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Chapter

Current Knowledge and Therapeutic Strategies of Herbal Medicine for Acute Diarrhea

Muhammad Akram, Muhammad Daniyal, Aatiqa Ali, Iftikhar Ahmed Khan, Rida Zainab, Khan Usmanghani and Wei Wang

Abstract

Diarrhea is a common gastrointestinal problem characterized by loose watery stool and mild to severe dehydration. Annually, about 1.7–5 billion new cases of diarrhea were reported. In developing countries, it is more common, where young kids have diarrhea approximately three times/year. In 2013, 1.26 million deaths occurred due to diarrhea, whereas in 1990, the figure was slightly higher (2.58 million). In 2012, diarrhea was the second most common reason of death (11%, n = 0.76 million) in children less than 5 years. Although various synthetic drugs are being prescribed as standard therapy for diarrhea, they have side effects. It is possible to prescribe the herbal medicine for diarrhea, which is safe and effective. In this study, medicinal plants discussed are proven to be scientifically active in diarrheal diseases. This study reviews about current medicinal plants used in the treatment of diarrhea. The use of medicinal plants for diarrhea results in improvement of the symptom. Moreover, studies on large scale are needed to characterize the beneficial role of medicinal plants in the treatment of diarrhea.

Keywords: diarrhea, infectious disease, medicinal plants, efficacy, literature review

1. Introduction

Diarrhea increased the frequency of bowel movements. Diarrhea is a clinical syndrome of diverse etiology associated with loose or watery stools often with vomiting and fever. Various bacteria, viruses, and parasites cause diarrhea. The most common causes of acute diarrhea are infectious agents [1]. In the Western world, normal fecal weight is less than 200 grams/day with firm to hard consistency of the stools. In India, greater dietary fiber content of the diet increases the fecal mass and its water content. Therefore, it is better to define diarrhea as the condition in which fecal mass and water content are greater than usual. Diarrhea is of two types. One type is called infectious and other is called noninfectious. Bacterium, virus, and parasites cause infectious diseases. Diarrhea affects all age groups but it is most commonly seen in children. Transmission of infection mostly occurs through the fecal-oral pathway. Microscopy and stool cultures are diagnostic investigation for diarrhea. Diarrhea is prevented by precaution such as handwashing. Acute diarrhea

Cynodon dactylon	Poaceae	Leaves and stems	Antidiarrheal, anti-inflammatory, chemopreventive	[52]
Ziziphus mauritiana	Rhamnaceae	Roots	Antidiarrheal	[53]
Calotropis gigantea	Apocynaceae	Roots, bark, and leaves	Antidiarrheal	[16]
Punica granatum	Lythraceae	Seeds	Antidiarrheal	[36]
Asparagus racemosus	Asparagaceae	Roots	Antidiarrheal	[54]
Xylocarpus moluccensis	Meliaceae	Bark, fruit	Antidiarrheal	[55]
Xylocarpus granatum	Meliaceae	Bark	Antidiarrheal	[56]
Psidium guajava	Myrtaceae	Leaf	Antidiarrheal	[57]
Rhizophora mucronata	Rhizophoraceae	Bark	Antidiarrheal	[58]
Ixora coccinea Linn.	Rubiaceae	Flowers	Antidiarrheal	[59]
Diospyros peregrine	Ebenaceae	Bark	Antidiarrheal	[56]
Moringa oleifera	Moringaceae	Leaf	Antidiarrheal	[60]
Elettaria cardamomum	Zingiberaceae	Fruit	Antidiarrheal	[61]
Mimosa pudica	Fabaceae	Root, leaves	Antidiarrheal, antidepressant, hypolipidemic	[62]
Anthocephalus cadamba	Rubiaceae	Flowering tops	Antidiarrheal	[63]
Alchornea cordifolia	Euphorbiaceae	Leaves	Antidiarrheal	[64]
Nymphaea alba	Nymphaeaceae	Roots, flowers	Antidiarrheal, anxiolytic, anticancer	[65]
Nelumbo nucifera	Nelumbonaceae	Rhizome	Antidiarrheal	[66]
Paederia foetida Linn.	Rubiaceae	Roots, leaves	Antidiarrheal, anti-inflammatory	[67]
Mangifera indica	Anacardiaceae	Seed	Antidiarrheal, immunomodulant, hypoglycemic	[52]
Mezoneuron benthamianum Baill.	Caesalpiniaceae	Leaves	Antidiarrheal, Anti-inflammatory, antipyretic, analgesic	[68]
Piper nigrum L.	Piperaceae	Fruit	Antidiarrheal	[69]
Mimosa pudica	Fabaceae	Leaves	Antidiarrheal	[70]
Cyperus rotundus	Cyperaceae	Roots	Antidiarrheal	[71]

