Review Article

Exploring the efficacy of Indigenous antidiarrheal plants through an evidence-based review

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Abstract

Diarrhea is a common gastrointestinal disorder that might result in mortality if left untreated because of dehydration. 1.7 to 5 billion new cases of diarrhea have been identified each year. Numerous chemical drugs are prescribed as routine treatment for diarrhea, however they have drawbacks. It is possible to recommend a safe and efficient herbal remedy for diarrhea. Medicinal floras have been used as a traditional remedy for diarrhea since ancient times. This article reviews the common medicinal plants that have been scientifically proven to possess antidiarrheal activity. The plants discussed in this review include *Psidium guajava*, *Zingiber officinale, Aegle marmelos, Terminalia chebula*, and many others. The article summarizes the pharmacological properties, phytochemicals, and mechanisms of action of these plants. In addition, the article provides information on the safety and toxicity of these plants, as well as their traditional uses. This analysis seeks to provide a comprehensive guide for healthcare professionals and researchers in the field of natural medicine, as well as individuals seeking safe and effective natural remedies for diarrhea.

***Keywords*:** Antidiarrheal, phytoconstituents, pharmacological action, diarrhea, Antidiarrheal Medication Classes

Introduction

In all age categories, diarrhea ranks as one of the most widespread infections and a leading origin of illness and death in countryside areas. It has been acknowledged as a significant hazard to people's health globally and in underdeveloped nations (Ugboko *et al.,* 2020). A digestive illness known as diarrhea is marked by an augment amount of stool, consistency, or frequency that causes a loss of vitamins and nutrients, salts, and water (Fine *et al.,* 1998). In diarrhea, there are more losses or liquid stools each day. It is typically a sign of gastrointestinal infection. This infection may be brought on by a wide range of microbes, viruses, and parasite species, and it transmits through food that has been contaminated, water, or people due to inadequate hygiene. Diarrhea may vary from a minor, socially awkward condition to a significant contributor to malnutrition among kids in impoverished nations. The World Health Organisation (WHO) estimates that diarrhea fatalities over 2.2 million individuals worldwide every year, predominantly kids in developing nations, accounting for 4% of all fatalities and 5% of health losses due to disability (Ugboko *et al.,* 2020). The causes of diarrhea are diverse and varied ranging from non-infectious to infectious origin (Farmer *et al.,* 1990). The use of herbs is still a significant at-home remedies for diarrhea. In the rice fields of India and Ceylon, a common weed known as *Cryptocyanin spiralis* Fisch. Ex. Wydler., family: Araneae, can be found. It is extensively accessible in Calicut, West Bengal and the Coromandel Coast of India. The plant's rhizomes are commonly utilised as an inexpensive alternative to the pricey Aconitum heterophyllum Wall. (Ranunculaceae) for the handling diarrhea (Prasad *et al.,* 2014). The most common causes of diarrhea among people are a variety of enteric pathogenic organisms such as *Vibrio cholerae, Shigella flexneri, Salmonella typhi, Escherichia coli, Staphylococcus aureus and Candida albicans*. A couple of these medicinal herbs have gained popularity recently, and research is being done to objectively assess their antidiarrheal effects (Giannella *et al.,* 1989). In example, studies conducted on experimental animals has examined the antidiarrheal properties of the plants *Cordia Africana, Stereospermum kunthianum, Calpurnia aurea, Indigofera*

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spicata, Lepidium sativum, Vernonia amygdalina, and *Zehneria scabra* (Woldeab *et al.,* 2018).

Material and methods

The publicly accessible documentation, including textbooks, theses, conferences, and reports, was consulted for information on the utilization of healing plants to treat diarrheal disorders. Pubmed, Medline and other electronic databases were used to conduct literature searches like- Google Scholar and Elsevier. Certain search parameters like "medicinal plants", "herbal medicines", and "Indigenous" were used for literature survey. Data collected from the literature includes biological source, parts used, additives, condition, and dosages used. This review only included journal reports, research papers, conference proceedings, books, book chapters, and policy statements that discussed plant identification, dysentery, and used plant components.

Types of diarrhea

There are several types of diarrhea, each with its own underlying causes and characteristics. Acute diarrhea is typically caused by viral or bacterial infections, and it lasts for a short period. Traveler's diarrhea occurs when individuals consume contaminated food or water while traveling to new regions (Kim and Ravinde, 2010). Chronic diarrhea, on the other hand, persists for an extended duration and might be indicative of underlying health issues, such as inflammatory bowel disease or irritable bowel syndrome. Another type is osmotic diarrhea, caused by malabsorption of nutrients, which draws excess water into the intestines. Inflammatory diarrhea is related to inflammation of the digestive tract, often due to infections or certain diseases. Identifying the specific type of diarrhea is crucial for proper diagnosis and effective treatment. Hydration and seeking medical advice are essential, especially when diarrhea is severe or persistent (Schiller *et al.,* 2013). The pictorial form of types of diarrhea is shown in figure 1.

Causes of diarrhea

There are two groups of causes of diarrhea: variables from the environment and pathogenic entities.

Environmental factors

Compared to breastfed children, fed through bottles youngsters experience more diarrhea. Infection of milk, an ideal medium for the growth and proliferation of organisms, may result from unclean milk feed preparations, the use of dirty bottles, and flies and other insects contaminating them (Hashi *et al.,* 2016). Contrarily, breast milk is pure and prevents the growth of organisms because it contains antibodies, lactoferrin, lysozymes, leucocytes, macrophages, and lactobacillus. In older children and adults, diarrhea is frequently caused by contaminated water and food (Dearden *et al.,* 2017).

Causative agents

Diarrhea can be caused by various infectious agents, toxins, and other factors. The most common causative agents of diarrhea are viral and bacterial infections (Hashi *et al.,* 2016). Viral infections, such as norovirus, rotavirus, and enteric adenoviruses, are highly contagious and spread through contaminated food, water, or person-to-person contact. Bacterial infections can be caused by pathogens like Escherichia coli (*E. coli*), Salmonella, Campylobacter, Shigella, and Vibrio cholerae. These bacteria enter the body through contaminated food, water, or poor hygiene practices. Additionally, parasites like Giardia lamblia and Cryptosporidium can also lead to diarrhea when ingested through contaminated water sources (Mohammeda *et al.,* 2016). Apart from infectious causes, certain medications, food intolerances, and underlying medical conditions, such as inflammatory bowel disease or celiac disease, can trigger diarrhea. Accurate identification of the causative agent is essential for appropriate treatment and management of

