Persicaria hydropiper (L.) Delarbre (Polygonaceae)	Ameta/Chinese knotweed	H	St	Infusion of the tender shoot is orally administrated to cure the diarrhea (15) and dysentery (7).	22/0.15
Quercus leucotrichophora A.Camus (Fagaceae)	Bhanj/White Oak	T	St	Decoction of shoot apex is given with hot water thrice a day after 20 minutes of meals for 21 days to cure digestive problems (54).	54/0.39
Rhododendron arboreum Sm. (Ericaceae)	Burans/Rhododendron	T	Fl	150 ml fresh juice of flowers petals is orally taken, once a day to cure diarrhea (65), and dysentery (12), it also increases the number of red blood cells (125).	122/0.88
Rubus ellipticus Sm. (Rosaceae)	Hissaar/ Himalayan Yellow Raspberry	S	Rt	10-15 ml decoction of roots is administrated orally 2 times a day in morning and evening before meal for 14 days to cure diarrhea (127), oral and stomach ulcers (26).	113/0.81
Rumex dentatus L. (Polygonaceae)	Jangli-palak/Toothed Dock	H	Rt	Decoction of the root is utilized to relieve flatulence (8) and dyspepsia (7).	15/0.10
Rumex nepalensis Spreng. (Polygonaceae)	Kholiya/ Nepal Dock	H	Lf	The leaves is cooked and administrated orally to cure stomach problems (68).	68/0.49
Scutellaria repens Buch. - Ham. ex D.Don (Lamiaceae)	Karwi-ghas/Creeping Skullcap	H	Lf	5-10 ml decoction of leaves is orally taken 2 times a day for 10 days to cure diarrhea (7) and dysentery (3).	10/0.072

Urtica ardens Link (Urticaceae)	Kandali/ Stinging Nettles	S	Lf	Leaves are cooked and eaten to cure the digestive problems (120).	120/0.86
Viburnum cotinifolium D.Don (Viburnaceae)	Indian wayfaring tree	S	Br	20 ml decoction of bark is administrated orally thrice a day for curing the of digestive (13), and liver problems (9).	22/0.15
Zanthoxylum armatum DC. (Rutaceae)	Timroo/ winged prickly ash	S	Sd	One small tea cup decoction of 20-30 number of dried seeds is administrated orally to cure diarrhea (92) and dysentery (31).	123/ 0.89

Where, **H=** "Herbs", **S=** "Shrubs", **T=** "Trees" **Lf** = "Leaves", **Tw**= "Twigs", **Fr** = "Fruits", **Rt** = "Roots", **Rz** = "Rhizomes", **Wp** = "Whole plants", **St** = 'Stem", **Fl** = "Flowers", **Br**= "Bark", **Sd** = "Seeds", **UV =** "Use Value", **U =** "Total Citation", and **n** is the "total number of informants". **Category i, UV**= >0.80, **Category ii,** UV= 0.60 to 0.80, **Category iii,** UV= <0.6

Results and Discussion

Characteristics of informants

During the fieldwork, a total of 138 local inhabitant's females 48 and males 90, were the main key respondents. The farmers, vaidyas, shepherds, teachers, priests (pujari), laborers and housewives of distinct age groups (25– 93) were selected for an interview and personal observations and also recorded to collect valuable information on various usage and remedies of dysentery and diarrhea.

Floristic characteristics of ethnomedicinal plants

The present study resulted in the documentation of 30 plant species belonging to 28 genera and 19 families used for diarrhea and dysentery. These species are enlisted alphabetically in (Table 1), along with relevant information like botanical name, family, local name, part used and dosage pattern. Among the total species, 19 were herbs (63%), 6 were trees (20%), and shrubs were 5 (17%), respectively. Rosaceae (5 species), were the most dominant family in number of accounted species proceeded by Lamiaceae, Polygonaceae, and Rutaceae (3 species each), and followed the least dominant families were Asteraceae, Boraginaceae, Caryophyllaceae, Crassulaceae, Ericaceae, Fagaceae, Hypoxidaceae, Moringaceae, Myricaceae, Oxalidaceae, Saxifragaceae, Simaroubaceae, Urticaceae and Viburnaceae (1 species each), respectively (Figure 2). The inhabitant uses specific plant parts viz., bark (3% spp.), fruits (10%), flowers (3%), leaves (45%), rhizomes (7%), roots (13%), seeds (3%), stems (7%), twigs (3%), and whole plant (6%), respectively. Herbal preparations method used viz., decoction (56% spp.), infusion (20%), juice (12%), paste (8%), and powder (4%). All these remedies are taken orally to cure various gastrointestinal problems like diarrhea, dysentery, appetizer, gastroenteritis, dyspepsia, acidity, oral ulcers, constipation, flatulence and digestive problems (Table 1**).**