Table 1.
Medicinal plants having antidiarrheal activity.

may also be caused by drugs or toxins. Infectious agents are also responsible for chronic diarrhea. Foods additives, medications, irritable bowel syndrome, malabsorption, and inflammatory bowel diseases are other causes of diarrhea. Diarrhea occurs due to various drugs. Digoxin is usually prescribed for treatment of heart disorders; sometimes diarrhea is seen in the patients taking digoxin. Antibiotics are prescribed for treatment of various ailments including diarrhea, but sometimes it has been observed that diarrhea occurs in the patient taking antibiotics. Diverticulitis is another cause of diarrhea. Infarction of bowel is also responsible for diarrhea [2]. *Salmonella* infection also causes diarrhea that is endemic in Southeast Asia. Other bacterial infections include *Shigella*, *Campylobacter*, *Clostridium difficile*, and *Yersinia*. Toxins of *Staphylococcus aureus*, *Vibrio cholerae*, and *E. coli* are

also responsible for diarrhea [3]. Medicinal plants are one of the most popular forms of complementary and alternative medicine. In rural areas, people use medicinal plants as self-medication, and they know medicine for their efficacy in chronic disorders. Therefore, they do not come to doctor for common ailments. Traditional medicine nourishes the body or systems of the body. Medicinal plants have been used since ancient times. This precocious knowledge is transferred from generation to generation. The herbal pharmacopeia has been developed by refining and updating this practice. Gonçalves et al. reported the in vitro anti-rotavirus activity of some medicinal plants used in Brazil against diarrhea [4]. Ojewole et al. reported the antidiarrheal activity of *Psidium guajava* Linn. (Myrtaceae) leaf aqueous extract in rodents [5]. Joshi et al. reported the antidiarrheal activity and chemical profile of *Berberis aristata* [6]. In all cases, the source of diarrhea should be ascertained, and appropriate treatment should then follow. Various modern medicines are originated from plant sources such as aspirin. Plants exert their effects by secondary metabolites present in them. Though a large number of medicinal plants used to treat diarrhea are identified, scientific validation of the medicinal plants of antidiarrheal properties is imperative (**Table 1**). This chapter has shown that multiple plant prescriptions are most commonly used for the management of diarrhea in different systems of medicines.

1.1 Types of diarrhea

1.1.1 Acute diarrhea

Acute diarrhea remains less than 2 weeks. Protozoa, bacteria, virus, food intolerance, and emotional stress cause acute diarrhea [7].

1.1.2 Chronic diarrhea

Chronic diarrhea remains more than 4 weeks.

1.1.2.1 Types of acute diarrhea

Inflammatory diarrhea.
Noninflammatory diarrhea.

1.1.2.1.1 Inflammatory diarrhea

The large intestine is involved in inflammatory diarrhea by invasive parasites or bacteria. Signs and symptoms include fecal urgency, tenesmus, abdominal cramps, fever, small-volume stools, and bloody stool [8].

1.1.2.1.2 Noninflammatory diarrhea

The small intestine is involved in noninflammatory diarrhea. In this type, toxins or viruses affect the small intestine that interferes with water and salt balance. Signs and symptoms include cramps, vomiting, nausea, and large-volume watery diarrhea [9].

1.2 Causes of diarrhea

Causes of diarrhea can be divided into two categories: environmental factors and causative agents.