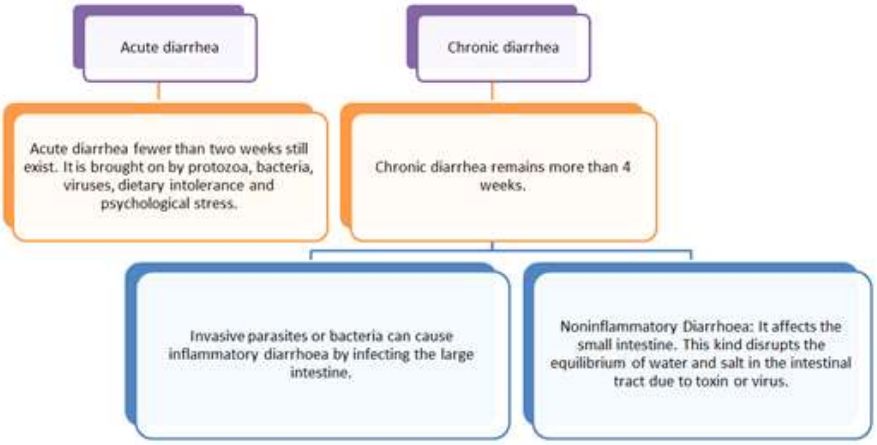

Figure 1. Types of diarrhea

Table 1. Detail of causative agents and their modes of transmission

Causative agents	Transmission	Transmission and Etiology
Vibrio cholerae (Cholera) (Wong et. al., 1999)	Tainted food or drink from a patient or carrier. The diagnosis is frequently clinical. Dark-field illumination used to detect fast moving vibrios in fresh faeces is diagnostic. Rectal swabs or stool culture should be obtained.	Mucinase aids Vibrio cholerae in adhering to the microvilli of the intestinal epithelium's brush border. diarrhoea results from the release of cholera enterotoxin. Stools include mucus, epithelial cells, and vibrios and resemble rice water.
Escherichia coli (Tânia et. al., 2016; Shane et. al., 2017)	The primary means of transmission to people is by consumption of contaminated foods, including as raw or undercooked ground beef products, raw milk, contaminated uncooked vegetables, and sprouts.	There are two components in it: A and B. A glycolipid in the microvillus membrane is bound by subunit B. The 60S ribosomal subunit is rendered inactive when subunit A enters the cell. Bloody diarrhoea results from the stoppage of the synthesis of proteins and the shedding of cells that have died.
Rotavirus (Crawford et. al., 2017; Graham et.al., 1984)	Rotavirus can be identified in the faeces of an infected individual 2 days before the beginning of symptoms and for up to 10 days after they go away. Even when the infected person is symptom-free, the virus can easily spread by hand-to-mouth contact during this time.	Rotavirus predominantly affects enterocytes and causes dysentery by destroying absorbent enterocytes, which results in poor absorption, stimulating intestinal outflow in response to rotavirus non-structured protein 4, and activating the nervous system of the gut.
Shigella: *S. flexneri, S. sonnei, S. boydii*, and S. dysenteri. (Aslam et. al., 2022; Williams et. al., 2018; Zaidi et. al., 2014)	via direct human contact, ill-maintained facilities, or eating food that has been tainted	Dysentery caused by Shigella is extremely fatal and serious. It is a prevalent illness among kids under the age of five.
Salmonella (Black et. al., 1960)	It can be obtained by food, water, direct contact with animals, and very seldom, interpersonal contact. It spreads via the fecal-oral pathway.	When epithelial cells are penetrated, proinflammatory cytokines are produced, which causes an inflammatory reaction. The initial inflammatory response may result in mucosal rupture and injury in addition to diarrhoea.
Clostridium perfringens (spore-bearing bacillus) (Carney et. al., 2002, Modi et. al., 2001, Azimirad et.al., 2019)	causes that result from food eating. Heat kills vegetative cells in cooked, stored food, whereas cooling or preserving the food causes spores to develop into cells that grow.	After consuming affected food, people with infringes infection have diarrhoea and stomach pains. Consume lots of water since diarrhoea can lead to dehydration.
Staphylococcus aureus: (enterotoxins) (Avery et. al., 2015; McDonald et. al., 1982; Pecha et. al., 2005)	It frequently lives in people's throat, nostrils, faeces, and skin. Items like meat and potato products are excellent development media for it. Despite being thermally stable, toxins is not eliminated by warming.	Symptoms of Staphylococcus aureus toxicity include nausea, vomiting, and severe cramps in the abdomen. Diarrhoea is another common condition. Symptoms often appear 30 minutes to 8 hours after ingesting or consuming anything containing Staph toxin, and they disappear within a day.
Bacillus cereu (McDowell et.al., 2022; Fox et.al., 2020)	Food that has been tainted with the emetic toxin (cereulide) produces vomiting when consumed. Whenever enterotoxins are created in the gut as a result of eating food infected with B. cereus, the diarrheal syndrome develops.	The foodborne bacteria Bacillus cereus can cause two GI disorders, the emetic (vomiting) syndrome and the syndrome of diarrhoea. Vomiting happens after consuming contaminated food when the emetic toxin (cereulide) is created in the meal.
Entamoeba histolytica (Dans et. al., 2007)	Cysts and RBC-containing trophozoites are diagnostic. Cysts are contagious, while trophozoites are not. External encystment does not take place. It spreads from person to person and through undercooked food, drink, and other surfaces.	Cysts from colon produce trophozoite, which invade the big bowel's mucous membrane. The cecum is most severely impacted, however ulcers in the form of flasks can develop in any area of the colon. A localised granuloma (ameboma) can occasionally manifest as a lump that can be felt in the rectum.
Giardia lamblia (Rumsey et. al., 2022)	*Giardia lamblia* cysts are transmitted by human and animal excretions, which contaminate food. Additionally, it spreads through touch with other people and in water.	They adhere to the jejunum and duodenal mucosa, causing inflammation and partial villous atrophy. Giardia lamblia is characterised by loose, pale stool, fatigue, nausea, epigastric pain, flatulence, and abdominal distension.

diarrhea episodes. The causative agents are shown in table 1.

Treatment

Antidiarrheal agents (Antidiarrheal Medication Classes)

Adsorbents, which aid in removing toxins or gastrointestinal tract bacteria with anti-motility drugs, which decrease peristalsis, and probiotics, which aid in re-establishing the normal bacteria present in the lower intestine, are the 3

typical modes of action used by of antidiarrheal drugs. Patients with diarrhea may also use oral rehydration medications to replenish. Diarrhea is not treated by replenishing fluid or electrolytes. Infection-specific diarrhea may also be treated with antibacterial medications (Cindy et. al., 1998).

Adsorbents

The attachment of molecules to a surface is known as adsorption. Contrasted with absorption, which occurs when a material dissolves or permeates a surface, is this process. Adsorbent drugs function by covering the walls of the GI tract and binding the harmful bacteria or toxin for removal from the GI tract from side to side the stool. Bismuth subsalicylate is an example of an adsorbent (Lilley *et al.,* 2014). Additionally, by limiting the stream of fluid and salts into the gut, bismuth subsalicylate lowers inflammation in the intestine.

Antimotility

By reducing motility, antimotility drugs can cure diarrhea. Anticholinergics and opiate-like medications fall under the category of these drugs (Turnheim *et al.,* 1989).

(a) Anticholinergics

The mode of Action of Anticholinergics Hyoscyamine is an anticholinergic that inhibits locomotor motility in the GI tract's smooth muscle cells and reduces stomach acid output.

(b) Drugs that resemble opioids

Although it has a molecular structure similar to an opioid, loperamide has less CNS side effects. It functions by lowering the bowel's motility and reducing the passage of fluids and electrolytes into the intestine to reduce the frequency of stool production (Portnoy et. al 1976).

Probiotics

They are used to manage as well as avoid diarrhea by re-establishing the natural bacterial flora in the digestive system. Diarrhea can be prevented and treated with probiotics. They are frequently taken in conjunction with antibiotics to lessen the likelihood of diarrhea's major adverse effects (Paul et. al., 2021).

Modalities of execution: Probiotics aid in restoring the gastrointestinal tract's natural culture of bacteria.

The details of different classes of antidiarrheal agents with their therapeutic and adverse effects were shown in table 2.

Botanical Characteristics of antidiarrheal medicinal plants

Indigenous antidiarrheal plants belong to different plant families, including Acanthaceae, Fabaceae, Lamiaceae, and Zingiberaceae, among others. These plants are mostly found in hot and subtropical area and can grow in a variety of habitats, including forests, savannahs, and wetlands. Some common examples of indigenous antidiarrheal plants include *Anogeissus leiocarpa, Zanthoxylum zanthoxyloides*, and *Psidium guajava* (Shoba et al., 2001).

Table 2. Details of different classes of antidiarrheal agents with their therapeutic and adverse Effects

Groups	Examples	Curative Efficacy	Adverse Action
Adsorbent	Bismuth subsalicylate	reduced signs of diarrhoea	May result in a darker or black tongue. If signs intensify, a temperature appears, tinnitus develops, or if diarrhoea persists for more than 48 hours, call your doctor right once.
Anticholinergic	hyoscyamine	reduced signs of diarrhoea	may result in CNS & erstwhile negative effects from anti-cholinergic agents
Opiate derivatives	loperamide	reduced signs of diarrhoea	Black Box Warning: Could result in an irregular heart beat
Probiotics	lactobacillus	reduced signs of diarrhoea	mild, like gas and feeling bloated
Antimotility agents	Anti-muscarinic agents like-mepenzolate, propantheline & atropine	Decreased diarrhea Symptoms	stomach pain or bloating, dizziness
	Loperamide	Decreased diarrhea Symptoms	tiredness, or constipation may occur
Antibiotic therapy	Metronidazole	treat inflammation of the large intestine	A racing pulse (palpitations), nausea, abdominal pain, hot flashes, and difficulties respiration
	Levofloxacin	To treat febrile diarrhea / dysentery in regions with high rates of Shigella,	Inactive against invasive causes of diarrhea
Miscellaneous	Octreotide	prevents the release of some gastrointestinal hormones, including serotonin, glucagon, gastrin, motilin, VIP, and gastrin.	GIT disturbances and nausea. Continued treatment may result in cholelithiasis-like side effects from elevated somatostatin.

Phytochemistry of antidiarrheal medicinal plants

The chemical composition of indigenous antidiarrheal plants is complex and varies depending on the plant species, the plant part used, and the geographic location. These plants contain various phytochemicals, including alkaloids, flavonoids, tannins, terpenoids, and saponins, among others. (Schiller *et al.,* 2013) These phytochemicals have been found to possess antidiarrheal action by regulating GI motility, reducing inflammation & inhibiting pathogenic microorganisms.

Reported Pharmacological Actions of antidiarrheal plants

Indigenous antidiarrheal plants have been widely studied for their pharmacological activities. A number of works have demonstrated that this flora possesses significant antidiarrheal action through various mechanisms of action, including:

Inhibition of intestinal motility: Many indigenous antidiarrheal plants, such as *Anogeissus leiocarpa* and *Zanthoxylum zanthoxyloides*, have been shown to reduce intestinal motility and secretion, resulting in the reduction of diarrhea symptoms. *(*Zavala et. al.,1998, Shashi et. al., 1993)

Anti-inflammatory activity: Several indigenous antidiarrheal plants, such as *Psidium guajava* and *Anacardium occidentale,* possess anti-inflammatory activity, which helps reduce inflammation in the intestinal tract and promote healing of the gut lining. (Shamkuwar et. al., 2013, Sheikh et. al., 2010)

Antimicrobial activity: Some indigenous antidiarrheal plants, such as *Senna alata* and *Terminalia avicennioides*, have been found to have noteworthy antimicrobial action against pathogenic microorganisms responsible for causing diarrhea. *(Brijesh et. al., 2009)*

Antioxidant activity: Many indigenous antidiarrheal plants, such as *Carica papaya* and *Ageratum conyzoides*, possess antioxidant activity, which helps reduce oxidative stress in the intestinal tract and promote healing. (Amabeoku., 2009).