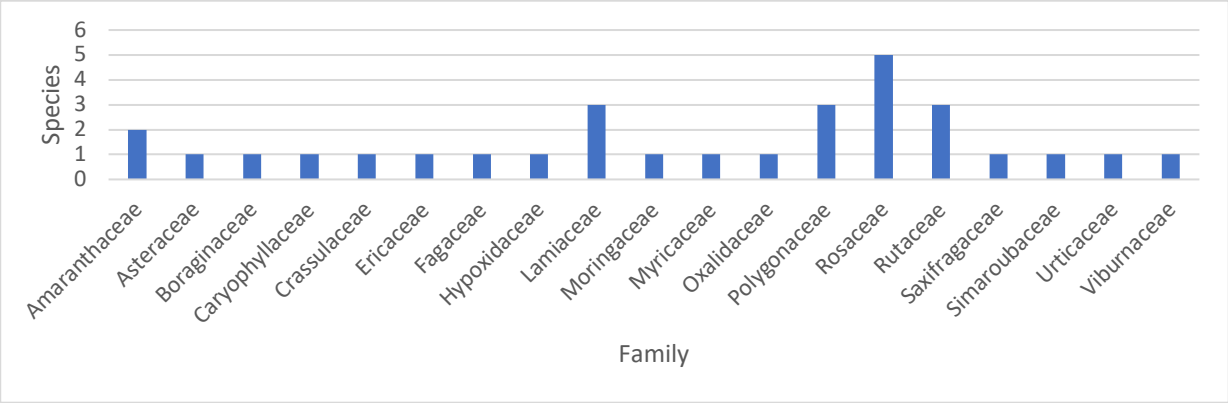

Figure 2. Number of species vs family

Use value of medicinal plants

According to use value most valuable and important ethnomedicinal is categorized into three groups of the present study site: In group i category, UV= >0.80 are: *Aegle marmelos, Bergera koenigii,* and *Duchesnea indica,* use value were (UV=0.90), *Zanthoxylum armatum* (UV=0.89), *Myrica esculenta* and *Rhododendron arboreum, were* (UV= 0.88), *Urtica ardens* (UV=0.86), *Ainsliaea aptera*, *Rubus ellipticus were* (UV=0.81). In group ii category, UV= 0.60 to 0.80 were: *Achyranthes aspera* (UV=0.79), *Bergenia ciliata* (UV=0.71), *Amaranthus spinosus, Fragaria nubicola, were* (UV=0.68), *Oxalis corniculata* (UV=0.67), *Moringa oleifera* (UV=0.63). In group iii category, UV= <0.60 were: *Agrimonia eupatoria* (UV=0.59), *Arenaria serpyllifolia*, *Brucea javanica,* were (UV=0.55), *Cynoglossum zeylanicum* (UV=0.54), *Rumex nepalensis* (UV=0.49), *Micromeria biflora* (UV= 0.47), *Quercus leucotrichophora* (UV=0.39), *Agrimonia pilosa* (UV=0.31), *Persicaria hydropiper* (UV=0.15), *Viburnum cotinifolium* (UV=0.15), *Curculigo orchioides* (UV=0.11), *Rumex dentatus* (UV= 0.10), *Leucas lanata* (UV=0.5), *Bryophyllum pinnatum* (UV=0.094), *Scutellaria repens* (UV= 0.072) (Table 1).