1.2.1 Environmental factors

Diarrhea is common in bottle-fed children than in breast-fed children. Unhygienic preparations of milk feed, the use of unhygienic bottles, and their contamination by flies and insects may lead to infection of milk, which is an excellent media for the growth and multiplication of organism. On the contrary, breast milk is clean, and it inhibits the growth of organism due to the presence of lactoferrin, lysozymes, leucocytes, macrophages, lactobacillus, and antibodies in it. Infected water and food are also responsible for frequent diarrhea in older children and adults.

1.2.2 Causative agents

Acute diarrhea may be secretory or invasive. Secretory types of diarrhea are caused by bacteria *Vibrio cholerae* and *E. coli*; *Shigella*, *Salmonella*, and *Staphylococcus* may cause invasive diarrhea. Acute diarrhea is also caused by viruses; *Rotavirus* is responsible for 50% of diarrhea in children. Newer viruses like adenoviruses and Norwalk viruses have been found causing diarrhea in children and adults.

1.2.2.1 Cholera

Cholera is a severe acute gastrointestinal infection cause by *Vibrio cholerae*. Transmission is by food or water contaminated by feces from a patient or carrier. Spread may occur from case to case through direct contact with feces. It occurs mostly in hot humid season. *Vibrio cholerae* attach to microvilli of brush border of intestinal epithelium being helped by mucinase. Cholera enterotoxin is released and diarrhea occurs. Stools resemble rice water and contain mucus, epithelial cells, and vibrios. Diagnosis is usually clinical. The presence of rapidly motile vibrios in fresh stool by dark-field illumination is diagnostic. Culture of stool or rectal swabs should be taken [10].

1.2.2.2 Escherichia coli

It consists of two subunits A and B. Subunit B binds to a glycolipid in microvillus membrane. Subunit A enters into cell and inactivates 60S ribosomal subunit. Protein synthesis is stopped and sloughing off of dead cells occurs, and as a result bloody diarrhea occurs [6].

1.2.2.3 Rotavirus

This virus causes typical clinical symptoms of diarrhea preceded or followed by vomiting and fever. It is responsible for 50% diarrheal cases, in children between 6 months and 2 years of age. In developing countries, *Rotavirus* infection is devastating, and lack of treatment leads to high morbidity and mortality [11].

1.2.2.4 Shigella

Shigella dysentery is due to *S. flexneri*, *S. sonnei*, *S. boydii*, and *S. dysenteri*. These four types of serotypes of *Shigella* group produce watery diarrhea and dysentery. *Shigella* dysentery is severe with high mortality. It is a common disease of children below 5 years of age [12].

1.2.2.5 Salmonella

This genus consists of 200 serotypes, which cause diarrhea both in man and animals. *Salmonella* group of organisms causes acute fatal gastroenteritis, enteric

fever, bacteremia, and localized infections. These organisms invade the intracellular epithelial cells small intestine. The children are affected more and may continue excrete the organisms up to 2 months after diarrhea has stopped. Indiscriminate use of antibiotics may cause resistance in the organism. Animals are main reservoir, and transmission is passed through food; waterborne and person-to-person transmission is also possible. Enteric fever is a clinical syndrome characterized by gastrointestinal symptoms. Typhoid is the typical form of enteric fever that is caused by *Salmonella typhi*, while a similar less severe illness known as paratyphoid is caused by *Salmonella paratyphi* A, B, or C. Signs and symptoms of typhoid fever include headache, body ache, malaise, sore throat, anorexia, diarrhea, vomiting, stepladder fever, cough, relative bradycardia, palpable spleen, and rose spot rashes [13].

1.2.2.6 Clostridium perfringens

It is a spore-bearing bacillus. It causes primarily abdominal cramps and watery diarrhea. Organisms are transmitted through food. In cooked stored food, vegetative cells are destroyed by heat, but spores germinate into vegetative cells on cooling or storing the food [14].