We had collected the data of antidiarrheal medicinal plants from different credible and reliable sources. It includes published articles, books, scientific journals, online databases, and other reputable sources of information. The process of data collection involved using specific search terms or keywords related to antidiarrheal medicinal plants, such as their common or scientific names, active compounds, pharmacological properties, traditional uses, and safety profiles.

After the relevant information has been identified, it was evaluated for quality and reliability of each source, as well as the accuracy and relevance of the information obtained. The collected information can helps to facilitate the analysis and comparison of different sources of information, and to identify any gaps or inconsistencies in the data. The collected information is shown in table 3.

Table 3. The analysis and comparison of different plant species

Sr. No	Plant	Investigated part	Chemical Constituents	Solvent used for isolation	Technique utilized
1	*Acacia catechu* (leguminosae) (Ray et. al., 2006)	Bark	Flavonoids	Ethyl acetate, methanol, Petroleum ether, aqueous	Castor oil–induced diarrhea in mice, Against pathogenic Escherichia coli
2	*Acacia nilotica* (Patel et. al., 2010)	Bark	Tannin	Methanol, chloroform, Petroleum ether, aqueous	Against pathogenic Escherichia coli
3	*Acorus calamus (*Shoba et. al., 2001)	Rhizome	-	Aqueous and methanol	Castor oil–induced diarrhea in mice
4	*Aegle marmelos(Rutaceae)* (Brijesh et. al., 2009, Joshi et. al., 2009)	Unripe fruit,	proteins, amino acids, Glycosidestannins, flavanoids, phytosterols, coumarins such as marmelide, marmelosin	Aqueous and methanolic, Petroleum ether, chloroform, Ethanol	Mouse with castor oil-induced diarrhoea, invasive Escherichia coli, colonisation, fabrication, and enterotoxin activity. Efficacy towards 4 shigella species
5	*Alhagi maurorum (*Atta et. al., 2004)	-	Flavonoids, tannins, sterols, triterpenes, saponins, anthraquinones.	Methanol	Castor oil-induced diarrhoea
6	*Alstonia scholaris (Apocynaceae) (*Shah et. al., 2010, Saifuzzaman et. al., 2013)	barks	porphyrin, alstonine, echitamine, picrinine, detamine, and strictamine	Methanolic	Castor oil–induced diarrhea in mice
7	*Alternathera repens (Amaranthaceae) (*Zavala et. al.,1998)	Dried powdered plant	-	Hexane, methanol, chloroform, aqueous	Castor oil and MgSO4 cause diarrhoea in mice
8	*Andrographis paniculata (Acanthaceae) (*Zavala et. al.,1998, Shashi et. al., 1993)	Whole plant	Diterpenes, Andrographolide, neoandrographol	Alcoholic	*the secretory reaction to an E. coli enterotoxin that causes diarrheal symptoms*
9	*Annona senegalensis (Annonaceae)* (Suleiman et. al., 2008)	Stem-bark	Flavonoids, tannins, sterols, triterpenes, saponins,	Methanol, Petroleum ether, chloroform, and aqueous	Intestinal transit time against pathogenic Escherichia coli with meal containing charcoal
10	*Annona squamosa (*Patel et. al., 2010)	Leaves	Alkaloid, tannins	Petroleum ether, chloroform, methanol and aqueous	Against pathogenic Escherichia coli

Table 3. Continue...

11	*Anthocephalus cadamba (Rubiaceae)*(Dubey et. al., 2011)	Flowering tops	triterpenes and saponins, secoiridoids, Indole alkaloids	Hydroethanolic	Castor oil–induced diarrhea in mice
12	*Aristea spp. (*Ojewole et. al., 2008)	Stem	-	Aqueous and methanolic	Castor oil-induced diarrhoea in rats cause diarrhoea
13	*Artemisia ludoviciana (*Miguel et. al., 2002)	-	Nonanal, flavonoids	Essential oil	Castor oil-, magnesium sulphate-, arachidonic acid- and PGE2 -induced diarrhoea in CD1 mice
14	*Asparagus racemosus (*Venkatesan et. al., 2005)	Root	Alkaloids, saponins, flavonoids, sterols, terpenes and sugars	Ethanol and aqueous	Castor oil-induced diarrhoea model in rats
15	*Azadirachta indica (*Snyder et. al., 1982)	Leaves	-	Petroleum ether, chloroform, methanol and aqueous	Against pathogenic Escherichia coli
16	*Baphia nitida (Papilionaceae) (*Adeyemi et. al., 2008)	Fresh leaves	Flavonoids, isoflavonoids, isoflavones, saponins, tannins, and alkaloids	Ethyl acetate	diarrhoea caused by castor oil Abdominal transit caused by castor oil
17	*Berberis lyceum Royle (Berberidaceae)* (Shamkuwar et. al., 2013; Sheikh et. al., 2010)	Roots, fruits, leaves, and stem	palmitine, berberine, iron, zinc, calcium, and vitamin C	Ethanolic	Against pathogenic Escherichia coli
18	*Bidens bipinnata) (*Atta et. al., 2005)	Aerial parts	-	Ethanolic	Castor oil-induced diarrhoea, and on the motility of duodenum isolated from freshly slaughtered rabbits
19	*Bridelia micrantha (*Ojewole et. al., 2008)	Bark	-	Aqueous and methanolic	Rats' diarrheal illness brought on by castor oil
20	*Butea (*Gunakkunru et.al., 2005)	Stem bark	Steroids,	Ethanolic	Castor oil-induced dysentery and PGE2-induced enteropooling in rodents, as well as changes in GI motility following the administration of charcoal
21	*Byrsocarpus coccineus (Connaraceae) (*Akindele et. al., 2006)	Leaf	Alkaloids, saponins, flavonoids, anthraquinones, glycosides, simple sugars	Aqueous	Gastric draining, enteropooling, normal and castor oil-induced diarrhoea, and transit of the gut.
22	*Calotropis gigantean (Ascelpiadaceace) (*Chitme et. al., 2004)	Aerial parts	Sugars, flavonoids, flavonol glycosides, terpenes, terpene derivatives, triterpenoids	Hydroalcoholic	Castor oil-induced diarrhoea in rats
23	*Calotropis procera (*Kumar et. al., 2001)	Aerial parts	-	Latex	Castor oil–induced diarrhea in mice
24	*Capparis zeylanica L (Capparaceae)* (Ghule et al., 2006; Sini et. al., 2011)	flowers and leaves		Methanolic	Castor oil–induced diarrhea in mice
25	*Careya arborea Roxb (Lecythidaceae)(*Adzu et. al., 2003)	Leaves and stem	flavonoids, tannins, saponins, and triterpenoids	methanol	Castor oil-induced diarrhea
26	*Cassia fistula (*Shashi et. al., 1993)	-	-	Hexane, chloroform, butanol and aqueous	Forced release by E.coli guinea pig ileal loop models & enterotoxin in rabbit
27	*Celosia argentea Linn* (Amaranthaceae) (Sharma et. al., 2010; Priya et. al., 2004)	seeds		Alcoholic	castor oil and PGE (2).
28	*Cinnamomum tamala* (Rao et. al., 2008)	Dried leaves	Germacrene A, a-gurjunene, cymene, methyl eugenol and Tannins	50% aqueous ethanol.	Castor oil-induced diarrhoea in rats
29	*Cleome viscosa (Capparidaceae)* (Devi et. al., 2002)	Entire plant	Tannins, steroids, and flavonoids	Methanol	Castor oil-induced
30	*Clerodendrum phlomidis (Verbenaceae)* (Rani et. al., 1999)	Leaf	Steroid, alkaloid, flavanoids	Methanolic	Rats with enteropooling caused by PGE2 and castor oil-induced gastroenteritis
31	*Combretum* (Sini et. al. 2008)	Roots	Alkaloids, flavonoids	Aqueous	Gut motility, fluid buildup, and diarrhoea caused by castor oil
32	*Commelina coelestis (Commelinaceae)*	Dried powdered plant	-	Hexane, chloroform, methanol and aqueous	Castor oil and MgSO4-induced diarrhoea in mouse
33	*Convolvulus fatmensis (*Zavala et. al. 1998)	Aerial parts	-	-	Rats' intestinal motility was affected by castor oil (charcoal meal), as was the duodenum of newly killed rabbits, which was separated.
34	*Conyza dioscoridis* (Atta et. al., 2004)	-	-	Methanol	Castor oil-induced diarrhoea
35	*Costus lucanusianus (Costaceae)* (Owolabi et. al., 2007)	Leaves	Tannins, saponins, reducing sugars a	Aqueous	Castor oil-induced diarrhoea

Table 3. Continue .....