Informant consensus factor

In an investigated area, 30 plant species were studied to treat as many as 17 different diseases. According to (Heinrich *et al.* 1998), the illnesses were segregated into two main ailment categories (Table 2). The maximum number of species was (16) were utilized for curing diarrhea, followed by dysentery (10), stomach problems (6), appetizer (3), gastroenteritis (4), Dyspepsia (2), oral ulcers (1), flatulence (1), and digestive problems (7), respectively. The informants were more in agreement with the way that oral ulcers (ICF=1), flatulence (ICF=1), diarrhea (ICF=0.98), appetizer (ICF=0.98), gastroenteritis (ICF=0.98), digestive problems (ICF=0.98), dyspepsia (ICF=0.97), stomach problems (ICF=0.97) and dysentery (ICF=0.95), (Table 2).

Table 2. Ailment category and informant consensus factor (ICF)

Ailment Category (diseases)	Number of species (Nt)	Use citations (Nur)	Informant consensus factor (ICF)
Gastrointestinal			
Diarrhea	16	922	0.98
Dysentery	10	199	0.95
Stomach problem	6	233	0.97
Appetizer	3	152	0.98
Gastroenteritis	4	165	0.98
Dyspepsia	2	49	0.97
Oral ulcers	1	26	1
Flatulence	1	8	1
Digestive problem	7	384	0.98

Where, **Nt =** "Number of species", **Nur =** "Use citation", and **ICF=** "Informant consensus factor"

Fidelity index

In this investigation, the fidelity level value was between 15.38% to 100%. To increase the accuracy of cited species, fewer than five respondents were not included in the final study. The fidelity index values for (a). diarrhea viz., *Zanthoxylum armatum* (FI=80.43%), *Rubus ellipticus* (FI=72.41%), *Scutellaria repens* (FI=71.42%), *Fragaria nubicola* (FI=70.52%), *Amaranthus spinosus* (FI=61.53%), *Oxalis corniculata* (FI=60.52%), *Duchesnea indica* (FI=57.53%), *Aegle marmelos* (FI=56.78%), *Rhododendron arboreum* (FI=44.43%). (b). Dysentery is mainly treated by *Aegle marmelos* (FI=77.27%), *Persicaria hydropiper* (FI=71.42%), *Zanthoxylum armatum* (FI=67.74%), *Oxalis corniculata* (FI= 58.33%), *Rhododendron arboreum* (FI= 50%), *Duchesnea indica* (FI=50%). (c). Stomach problems were mainly cured by *Bergenia ciliata* (FI=73.80%), *Rumex nepalensis* (FI=67.64%), *Aegle marmelos* (FI=65.62%). (d). Appetizer were *Aegle marmelos* (FI=82.35%), *Bergera koenigii* (FI=66.66%). (e). Gastroenteritis were *Bergera koenigii* (FI=69.56%), *Moringa oleifera* (FI=65.21%), *Leucas lanata* (FI=64.81%). (f). Dyspepsia by *Rumex dentatus* (FI=71.42%). (g). Oral ulcer by *Rubus ellipticus* (FI=57.69%). (h). Flatulence by *Rumex dentatus* (FI=78%). (h). digestive problems were treated by *Urtica ardens* (FI=85%), *Agrimonia pilosa* (FI=83.33%), *Myrica esculenta* (FI=80.32%), (Table 3).

Table 3. Fidelity index (FI%) of significant species for different ailment categories

Ailment category	Significant species	Fidelity index (FI%)
1. Gastrointestinal		
a. **Diarrhea**	*Achyranthes aspera*	15.38%
	Aegle marmelos	56.75%
	Agrimonia pilosa	25%
	Ainsliaea aptera	40.90%
	Amaranthus spinosus	61.53%
	Arenaria serpyllifolia	25%
	Brucea javanica	30.26%
	Curculigo orchioides	31.25%
	Duchesnea indica	57.53%
	Fragaria nubicola	70.52%
	Oxalis corniculata	60.52%
	Persicaria hydropiper	40%
	Rhododendron arboreum	44.43%
	Rubus ellipticus	72.41%
	Scutellaria repens	71.42%
	Zanthoxylum armatum	**80.43%**
b. **Dysentery**	*Achyranthes aspera*	40.62%
	Aegle marmelos	**77.27%**
	Agrimonia pilosa	46.66%
	Arenaria serpyllifolia	46.15%
	Duchesnea indica	50%