36	*Cylicodiscus gabunensis (Mimosaceae) (*Kouitcheu et. al. 2006)	Stem bark	Tannins, Flavonoids, tannins, sterols, triterpenes, saponins, anthraquinones, sugar	Ethyl acetate	Castor oil-induced diarrhoea
37	*Cynachum acutum* (Atta et. al., 2005)	Aerial parts	-	-	Rats' intestinal motility was affected by castor oil (charcoal meal), as was the duodenum of newly killed rabbits, which was separated.
38	*Dalbergia lanceolaria (Fabaceae) (*Mujumdar et. al. 2005)	Bark	-	Ethanol	Castor oil and MgSO4-induced diarrhoea in mouse
39	*Dalbergiasissoo (Fabaceae)* (Brijesh et. al., 2009)	leaves	Carbohydrates, saponins, glycosides, flavonoids, amino acids, phytosterols, alkaloids, proteins, tannins.	Aqueous	gastrointestinal epithelial cell colonisation and enterotoxin generation and activity
40	*Diplotaxis acris* (Atta et.al., 2005)	Aerial parts	-	-	Castor oil-induced (charcoal meal) and on the motility of duodenum isolated from rabbits
41	*Eleutherina bulbosa* (Birdi et al., 2006)	Bulb	-	Aqueous and methanolic	Castor oil-induced diarrhoea
42	*Emilia coccinea* (Teke et. al., 2007)	Leaves	Tannins, flavonoids, saponins, alkaloids, steroids, terpenoids	Methanol and aqueous	Castor oil-induced diarrhoea
43	*Eremomastax speciosa (Acanthaceae)* (Oben et. al, 2006)	Ground leaves	Tannins and flavonoids	Aqueous	Castor oil-induced diarrhoea
44	*Eugenia jambolana* (Mukherjee et. al., 1998)	Bark	Alkaloids,steroids and tannins	Ethanol	Rats with enteropooling caused by PGE2 and castor oil-induced gastroenteritis
45	*Euphorbia paralias* (Atta et.al., 2005)	Aerial parts	-	Methanol	Castor oil–induced diarrhea in mice
46	*Ficus bengalensis (Moraceae)* (Mukherjee et. al., 1998)	Hanging roots	Alkaloids, steroids and tannins	Ethanol	Rats with enteropooling caused by PGE2 and castor oil
47	*Ficus hispida* (Mandal et. al., 2002)	Leaf	Tannins triterpenoids, alkaloid and saponin	Methanol	Rats with enteropooling caused by PGE2 and castor oil
48	*Ficus hispida (Moraceae)* (Ali et. al., 2011)	leaves	glucoside, tannin, beta-sitosterol, caoutchouc acid, bergapten, hispidin, psoralen latex	Methanol	Castor oil–induced diarrhea in mice Prostaglandin-E2 induced Diarrhea
49	*Ficus racemosa (Moraceae)* (Mukherjee et. al., 1998)	Bark	Alkaloids, steroids and tannins	Ethanol	Castor oil-induced diarrhoea
50	*Gentianopsis paludosa (Gentianaceae)* (Wang et. al., 2006)	Whole herb	Xanthones, terpenoids and flavonoids	Ethanol	Castor oil-induced diarrhoea
51	*Geranium incanum (Geraniaceae) (*Amabeoku, 2009).	Leaf	Tannins, saponins flavonoids, Gallic acid	Aqueous	Castor oil-induced diarrhoea
52	*Guiera senegalensis (Combretaceae) (*Aniagu et. al., 2005)	Root	flavonoids, Tannins, quinic acid gallates, anthraquinones, ascorbic acid polyphenols, alkaloids	Aqueous	Castor oil-induced diarrhoea
53	*Holarrhena antidysenterica* (Patel et. al., 2010)	Bark	-	Petroleum ether,chloroform, methanol and aqueous	Against pathogenic Escherichia coli
54	*Jatropha curcus (Euphorbiaceae) (*Mujumdar et. al., 2000)	Root	-	Methanol	Castor oil induced diarrhoea
55	*Juniperus phoenicia (Cupressaceae) (*Qnais et. al., 2005)	Leaves	Flavonoids, alkaloids and tannins	Aqueous	Castor oil-induced diarrhoea
56	*Leucas lavandulaefolia (*Mukherjee et. al., 1998)	Aerial parts	Alkaloids, steroids and tannins	Ethanol	Castor oil-induced diarrhoea and PGE2-induced enteropooling in rats.
57	*Litsea polyantha (Lauraceae) (*Poonia et. al., 2007).	Dried bark and aerial parts	Alkaloids, carbohydrate, flavonoids and saponins	Methanol	Castor oil–induced diarrhea in mice and propulsive gut motility in mice
58	*Ludwigia hyssopifolia (Onagraceae)* (Shaphiullah et. al., 2003)	Whole plant parts	Terpenoid and alkaloid	Methanol	Castor oil and serotonin induced diarrhea
59	*Mangifera indica* (Sairam et. al., 2003)	Seed	-	Methanolic and aqueous	Castor oil and magnesium sulphatein mice
60	*Mentha longifolia (Lamiaceae)(*Ali et. al., 2011).	dried leaves and young twigs		Petroleum ether, chloroform, methanol and aqueous	Castor oil–induced diarrhea in mice
61	*Mezoneuron Benthamianum (Caesalpiniaceae) (*Mbagwu et. al., 2008).	Whole plant	Tannins, flavonoids	Aqueous	Rats with enteropooling caused by PGE2 and castor oil
62	*Momordica cymbalaria (Cucurbitaceae) (*Hornbuckle et. al., 2008)	Fruit	Tannins, alkaloids, sterols, terpenes and flavanoids.	Methanol	Rats with enteropooling caused by PGE2 and castor oil

Table 3. Continue .....

63	*Nelumbo nucifera (*Pulok et al.,1995).	Rhizome	-	Methanolic	Rats with enteropooling caused by PGE2 and castor oil
64	*Ocimum basilica (*Patel et al., 2010)	Leaves	-	Petroleum ether, chloroform, methanol and aqueous	Against pathogenic Escherichia coli
65	*Ocimum gratissimum* (Labiatae) (Ezekwesili et al., 2005)	Leaves	Thymol eugenol, xanthones, terpenes and lactone	Aqueous	Castor oil–induced diarrhea in mice
66	*Ocimum selloi* (Lamiaceae) *(*Franca et al., 2008)	Leaves	trans-anethole, caryophyllene Methyl chavicol, cis-anethole, estragole	Essential oil	Castor oil in mice
67	*Papaver somniferum (*Suleiman et al., 2008)	-	Steroid	Alcohol, hexane, chloroform, butanol and aqueous	Enhanced release by Escherichia coli toxins in rabbit and guinea pig ileal loop models
68	*Parkia biglobosa* (Leguminosae) (Tijani et al., 2009).	Stem bark	Reducing sugars,	Aqueous	Castor-oil-induced diarrhoea
69	*Paullinia pinnata* (Sapindaceae) *(*Qnais et al., 2005*)*	Leaves	Carbohydrates, reducing sugars, saponins, tannins cardiac glycosides and anthracene derivatives.	Methanolic	Castor oil induced
70	*Pentaclethra macrrophylla (*Akah et al.,1999)	Leaf	-	Aqueous and ethanol	Castor oil in mice
71	*Phoenix dactylifera (*Al-zoreky et al., 2015)	-	Reducing sugars	Aqueous	Castor oil in mice
72	*Plantago major* (Atta et al., 2005)	Leaves	Reducing sugars	Methanol	Castor oil in mice
73	*Plantago major* (Atta et al., 2005)	Leaves	Steroid, flavonoids and tannin	Methanol	Castor oil in mice
74	*Pongamia glabra (Myrtaceae)(*Shoba et al., 2001).	Leaves	Steroid, flavonoids and tannin	Aqueous and methanolic	Castor oil–induced diarrhea in mice
75	Psidium guajava (Ojewole et al.,2008; Sheikh et al.,2010)	Fresh leaves	tannins, polyphenolic compounds, pentacyclic triterpenoids Quercetin,	Aqueous and methanolic	Castor oil in mice
76	*Punica granatum (Punicaceae)* (Das et al.,1999).	Seed	Steroid, flavonoids and tannin	Methanol	PGE2 induced enteropooling in rats.
77	*Rhus javanica (Anacardiaceae)* (Tangpu et al.,2004)	Fruit	Steroid, flavonoids and tannin	Methanolic	Castor oil in mice
78	*Rumex maritimus (Polygonaceae* (Rouf et al., 2003)	Root	-	Partitioned nhexane,ethylacetate and residual methanol	Castor oil in mice
79	*Saccharum spontaneum (Gramineae)(* Vhuiyan et al.,2008)	Whole plant	Steroid, flavonoids and tannin	Methanolic	Castor oil in mice
80	*Sanseviera liberica (Agavaceae)* (Adeyemi et al.,2009)	Root	saponins,Reducing sugars, , anthraquinones, alkaloids, tannins	Aqueous	Castor oil in mice
81	*Schouwia thebaica (*Atta et al., 2004)	Aerial parts	Reducing sugars, tannins, saponins, alkaloids, anthraquinones	Aqueous	Castor oil in mice
82	*Securinega virosa (Euphorbiaceae)(*Magaji et al.,2007)	Leaves, stem, root	Flavonoids	Methanolic	Castor oil–induced diarrhea in mice
83	*Sphaeranthus senegalensis (Asteraceae)* (Rouf et al.,2003)	Whole plant	Tannin	Aqueous	Castor oil in mice
84	*Spondias Mangifera* (Sameh et al.,2018)	Bark	Steroid, flavonoids and tannin	Methanolic	Castor-oil induced diarrhoeal activity
85	*Stereospermum kunthianum (Bignoniaceae)* (Ching et al., 2008).	Stem bark	Reducing sugars	Aqueous	Castor oil-induced intestinal transit in mice
86	*Strychnos nuxvomica* (Shoba et al., 2001)	Root bark	Reducing sugars	Aqueous and methanolic	Castor oil in mice
87	*Strychnos Potatorum (Loganiaceae)(*Biswas et al., 2002)	Seed	Steroids, alkaloids, tannins and reducing sugars.	Methanol	Castor oil in mice, PGE2
88	*Swietenia macrophylla (Meliaceae)* (Maiti et al., 2007)	Seed	Steroids and triterpenes	Petroleum ether	Castor oil induced

Table 3. Continue .....

89	*Terminalia bellirica (Combretaceae)* (Gilani et al., 2008)	fruit	chebulagic acid, tannins, ethyl gallate, beta-sitosterol, gallic acid, ellagic acid		
90	*Thespesia populnea (Malvaceae)* (Nampoothiri et al.,2011)	Stem barks	Steroid, flavonoids and tannin	Aqueous and alcoholic	Castor oil in mice, PGE2
91	*Trachyspermum ammi* (Patel et al., 2010)	Seeds	-	Petroleum ether, chloroform, methanol and aqueous	Against pathogenic Escherichia coli
92	*Trichodesma indicum (Boraginaceae)* (Perianayagam et al., 2005).	roots	n-decanyl laurate, n-nonacosanyl palmitate, n-tetradecanyl laurate	Aqueous, chloroform, Petroleum ether, methanol	Castor oil induced
93	*Tridex procumbens* (Shashi et al., 1993)	-	-	Aqueous, Alcoholic, hexane, butanol chloroform	*Enhanced release by E. coli toxins in guinea pig & rabbit*
94	*Vitex doniana* (Suleiman et al., 2008)	Fruits	Flavonoids,tannins	Aqueous	Castor oil–induced diarrhea in mice
95	*Xanthium Indicum(Compositae)* (Akter et al., 2009)	Leaves	Flavonoids,Tannins	Hydromethanolic	Castor oil andMgSO4-induced
96	*Xylocarpus granatum* (Uddin et al., 2005)	Bark	Anthraquinones, flavonoids, tannins and saponins	Methanol	magnesium sulphate and Castor oil in mice
97	*Xylocarpus moluccensis (Meliaceae)* (Uddin et al.,2005)	Barks	-	Methanol	magnesium sulphate and Castor oil in mice
98	*Zingiber officinale (Zingiberaceae)* (Daswani et al., 2010)	Rhizomes	essential oil, gingerols flavonoids, sulphonatated compounds, zingerone, Tannins,	Water	synthesis of enterotoxins and colonisation of epithelial cells.
99	*Ziziphus mauritiana* (Dahiru, et al., 2006)	Root	saponins Alkaloids, flavonoids glycosides, volatile oils	Methanolic	Castor oil induced
100	Zizyphus spinachristi (Rhamnaceae) (Adzu et al., 2003)	Stem bark	Tannins	Methanol	Castor oil induced

Discussion and conclusion

The use of indigenous antidiarrheal plants is associated with minimal adverse effects and offers a cost-effective and accessible alternative to conventional pharmacological therapies. Further investigations are needed to set up the safety and effectiveness of these plants, as well as to explore their potential for use in combination with other natural remedies or conventional medications.

In conclusion, indigenous antidiarrheal plants offer a promising source of natural remedies for handling the diarrhea. The literature review suggest that these plants and their parts being used from long time as a conventional remedy for diarrhea and have been scientifically proven to possess antidiarrheal activity. The active compounds found in these plants, such as tannins, flavonoids, and alkaloids, exert their antidiarrheal effects through various mechanisms of action, including inhibition of intestinal motility, reduction of fluid secretion, and modulation of gut microbiota.

Future scope

The review highlights the significance of indigenous antidiarrheal flora as a valuable foundation of natural remedies for the handling the diarrhea, and suggests that further research in this field can lead to the establishing new and effective therapies for gastrointestinal disorder

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References

Adeyemi OO, Akindele AJ, Ogunleye EA. 2009. Evaluation of the antidiarrheal effect of Sanseviera

liberica Gerome & Labroy (Agavaceae) root extract. Journal of Ethnopharmacology, 123(3):459–463. https://doi.org/10.1016/j.jep.2009.03.023

Adeyemi OO, Akindele AJ. 2008. Antidiarrheal activity of the ethyl acetate extract of Baphia nitida (Papilionaceae). Journal of Ethnopharmacology, 116(3):407–412. https://doi.org/10.1016/j.jep.2007.12.004

Adzu B, Amos S, Amizan MB, Gamaniel, K. 2003. Evaluation of the antidiarrheal effects of Zizyphus spina-christi stem bark in rats. Acta tropica, 87(2), 245–250. https://doi.org/10.1016/s0001-706x(03)00114-1

Akah, P.A., Aguwa, C.N. and Agu, R.U. 1999. Studies on the antidiarrheal properties of Pentaclethra macrophylla leaf extracts. Phytotherapy Research, 13: 292-295. https://doi.org/10.1002/(SICI)1099-1573(199906)13:4

Akindele AJ, Adeyemi OO. 2006. Evaluation of the antidiarrheal activity of Byrsocarpus coccineus. Journal of Ethnopharmacology. 108(1):20-25. DOI: 10.1016/j.jep.2006.03.038.

Akter, Raushanara & Hasan, Raquibul & Hossain, Mokarram & Jamila, M. & Hoque Mazumder, Mohammed Ehsanul, Rahman, Shafiqur. 2009. In Vitro Antioxidant and In Vivo Antidiarrheal Activity of Hydromethanolic Extract of Xanthium Indicum Koenig. Leaves. European Journal of Scientific Research. 33:305-312.

Ali M, Chaudhary N. 2011. Ficus hispida Linn.: A review of its pharmacognostic and ethnomedicinal properties. Pharmacognosy reviews, 5(9): 96–102.

Al-zoreky, Najeeb, Al–Taher, Abdulla. 2015. Antibacterial activity of spathe from Phoenix dactylifera L. against some food-borne pathogens. Industrial Crops and Products. 65:241-246. 10.1016/j.indcrop.2014.12.014.

Amabeoku GJ. 2009. Antidiarrheal activity of Gerannium incanum Burm. f. (Geraniaceae) leaf aqueous extract in mice. Journal of Ethnopharmacology, 123:190-193.

Aniagu SO, Binda LG, Nwinyi FC, Orisadipe A, Amos S, Wambebe C, Gamaniel K. 2005. Anti-diarrheal and ulcer-protective effects of the aqueous root extract of Guiera senegalensis in rodents. Journal of Ethnopharmacology, 97(3):549–554. https://doi.org/10.1016/j.jep.2005.01.009

Aslam A, Okafor CN. Shigella. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2022 Available from: https://www.ncbi.nlm.nih.gov/books/NBK482337/

Atta AH, Mouneir SM. 2004. Antidiarrheal activity of some Egyptian medicinal plant extracts. Journal of Ethnopharmacology, 92(2-3):303–309. https://doi.org/10.1016/j.jep.2004.03.017

Atta AH, Mouneir SM. 2005. Evaluation of some medicinal plant extracts for antidiarrheal activity. Phytotherapy research PTR, 19(6):481-485. https://doi.org/10.1002/ptr.1639

Attah EI, Ugwuagbo SC, Chinnam S, Eze FI, Nnadi CO, Agbo MO, Obonga W, Rudrapal M, Walode SG, Nizam A, Sahoo RK. 2022. Anti-inflammatory activity of Sabicea brevipes Wernharm (Rubiaceae). Pharmacia, 69(2):311-317.

Avery LM, Zempel M, Weiss E. 2015. Case of antibiotic-associated diarrhea caused by Staphylococcus aureus enterocolitis. American journal of health-system pharmacy, AJHP official journal of the American Society of Health-System Pharmacists, 72(11): 943–951. https://doi.org/10.2146/ajhp140672

Azimirad M, Gholami F, Yadegar A. et al. 2019. Prevalence and characterization of Clostridium perfringens toxinotypes among patients with antibiotic-associated diarrhea in Iran. Sci Rep 9, 7792. https://doi.org/10.1038/s41598-019-44281-5

Birdi T, Brijesh S, Daswanin PG, Tetali P, Antia NH. 2006. Studies on Dalbergia sissoo (Roxb.) leaves: Possible mechanism(s) of action in infectious diarrhea. Indian Journal of Pharmacology, 38(2):120. doi:10.4103/0253-7613.24618

Biswas S, Murugesan T, Sinha S, Maiti K, Gayen JR, Pal M, Saha BP. 2002. Antidiarrheal activity of Strychnos potatorum seed extract in rats. Fitoterapia, 73(1):43–47. https://doi.org/10.1016/s0367-326x(01)00368-9

Black PH, Kunz LJ, Swartz MN. 1960. Salmonellosis—a review of some unusual aspects. The New England Journal of Medicine. 262:811, 864, 921.