	Oxalis corniculata	58.33%
	Persicaria hydropiper	71.42%
	Rhododendron arboreum	50%
	Zanthoxylum armatum	67.74%
c. **Stomach problem**	*Aegle marmelos*	65.62%
	Ainsliaea aptera	37.5%
	Bergenia ciliata	**73.80%**
	Bryophyllum pinnatum	46.15%
	Rumex nepalensis	67.64%
d. **Appetizer**	***Aegle marmelos***	**82.35%**
	Amaranthus spinosus	37.5%
	Bergera koenigii	66.66%
e. **Gastroenteritis**	*Leucas lanata*	64.81%
	Micromeria biflora	47.69%
	Moringa oleifera	65.21%
	Bergera koenigii	**69.56%**
f. **Dyspepsia**	*Cynoglossum zeylanicum*	30.95%
	Rumex dentatus	**71.42%**
g. **Oral ulcers**	***Rubus ellipticus***	**57.69%**
h. **Flatulence**	***Rumex dentatus***	**78%**
i. **Digestive problems**	*Agrimonia pilosa*	83.33%
	Cynoglossum zeylanicum	39.39%
	Myrica esculenta	80.32%
	Quercus leucotrichophora	40.74%
	Urtica ardens	**85%**
	Viburnum cotinifolium	46.15%

Where, **FI%** = Fidelity Index percentage

Conclusions

The present communication provides profound knowledge about the indigenous uses and accessibility of ethnomedicinal plants used for diarrhea and dysentery. The medicinal plants listed in the present study mainly used for the treatment of gastrointestinal ailments like (Diarrhea, dysentery, stomach problems, appetizers, gastroenteritis, dyspepsia, oral ulcers, flatulence, digestive problems), etc., but the main focus of the present communication is the causes, cure and treatment of diarrhea and dysentery problems shown in (Table 1). In this area, local inhabitants are economically weak, and limited the challenge of allopathic medicines, because they believe in traditional herbal remedies. These are very cheaper and more accessible. Even if the prevalence of diarrhea has been decreasing in the villages due to the local traditional ethnomedicinal practitioners. There is still need to advance interventions for its prevention and control of the diseases quickly in order to reduce the enormous number of deaths in India as well as neighboring countries.

The various reasons for deaths happened of diarrhea and dysentery diseases viz., unsafe sanitation, no access to hand wash facility, air pollution, maternal and child malnutrition, child growth failure, low birth weight, suboptimal breastfeeding, child stunting, short gestation for birth weight, vitamin A and Zinc deficiency. These are some preventive measures that need to be from diarrhea and dysentery illnesses viz., consuming safe and clean water, having proper sanitation in every home, ensuring that mothers and children receive the nutrition they need safely nursing and disposing of waste, carefully managing cases, and getting vaccinated against the rotavirus are just a few of the effective interventions that need to be put into place worldwide.

Major obstacles in the sustainability of natural medicinal resources in the area include over-utilization, forest fires, landslides, road expansion, and houses/building construction which are threatening and reducing the population of noteworthy ethnomedicinal plants. On the other hand, the existing traditional knowledge is also disappearing at an alarming rate from old to new generations. As still the old aged traditional practitioners dwelling in the villages and they are using herbal medicines consistently for their treatment while the young generations migrate to cities for their education, employment, and money-making possibilities where modern medicine is easily available to them. Hence, this traditional knowledge wealth

of using ethnomedicinal plants to cure numerous ailments may disappear in future generations. Hereby, there is an urgent need to conserve their traditional knowledge through documentation and traditional practices.

Plate 1. Diarrhea and Dysentery diseases curing ethnomedicinal plants in the Jaunpur region: (A). Leucas lanata (B). *Myrica esculenta* (C). *Rubus ellipticus* (D). *Bergenia ciliata* (E). *Duchesnea indica* (F). *Rhododendron arboreum* (G). *Fragaria nubicola* (H). *Bergera koenigii* (I). *Oxalis corniculata* (J). *Quercus leucotrichophora* (K). *Urtica ardens* (L). *Zanthoxylum armatum* information gathered from local informant (Sh. Makahan Singh) at Devalsari Village

Declarations

List of abbreviations: H= Herbs, S= Shrubs, T= Trees, Lf = Leaves, Tw= Twigs, Fr = Fruits, Rt = Roots, Rz = Rhizomes, Wp = Whole plants, St = Stem, Fl = Flowers, Br= Bark, Sd = Seeds, UV = Use Value, U = Total Citation, n= total number of informants, Nt = Number of species, Nur = Use citation, and ICF= Informant consensus factor, FI% = Fidelity Index percentage

Ethics approval and consent to participate: This study did not involve the export of any animal or plant material. Information was obtained from the participants. All informants were orally consented.