Brijesh S, Daswani P, Tetali P, Antia N, Birdi T. 2009. Studies on the antidiarrheal activity of Aegle marmelos unripe fruit: validating its traditional usage. BMC complementary and alternative medicine, 9, 47. https://doi.org/10.1186/1472-6882-9-47

Brijesh S, Daswani P, Tetali P, Antia N, Birdi T. 2009. Studies on the antidiarrheal activity of Aegle marmelos unripe fruit: validating its traditional usage. BMC complementary and alternative medicine, 9,47. https://doi.org/10.1186/1472-6882-9-47

CarneyT, Perry JD, Ford M, Majumdar S, Gould FK. 2002. Evidence for antibiotic induced Clostridium perfringens diarrhea. Journal of clinical pathology, 55(3):240. https://doi.org/10.1136/jcp.55.3.240

Chen JC, Ho TY, Chang YS, et al. 2009. Identification of Escherichia coli enterotoxin inhibitors from traditional medicinal herbs by in silico, in vitro, and in vivo analyses. Journal of Ethnopharmacology. Jan; 121(3):372-378. https://doi.org/10.1016/j.jep.2008.11.011.

Chin FP, Omogbai EKI, Ozolua RI, Okpo SO. 2008. Antidiarrheal activities of aqueous extract of

Stereospermum kunthianum (Cham, Sandrine Petit) stem bark in rodents. African Journal of Biotechnology , 7(9):1220-1225

Chitme HR, Chandra M, Kaushik S. 2004. Studies on anti-diarrheal activity of Calotropis gigantea R.Br. in experimental animals. Journal of pharmacy & pharmaceutical sciences : a publication of the Canadian Society for Pharmaceutical Sciences, Societe canadienne des sciences pharmaceutiques, 7(1):70–75.

Cindy I, Pharm D.1998. Antidiarrheal agents for the management of treatment-related diarrhea in cancer patients, American Journal of Health-System Pharmacy, Volume 55, Issue 15, 1 August, Pages 1573–1580, https://doi.org/10.1093/ajhp/55.15.1573

Crawford SE, Ramani S, Tate JE, Parashar UD, Svensson L, Hagbom M, Franco MA, Greenberg HB, O'Ryan M, Kang G, Desselberger U, Estes MK. 2017. Rotavirus infection. Nature reviews. Disease primers, 3, 17083. https://doi.org/10.1038/nrdp.2017.83

Dahiru D, Sini JM, John-Africa L. 2006. Antidiarrheal activity of Ziziphus mauritiana root extract in rodents. African Journal of Biotechnology, 5(10):941-945. https://doi.org/10.5897/AJB06.051

Dans LF, Martínez EG. 2007. Amoebic dysentery. BMJ clinical evidence, 0918.

Danao K, Kale S, et. al. 2023. In Silico Prediction of Antidiabetic Activity of Phytoconstituents of Pterocarpus Marsupium Targeting α-Amylase Enzyme. Biosciences Biotechnology Research Asia, 2023;20(1).

Das AK, Mandal SC, Banerjee SK, Sinha S, Das J, Saha BP, Pal M. 1999. Studies on antidiarrheal activity of Punica granatum seed extract in rats. Journal of Ethnopharmacology, 68(1-3), 205–208. https://doi.org/10.1016/s0378-8741(99)00102-6

Daswani PG, Brijesh S, Tetali P, Nh A, Birdi T. 2010. Antidiarrheal activity of Zingiber officinale (Rosc.). Current Science, 98, 222-229.

Dearden KA, Schott W, Crookston BT, Humphries DL, Penny ME, Behrman JR. 2017. Children with access to improved sanitation but not improved water are at lower risk of stunting compared to children without access: a cohort study in Ethiopia, India, Peru, and Vietnam. BMC Public Health, 17(1):110.

Devi BP, Boominathan R, Mandal SC. 2002. Evaluation of anti-diarrheal activity of Cleome viscosa L. extract in rats. Phytomedicine : international journal of phytotherapy and phytopharmacology, 9(8):739–742. https://doi.org/10.1078/094471102321621368

Dubey A, Nayak S, Goupale DC. 2011. Anthocephalus Cadamba: A Review. Pharmacognosy Journal, 2(18):71–76. https://doi.org/10.1016/s0975-3575(11)80029-5

Ezekwesili CN, Obiora KA, Ugwu OP. 2005a. Evaluation of anti-diarrheal property of crude aqueous extract of Ocimum gratissimum L. (labiatae) in rats. Biokemistri, 16(2): https://doi.org/10.4314/biokem.v16i2.32580

Farmer RG. 1990. Infectious causes of diarrhea in the differential diagnosis of inflammatory bowel disease. Medical Clinics of North America, 74:29–37.

Fine KD, Krejs GJ, Fordtran JS, Diarrhea In, Sleisenger MH, Fordtran JS. 1998. editors. Gastrointestinal Disease: Pathophysiology, Diagnosis, Management. 6th ed. WB Saunders; Philadelphia. pp. 1043–1072

Fox D, Mathur A, Xue Y, Liu Y, Tan WH, Feng S, Pandey A, Ngo C, Hayward JA, Atmosukarto II, Price JD, Johnson MD, Jessberger N, Robertson AAB, Burgio G, Tscharke DC, Fox EM, Leyton DL, Kaakoush NO, Märtlbauer E, Leppla SH, Man SM. 2020. Bacillus cereus non-haemolytic enterotoxin activates the NLRP3 inflammasome. Natural Communication, Feb 06;11(1):760

Franca CS, Menezes FS, Costa LC, Niculau ES, Alves PB, Pinto JE, Marçal RM. 2008. Analgesic and antidiarrheal properties of *Ocimum selloi* essential oil in mice. Fitoterapia, 79(7-8):569–573. https://doi.org/10.1016/j.fitote.2008.06.002

Ghule BV, Murugananthan G, Nakhat PD, Yeole PG. 2006. Immunostimulant effects of Capparis zeylanica Linn. leaves. Journal of Ethnopharmacology, 108(2):311–315. https://doi.org/10.1016/j.jep.2006.03.041

Giannella RA. Gastrointestinal infections. In: Kelley WN, ed. Textbook of Internal Medicine. Philadelphia: JB Lippincott, 1989:554–562

Gilani AH et al. 2008. Mechanisms underlying the antispasmodic and bronchodilatory properties of Terminalia bellerica fruit. Journal of Ethnopharmacology. 116(3):528-538

Graham DY, Sackman JW, Estes MK. 1984. Pathogenesis of rotavirus-induced diarrhea. Digestive Diseases and Sciences, 29:1028–1035. https://doi.org/10.1007/BF01311255

Gunakkunru A, Padmanaban K, Thirumal P, Pritila J, Parimala G, Vengatesan N, Gnanasekar N, Perianayagam JB, Sharma SK, Pillai KK. 2005. Anti-diarrheal activity of Butea monosperma in experimental animals. Journal of Ethnopharmacology, 98(3):241–244. https://doi.org/10.1016/j.jep.2004.12.021

Gupta S, Choudhry MA, Yadava JNS, Srivastava V, Tandon JS. 1990. Antidiarrheal Activity of Diterpenes of Andrographis paniculata (Kal-Megh) against Escherichia coli Enterotoxin in in vivo Models, International Journal of Crude Drug Research, 28:4, 273-283, 10.3109/13880209009082833

Gupta S, Yadava JNS, Tandon JS. 1993. Antisecretory (Antidiarrheal) Activity of Indian Medicinal Plants Against Escherichia Coli Enterotoxin-Induced Secretion in Rabbit and Guinea Pig Ileal Loop Models, International Journal of Pharmacognosy, 31:3,198-204, DOI: 10.3109/13880209309082942

Hashi A, Kumie A, Gasana J. 2016. Prevalence of Diarrhea and associated factors among under-five children in Jigjiga

District, Somali region, eastern Ethiopia. Open journal of Preventive Medicine, 6(10):233.

Hornbuckle WE, Simpson KW, Tennant BC. 2008. Gastrointestinal Function. Clinical Biochemistry of Domestic Animals, 413–457. https://doi.org/10.1016/B978-0-12-370491-7.00014-3

Joshi PV, Patil RH, Maheshwari VL. 2009. In vitro antidiarrheal activity and toxicity profile of Aegle marmelos Correa ex Roxb. dried fruit pulp. Natural Product Radiance, 8(5):498-502.

Joshi PV, ShirkhedkarAA, Prakash K, Maheshwari VL. 2011. Antidiarrheal activity, chemical and toxicity profile of Berberis aristata. Pharmaceutical Biology, 49(1):94–100. https://doi.org/10.3109/13880209.2010.500295

Kim H, Ravinder G. 2010. Infectious diarrhea, Gut Microbes, 1:1, 4-21, DOI: 10.4161/gmic.1.1.11036

Kouitcheu MLB, Penlap BV, Kouam J, Ngadjui BT, Fomum ZT, Etoa FX. 2006. Evaluation of antidiarrheal activity of the stem bark of Cylicodiscus gabunensis (Mimosaceae). African Journal of Biotechnology, 5(11).

Kumar S, Dewan S, Sangraula H, Kumar V L. 2001. Anti-diarrheal activity of the latex of Calotropis procera. Journal of Ethnopharmacology, 76(1):115–118. https://doi.org/10.1016/s0378-8741(01)00219-7

Lilley L, Collins S, Snyder J. 2014. Pharmacology and the Nursing Process. pp. 782-862. Elsevier

Magaji MG, Yaro AH, Mohammed A, Tanko Y. 2007. Preliminary antidiarrheal activity of methanolic extracts of Securinega virosa (Euphorbiaceae). African Journal of Biotechnology, 6:2752-2757.

Maiti A, Dewanjee S, Mandal SC. 2007. In Vivo Evaluation of Antidiarrheal Activity of the Seed of Swietenia macrophylla King (Meliaceae). Tropical Journal of Pharmaceutical Research: TJPR, 6(2):711–716. doi:10.4314/tjpr.v6i2.14650

Mandal SC, Ashok Kumar CK. 2002. Studies on anti-diarrheal activity of Ficus hispida. Leaf extract in rats. Fitoterapia, 73(7-8):663–667. https://doi.org/10.1016/s0367-326x(02)00225-3

Mbagwu HOC, Adeyemi OO. 2008. Anti-diarrheal activity of the aqueous extract of Mezoneuron benthamianum Baill (Caesalpiniaceae). Journal of Ethnopharmacology, 116(1):16–20. doi:10.1016/j.jep.2007.10.037

McDonald M, Ward P, Harvey K. 1982. Antibiotic-associated diarrhea and methicillin-resistant Staphylococcus aureus. The Medical journal of Australia, 1(11):462–464.

McDowell RH, Sands EM, Friedman H. 2022. Bacillus Cereus. [Updated 2021 Sep 16]. In: StatPearls [Internet]. Treasure Island (FL): Stat Pearls Publishing.

Miguel A, Zavala-S, Salud P-G, Cuauhtemoc P-G, David S-S Lucina A-G. 2002. Antidiarrheal Activity of Nonanal, an Aldehyde Isolated from Artemisia ludoviciana, Pharmaceutical Biology, 40:4, 263-268, DOI: 10.1076/phbi.40.4.263.8465

Modi N, Wilcox MH. 2001. Evidence for antibiotic induced Clostridium perfringens diarrhea. Journal of Clinical Pathology, 54(10):748–751. https://doi.org/10.1136/jcp.54.10.748

Mohammeda A, Zungub L. 2016. Environmental health factors associated with diarrheal diseases among under-five children in the Sebeta town of Ethiopia. Southern African Journal of Infectious Diseases, 31(4):122–9

Mujumdar AM, Misar AV, Upadhye AS. 2005. Antidiarrheal activity of ethanol extract of the bark of Dalbergia lanceolaria. Journal of Ethnopharmacology, 102(2):213–216. https://doi.org/10.1016/j.jep.2005.06.014

Mujumdar AM, Upadhye AS, Misar AV. 2000. Studies on antidiarrheal activity of Jatropha curcus root extract in albino mice. Journal of Ethnopharmacology, 70(2):183–187. https://doi.org/10.1016/s0378-8741(99)00167-1

Mukherjee PK, Saha K, Murugesan T, Mandal SC, Pal M, Saha BP. 1998. Screening of anti-diarrheal profile of some plant extracts of a specific region of West Bengal, India. Journal of Ethnopharmacology, 60(1):85–89. https://doi.org/10.1016/s0378-8741(97)00130-x

Nampoothiri SV et al. 2011. In vitro antioxidant and inhibitory potential of Terminalia bellerica and Emblica officinalis fruits against LDL oxidation and key enzymes linked to type 2 diabetes. Food and Chemical Toxicology, 49(1):125-131

Naphade VD, Bendale AR, Narkhede SP, Narkhede SB, Jadhav AG. 2018. Phytopharmacognostical investigation of Samasarkara churna. International Journal of Pharmacognosy, 5(4):249-55.

Oben JE, Assi SE, Agbor GA, Musoro DF. 2006. Effect of Eremomastax speciosa on experimental diarrhoca. African Journal of Traditional and Complimentary Alternative Medicine, 3(1):95–100.

Ojewole JA, Awe EO, Chiwororo WD. 2008. Antidiarrheal activity of Psidium guajava Linn. (Myrtaceae) leaf aqueous extract in rodents. Journal of smooth muscle research Nihon Heikatsukin Gakkai kikanshi, 44(6):195–207. https://doi.org/10.1540/jsmr.44.195

Owolabi OJ, Omogbai EKI, Oduru EE. 2007. Antidiarrheal Evaluation of the aqueous leaves extract of Costus lucanusianus-Family Costaceae. Journal of Applied Sciences Research, 3(12): 2052-2055

Patel JD, Patel DK, Shrivastava A, Kumar V. 2010. Screening of Plant Extracts used in Traditional Antidiarrheal Medicines against Pathogenic Escherichia coli. Scientific World, 6(6):63–67. https://doi.org/10.3126/sw.v6i6.2636

Paul A. Antidiarrheal Agents. In: Paul A, Anandabaskar N, Mathaiyan J, Raj GM. 2021. (eds) Introduction to Basics of Pharmacology and Toxicology. Springer,

Singapore. https://doi.org/10.1007/978-981-33-6009-9_38

Pecha R. Erick MD. Prindiville Thomas MD. Drell Eliot RMD, Redor Mark WMD. 2005. Severe Colitis Caused by Staphylococcus aureus Associated with Antibiotic Use, American Journal of Gastroenterology, 100: S167

Perianayagam JB, Sharma SK, Pillai KK. 2005. Evaluation of antidiarrheal potential of trichodesma indicum root extract in rats. Methods and findings in experimental and Clinical Pharmacology, 27(8):533–537. https://doi.org/10.1358/mf.2005.27.8.928298

Poonia BS, Sasmal D, Mazumdar PM. 2007. Anti-diarrheal activity of methanol extract of Litsea polyantha bark in mice. Fitoterapia, 78(3):171–174. doi:10.1016/j.fitote.2006.10.004

Portnoy BL, DuPont HL, Pruitt D, Abdo JA, Rodriguez JT. 1976. Antidiarrheal Agents in the Treatment of Acute Diarrhea in Children. JAMA. 236(7):844–846. doi:10.1001/jama.1976.03270080026025

Prasad SK, Jain D, Patel DK, Sahu AN, Hemalatha S. 2014. Antisecretory and antimotility activity of Aconitum heterophyllum and its significance in treatment of diarrhea. Indian Journal of Pharmacology, 46(1):82–87. https://doi.org/10.4103/0253-7613.125182

Priya KS, Arumugam G, Rathinam B, Wells A, Babu M. 2004. Celosia argentea Linn. leaf extract improves wound healing in a rat burn wound model. Wound repair and regeneration : official publication of the Wound Healing Society [and] the European Tissue Repair Society, 12(6):618–625. https://doi.org/10.1111/j.1067-1927.2004.12603.x

Pulok Mukherjee K, Das J, Balasubramanian R, Kakali S, Pal M, Saha BP. 1995. Antidiarrheal evaluation of Nelumbo nucifera rhizome extract. Indian Journal of Pharmacology, 27(4): 262.

Qnais FA, bdulla YY, Abu G. 2005. Antidiarrheal Effects of Juniperus phoenicia L. Leaves Extract in Rats. Pakistan Journal of Biological Sciences, 8:867-871. https://doi.org/10.3923/pjbs.2005.867.871

Rani S, Ahamed N, Rajaram S, Saluja R, Thenmozhi S, Murugesan T. 1999. Anti-diarrheal evaluation of Clerodendrum phlomidis Linn. leaf extract in rats. Journal of Ethnopharmacology, 68(1–3):315–319. https://doi.org/10.1016/s0378-8741(99)00103-8

Rao CV, Vijayakumar M, Sairam K, Kumar V. 2008. Antidiarrheal activity of the standardised extract of Cinnamomum tamala in experimental rats. Journal of Natural Medicines, 62(4):396–402. https://doi.org/10.1007/s11418-008-0258-8

Ray D, Sharatchandra Kh, Thokchom IS. 2006. Antipyretic, antidiarrheal, hypoglycaemic and hepatoprotective activities of ethyl acetate extract of Acacia catechu Willd. in albino rats. Indian Journal of Pharmacology, 38:408-13.

Rouf ASS, Islam MS, Rahman MT. 2003. Evaluation of antidiarrheal activity Rumex maritimus root. Journal of Ethnopharmacology, 84(2–3):307–310. doi:10.1016/s0378-8741(02)00326-4

Rudrapal M, Celik I, Chinnam S, Ansari MA, Khan J, Alghamdi S, Almehmadi M, Zothantluanga JH, Khairnar SJ. 2022. Phytocompounds as potential inhibitors of SARS-CoV-2 Mpro and PLpro through computational studies. Saudi Journal of Biological Sciences, 29(5):3456-3465.