Consent for publication: Oral permission was taken from all the authors.

Availability of data and materials: The manuscript contains all the data.

Competing interests: We declare that there is no conflict of interest.

Funding: No funding

Authors' contributions: LRD Supervisor, conceptualization and review manuscript, TL and LRD designed the study, TL Plant and data collection, data analysis, preparation of manuscript, MR statistical analysis and designing. All the authors corrected and approved the manuscript.

Acknowledgements

We are highly thankful to the local informants of the Jaunpur region of the sub-Himalaya for sharing their precious traditional knowledge, and providing immense support during fieldwork. Tarseem Lal (author) is highly thankful to the University Grant Commission for providing me financial assistance.

Literature cited

Bhatia H, Sharma YP, Manhas RK, Kumar K. 2014. Ethnomedicinal plants used by villagers of district Udhampur, J&K, India. Journal of Ethnopharmacology 151(2014): 1005–1018.

Bonjar S. 2004. Evaluation of antibacterial properties of some medicinal plants used in Iran. Journal of Ethnopharmacology 94(2-3): 301–305.

Dangwal LR, Lal T. 2020. Uses of medicinal plants in exorcism in Udhampur district, Jammu and Kashmir. International Journal of Current Research 12(12): 15414–15417.

Dangwal LR, Lal T. 2021. Uses of Ethnomedicinal plants to enhance the memory of humans in Udhampur district, Jammu and Kashmir. World Journal of Pharmacy and Pharmaceutical Sciences 10(12): 2190–2198.

Dangwal LR, Lal T. 2023. Utilization of Psychomedicinal Plants in Udhampur District of Jammu and Kashmir. Mysore Journal of Agricultural Sciences 57(2): 62–71.

Dangwal LR, Lal T, Uniyal P. 2021. Psychomedicinal plants of District Udhampur, Jammu and Kashmir, India. Journal of Mountain Research 16(3): 379–386.

Dangwal LR, Lal T, Uniyal P. 2022. Uses of medicinal plants in the treatment of mental illnesses in Udhampur district, Jammu and Kashmir, India. World Journal of Pharmacy and Pharmaceutical Sciences 11(7): 1511–1519.

Dhimal M, Bhandari D, Karki KB, Shrestha SL, Khanal M, Shrestha RRP, Dahal S, Bista B, Ebi KL, Cissé G, Sapkota A, Groneberg DA. 2022. Effects of Climatic Factors on Diarrheal Diseases among Children below 5 years of Age at National and Subnational levels in Nepal: An Ecological study. International Journal of Environmental Research and Public Health 19(10): 6138(1–12).

Dutta BK, Dutta PK. 2005. Potential of ethnobotanical studies in North East India: An overview. Indian Journal of Traditional Knowledge 4(1): 7–14.

eUttaranchal, 2023. Jaunpur Block, Tehri Garhwal District. https://myroots.euttaranchal.com/block-jaunpur-tehri-garhwal-25.html. (Accessed 26/07/2023).

Friedman J, Yaniv Z, Dafni A, Palewitch D. 1986. A preliminary classification of the healing potential of medicinal plants, based on rational analysis of an ethnopharmacological field survey among Bedouins in the Negev desert, Israel. Journal of Ethnopharmacology 16: 275–287.

Gasana J, Morin J, Ndikuyeze A, Kamoso P. 2002. Impact of Water Supply and Sanitation on Diarrheal Morbidity among Young children in the Socioeconomic and Cultural Context of Rwanda (Africa). Environmental Research Section A 90: 76-88.

Gaur RD. 1999. Flora of the District Garhwal North West Himalaya (with ethnobotanical notes). Transmedia, Srinagar (Garhwal).

Gaur RD, Sharma J. 2011. Indigenous Knowledge on the Utilization of Medicinal Plant Diversity in the Siwalik Region of Garhwal Himalaya, Uttarakhand. Journal of Forest Science 27(1): 23–31.

Gaur RD, Sharma J, Painuli RM. 2011. Folk herbal medicines used by the Gujjar tribe of Sub-Himalayan tract, Uttarakhand. Journal of Economic and Taxonomic Botany 35(1): 224–230.

Gazzaneo LRS, de Lucena RFP, de Albuquerque UP. 2005. Knowledge and use of medicinal plants by local specialists in a region of Atlantic Forest in the state of Pernambuco (Northeastern Brazil). Journal of Ethnobiology and Ethnomedicine 1(9): 1–8.

Goleniowski ME, Bongiovanni GA, Palacio L, Nuñez CO, Cantero JJ. 2006. Medicinal plants from the "Sierra de Comechingones", Argentina. Journal of Ethnopharmacology 107(2006): 324–341.

Heinrich M, Ankli A, Frei B, Weimann C, Sticher O. 1998. Medicinal plants in Mexico: Healers' consensus and cultural importance. Social Science and Medicine 47(11): 1859–1871.

Jamil S, Ahmad S, Akhtar J, Alam K. 2003. Antiamoebic plants used in Unani System of Medicine. Natural Product Radiance 2(1): 16–21.

Jouret-Mourin A, Geboes K. 2002. Colites Infectieuses. Acta Endoscopica 32(2): 167–183.

Kar A, Borthakur SK. 2008. Medicinal plants used against dysentery, diarrhoea and cholera by the tribes of erstwhile Kameng district of Arunachal Pradesh. Natural Product Radiance 7(2): 176–181.

Krause R, Schwab E, Bachhiesl D, Daxböck F, Wenisch C, Krejs GJ, Reisinger EC. 2001. Role of Candida in Antibiotic-Associated Diarrhea. The Journal of Infectious Diseases 184(8): 1065–1069.

Laloo D, Hemalatha S. 2011. Ethnomedicinal plants used for diarrhea by tribals of Meghalaya, Northeast India. Pharmacognosy Reviews 5(10): 147–154.

Lin J, Puckree T, Mvelase TP. 2002. Anti-diarrhoeal evaluation of some medicinal plants used by Zulu traditional healers. Journal of Ethnopharmacology 79(1): 53–56.

Mohanty RB, Dash SK, Padhy SN. 1998. Traditional phytotherapy for diarrhoeal discharges in India – A review. Ethnobotany10 (1–2): 1998.

Mukherjee PK, Saha K, Murugesan T, Mandal SC, Pal M, Saha BP. 1998. Screening of anti-diarrhoeal profile of some plant extracts of a specific region of West Bengal, India. Journal of Ethnopharmacology 60(1998): 85–89.

Musa MS, Abdelrasool FE, Elsheikh EA, Ahmed LAMN, Mahmoud ALE, Yagi SM. 2011. Ethnobotanical study of medicinal plants in the Blue Nile State, South-eastern Sudan. Journal of Medicinal Plants Research 5(17): 4287–4297.

Njume C, Goduka NI. 2012. Treatment of Diarrhoea in Rural African Communities: An Overview of Measures to Maximise the Medicinal Potentials of Indigenous Plants. International Journal of Environmental Research and Public Health 2012(9): 3911–3933.

Otshudi AL, Vercruysse A, Foriers A. 2001. Antidiarrhoeal activity of root extracts from Roureopsis obliquifoliolata and Epinetrum villosum. Fitoterapia 72(3): 291–294.

Panda SK, Patra N, Sahoo G, Bastia AK, Dutta SK. 2012. Anti-diarrheal activities of medicinal plants of Similipal Biosphere Reserve, Odisha, India. International Journal of Medicinal and Aromatic Plants 2(1): 123–134.

Patel JD, Patel D, Shrivastava A, Kumar V. 2008. Screening of plant extracts used in traditional antidiarrhoeal medicines against pathogenic Escherichia coli. Scientific World 6(6): 63–67.

Phillips O, Gentry AH, Reynel C, Wilkin P, Gálvez-Durand B. 1994. Quantitative Ethnobotany and Amazonian Conservation. Conservation Biology 8(1): 225–248.