Rumsey P, Waseem M. 2022. Giardia Lamblia Enteritis. [Updated 2021 Nov 7]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK531495/

Saifuzzaman HA, ShahinulA IA, Ali ES. 2013. Antidiarrheal and cytotoxic activities of Alstonia scholaris bark. International Research Journal of Pharmacy, 4:101-3.

Sairam K, Hemalatha S, Kumar A, Srinivasan T, Ganesh J, Shankar M, Venkataraman S. 2003. Evaluation of anti-diarrheal activity in seed extracts of Mangifera indica. Journal of Ethnopharmacology, 84(1):11–15. https://doi.org/10.1016/s0378-8741(02)00250-7

Sameh S, Al-Sayed E, Labib RM, Singab AN. 2018. Genus Spondias: A Phytochemical and Pharmacological Review. Evidence-based Complementary and Alternative Medicine: eCAM, 2018, 5382904. https://doi.org/10.1155/2018/5382904

Schiller LR, et al. Gastro. 2013. APDW/WCOG Shanghai working party report: chronic diarrhea: definition, classification, diagnosis.J Gastroenterol Hepatol, 29 (2014), pp. 6-25

Shah AJ, Gowani SA, ZuberiAJ, Ghayur MN, Gilani AH. 2010. Antidiarrheal and spasmolytic activities of the methanolic crude extract of Alstonia scholaris L. are mediated through calcium channel blockade. Phytotherapy Research, 24(1):28–32. https://doi.org/10.1002/ptr.2859

Shamkuwar PB, Pawar DP. 2013. Antidiarrheal and Antispasmodic Effect of Berberis aristata. International Journal of Pharmacognosy and Phytochemical Research, 5(1):24-26

Shane AL, Mody RK, Crump JA, Tarr PI, Steiner TS, Kotloff K, et al. 2017. Infectious Diseases Society of America clinical practice guidelines for the diagnosis and management of infectious diarrhea. Clinical Infectious Diseases. 2017. Oct 19;65(12):e45–80.

Shaphiullah M, Bachar SC, Kundu JK, et al. 2003. Antidiarrheal activity of the methanol extract of Ludwigia hyssopifolia Linn. Pakistan Journal of Pharmaceutical Sciences. 16(1):7-11.

Sharma P, Vidyasagar G, Singh S, Ghule S, Kumar B. 2010. Antidiarrheal activity of leaf extract of celosia argentea in experimentally induced diarrhea in rats. Journal of advanced pharmaceutical technology & research, 1(1):41–48.

Sheikh NW, Upwar NI, Patel R, Darshana. 2010.

Evaluation of antidiarrheal activity of alcoholic extract of stem of Berberis aristata DC. Journal of Pharmacy Research, 3:2232-2234.

Shoba FG, Thomas M. 2001. Study of antidiarrheal activity of four medicinal plants in castor-oil induced diarrhea. Journal of Ethnopharmacology, 76(1):73–76. https://doi.org/10.1016/s0378-8741(00)00379-2

Sini JM, Umar IA, Anigo KM, Stantcheva I, Bage EN, Mohammed R. 2008. Antidiarrheal activity of aqueous extract of Combretum sericeum roots in rats. African Journal of Biotechnology, 7(17): 3134-3137.

Sini KR, Sinha BN, Rajasekaran A. 2011. Antidiarrheal activity of Capparis zeylanica leaf extracts. Journal of Advanced Pharmaceutical Technology & Research, 2(1):39–42. https://doi.org/10.4103/2231-4040.79803

Snyder JD, Merson MH. 1982. The magnitude of the global problem of acute diarrheal disease: a review of active surveillance data. Bulletin of the World Health Organization, 60(4):605–613.

Suleiman MM, Dzenda T, Sani CA. 2008. Antidiarrheal activity of the methanol stem-bark extract of Annona senegalensis Pers. (Annonaceae). Journal of Ethnopharmacology, 116(1):125–130. https://doi.org/10.1016/j.jep.2007.11.007

Suleiman MM, Yusuf S. 2008.Antidiarrheal Activity of the Fruits of Vitex doniana. in Laboratory Animals, Pharmaceutical Biology, 46:6, 387-392.

Tangpu V, YadavAK. 2004. Antidiarrheal activity of Rhus javanica ripen fruit extract in albino mice. Fitoterapia, 75(1):39–44. https://doi.org/10.1016/j.fitote.2003.08.015.

Tânia AT, Gomes et al. 2016. Diarrheagenic Escherichia coli, Brazilian Journal of Microbiology, 47, 1, 3-30, https://doi.org/10.1016/j.bjm.2016.10.015.

Teke GN, Kuiate JR, Ngouateu OB, Gatsing D. 2007. Antidiarrheal and antimicrobial activities of Emilia coccinea (Sims) G. Don extracts. Journal of Ethnopharmacology, 112(2):278–283. doi:10.1016/j.jep.2007.03.007

Tijani A Okhale S, Salawu T. Onigbanjo H, Obianodo L. Akingbasote J Salawu OA, Okogun J, Kunle F, Emeje M. 2009. Antidiarrheal and Antibacterial properties of crude aqueous stem bark extract and fractions of Parkia biglobosa (Jacq.) R. Br. Ex G. Don. African Journal of Pharmacy and Pharmacology, 3(7):347-353.

Turnheim K. 1989. Antidiarrhöika: Werkzeuge und Therapeutika [Antidiarrheal agents: tools and therapeutic agents]. Zeitschrift fur Gastroenterologie, 27(2):112–119.

Uddin SJ Shilpi JA, Alam SMS, Alamgir M, Rahman MT, Sarker SD. 2005. Antidiarrheal activity of the methanol extract of the barks of Xylocarpus moluccensis in castor oil- and magnesium sulphate-induced diarrhea models in mice, Journal of Ethnopharmacology, 101(1-3): 139-143 doi: 10.1016/j.jep.2005.04.006

Uddin SJ, Shilpi JA, Alam SM, et al. 2005. Antidiarrheal activity of the methanol extract of the barks of Xylocarpus moluccensis in castor oil- and magnesium sulphate-induced diarrhea models in mice. Journal of Ethnopharmacology, 101(1-3):139-143. DOI: 10.1016/j.jep.2005.04.006.

Ugboko HU, Nwinyi OC, Oranusi SU, Oyewale JO. 2020. Childhood diarrheal diseases in developing countries. Heliyon, 6(4), e03690. https://doi.org/10.1016/j.heliyon.2020.e03690

Venkatesan N, Thiyagarajan V, Narayanan S, Arul A, Raja S, Kumar VSG, Rajarajan T, Perianayagam, JB. 2005. Anti-diarrheal potential of Asparagus racemosus wild root extracts in laboratory animals. Journal of Pharmacy & Pharmaceutical Sciences, 8(1):39–46.

Vhuiyan MMI, Biva IJ, Saha MR, Islam MS. 2008. Anti-diarrheal and CNS Depressant Activity of Methanolic Extract of Saccharum spontaneum Linn. Stamford Journal of Pharmaceutical Sciences, 1(1): 63-68.

Viswanatha GL, Srinath R, Nandakumar K, Shylaja H, Lakshman K. 2007. Antidiarrheal activity of alcoholic and aqueous extracts of stem bark of Thespesia populnea in rodents. Pharmacologyonline, 3:222–230.

Wang H, Tan C, Bai X, Du Y, Lin B. 2006. Pharmacological studies of anti-diarrheal activity of Gentianopsis paludosa. Journal of Ethnopharmacology, 105(1-2):114–117. https://doi.org/10.1016/j.jep.2005.10.002

Williams P, Berkley JA. 2018. Guidelines for the treatment of dysentery (shigellosis): a systematic review of the evidence. Paediatrics and international child health, 38(sup1), S50–S65. https://doi.org/10.1080/20469047.2017.1409454

Woldeab B, Regassa R, Alemu T, Megersa M. 2018. Medicinal Plants Used for Treatment of Diarrheal Related Diseases in Ethiopia. Evidence-based Complementary And Alternative Medicine: eCAM, 4630371. https://doi.org/10.1155/2018/4630371

Wong PM, Desmarchelier VIBRIO, Vibrio C, Richard K. 1999. Robinson, Encyclopedia of Food Microbiology, Elsevier, 2242-2248, https://doi.org/10.1006/rwfm.1999.1655.

World Health Organization. (2017, May 2). Diarrheal disease.https://www.who.int/en/news-room/fact-sheets/detail/diarrheal-disease

Zaidi MB, Estrada-García T. 2014. Shigella: A Highly Virulent and Elusive Pathogen. Current Tropical Medicine Reports 1:81–87 (2014). https://doi.org/10.1007/s40475-014-0019-6

Zavala MA, Pérez S, Pérez C, Vargas R, Pérez RM. 1998. Antidiarrheal activity of Waltheria americana, Commelina coelestis and Alternanthera repens. Journal of Ethnopharmacology, 61(1):41–47. https://doi.org/10.1016/s0378-8741(98)00014-2