POWO (Plants of the World Online), 2024. POWO, Board of Trustees of the Royal Botanic Gardens, Kew. https://powo.science.kew.org/. (Accessed 02/02/ 2024).

Raju VS, Reddy KN. 2005. Ethnomedicine for dysentery and diarrhoea from Khammam district of Andhra Pradesh. Indian Journal of Traditional Knowledge 4(4): 443–447.

Saad-Hussein A, Helmy MA, Ellaithy LS, Wheida A, El Nazer M, Alfaro SC, Siour G, Borbon A, Wahab MMA, Mostafa AN. 2023. Temporal trend of diarrhea morbidity rate with climate change: Egypt as a case study. Environmental Science and Pollution Research 30: 5059–5075.

Sairam K, Hemalatha S, Kumar A, Srinivasan T, Ganesh J, Shankar M, Venkataraman S. 2003. Evaluation of anti-diarrhoeal activity in seed extracts of *Mangifera indica.* Journal of Ethnopharmacology 84(2003): 11–15.

Sarin RV, Bafna PA. 2012. Herbal antidiarrhoeals: A review. International Journal of Research in Pharmaceutical and Biomedical Science 3(2): 637-649.

Sen SK, Behera LM. 2008. Ethnomedicinal plants used by the tribals of Bargarh district to cure diarrhoea and dysentery. Indian Journal of Traditional Knowledge 7(3): 425–428.

Sharma J, Gairola S, Gaur R, Painuli RM. 2011a. Medicinal plants used for primary healthcare by Tharu tribe of Udham Singh Nagar, Uttarakhand, India. International Journal of Medicinal and Aromatic Plants 1(3): 228–233.

Sharma J, Gairola S, Gaur RD, Painuli RM. 2012a. The treatment of jaundice with medicinal plants in indigenous communities of the Sub-Himalayan region of Uttarakhand, India. Journal of Ethnopharmacology 143(1): 262–291.

Sharma J, Gairola S, Gaur RD, Painuli RM, Siddiqi TO. 2013b. Ethnomedicinal plants used for treating epilepsy by indigenous communities of sub-Himalayan region of Uttarakhand, India. Journal of Ethnopharmacology 150(1): 353–370.

Sharma J, Gaur RD, Gairola S, Painuli RM, Siddiqi TO. 2013a. Traditional herbal medicines used for the treatment of skin disorders by the Gujjar tribe of Sub-Himalayan tract, Uttarakhand. Indian Journal of Traditional Knowledge 12(4): 736–746.

Sharma R, Manhas RK, Magotra R. 2012. Ethnoveterinary remedies of diseases among milk yielding animals in Kathua, Jammu and Kashmir, India. Journal of Ethnopharmacology 141(2012): 265–272.

Thiam S, Diène AN, Sy I, Winkler MS, Schindler C, Ndione JA, Faye O, Vounatsou P, Utzinger J, Cissé G. 2017. Association between Childhood Diarrhoeal Incidence and Climatic Factors in Urban and Rural Settings in the Health District of Mbour, Senegal. International Journal of Environmental Research and Public Health 2017(14): 1049 (1–16).

Tona L, Kambu K, Ngimbi N, Cimanga K, Vlietinck AJ. 1998. Antiamoebic and phytochemical screening of some Congolese medicinal plants. Journal of Ethnopharmacology 61(1998): 57–65.

W.H.O. 2013a. World Health Organization. ⟨http://www.who.int/topics/diarrhoea/en/⟩ (Accessed 23/08/23).

WHO. 2013c. World Health Organization. ⟨http://www.who.int/topics/dysentery/en/⟩ (Accessed 23/08/23).

WHO. 2019. World Health Organization (https://www.who.int/health-topics/diarrhoea/en) (Accessed 25/08/23).

WHO. 2023. World Health Organization (https://www.emro.who.int/pandemic-epidemic-diseases/cholera/acute-watery-diarrhoeacholera-updates-115-april-2023.html) (Accessed 25/08/23).

Yang X, Xiong W, Huang T, He J. 2021. Meteorological and social conditions contribute to infectious diarrhea in China. Scientific Reports 2021(11): 23374 (1–13).