1.2.2.7 Staphylococcus aureus

They contain enterotoxins, which are responsible for vomiting and diarrhea. It is a common inhabitant of the human nose, throat, feces, and skin. Foodstuffs like meat and potato stuffs are favorable media for its growth. Enterotoxin being heat stable is not destroyed on heating [15].

1.2.2.8 Bacillus cereus

It contaminates soil-grown food and milk. It causes diarrhea and abdominal cramps. It may stimulate staphylococcal food poisoning characterized by nausea and vomiting. Its spores survive at high temperature and boiling and multiply rapidly on cooling and storage.

1.2.2.9 Entamoeba histolytica

It invades the large intestine and causes dysentery. Trophozoites containing RBC in stool or cysts are diagnostic. Trophozoites are not infectious but cysts are infectious. Encystment does not occur outside the body. It is passed through uncooked food, water, and from person to person. Cysts of *Entamoeba histolytica* are ingested in water or uncooked food, which has been contaminated by human feces. In the colon, trophozoite forms emerge from the cysts, invading the mucus membrane of the large bowel. The cecum is maximally affected, but any part of the colon may be affected producing flask-shaped ulcers. Sometimes a localized granuloma (ameboma) may present as a palpable mass in the rectum [16].

1.2.2.10 Giardia lamblia

It causes watery diarrhea, loose and foul-smelling stools. Abdominal cramps, anorexia, and distension of abdomen are common. Cysts of *Giardia lamblia* are passed through the excreta of man and animals, which infect food. It is also passed through water and person-to-person contact. Infection with *Giardia lamblia* is common in tropical countries. They attach to the mucosa of the duodenum and jejunum and produce inflammation and partial villous atrophy. Signs and symptoms of

Giardia lamblia include loose pale stool, abdominal discomfort, lethargy, nausea, epigastric pain, flatulence, and abdominal distension. For diagnosis, three specimens of stool are collected at 2–3 days interval and examined for cysts within an hour of collections. Duodenal fluid aspiration or jejunal biopsy during endoscopy shows *Giardia lamblia*. For treatment, tinidazole (Fasigyn 500 mg) initially four tabs as a single dose then two tabs daily are given for 5–7 days. Tab. Metronidazole (Flagyl 400 mg) is given three times daily for 5 days [17].

1.3 Levels of dehydration in children with acute diarrhea

1.3.1 Hydration

Sign and symptom of hydration include skin pinch (immediate), drinking (normal), eyes (not sunken), and alertness (normal) [18].

1.3.2 Mild dehydration

Signs and symptoms of mild dehydration include restlessness or irritability, slow skin pinch, drinking eagerly, and sunken eyes [19].

1.3.3 Severe dehydration

Severe dehydration includes very slow skin pinch, drinking poorly or not at all, sunken eyes, and abnormally sleepy or lethargic [20].

1.3.4 Etiology

Etiology of diarrhea includes entero-adhesive *E. coli*, enteropathic *E. coli*, enterotoxigenic *E. coli*, *Shigella*, *Cryptosporidium*, *Giardia lamblia*, *Campylobacter jejuni*, *Salmonella*, disaccharidase deficiency, lactulose, Zollinger-Ellison syndrome (gastrin), phenolphthalein, cascara, senna, partial gastrectomy, blind loop with bacterial overgrowth, lymphoma, adenocarcinoma, radiation enteritis, chronic pancreatitis, pancreatic carcinoma, vagotomy, scleroderma, fistula, small intestinal diverticulitis, allopurinol, celiac disease, tropical sprue, Whipple syndrome, eosinophilic gastroenteritis, Kaposi sarcoma, sarcoidosis, retroperitoneal fibrosis, SSRIs, cholinesterase inhibitors, NSAIDs, proton pump inhibitors, angiotensin II receptor blockers, metformin, ulcerative colitis, Crohn's disease, microscopic colitis, sorbitol, laxative, vipoma, carcinoid, medullary carcinoma of thyroid (calcitonin), and antacids [21].

1.3.5 Host factors

Host factors include malnutrition [22], lactose intolerance, and repeated bouts of diarrhea.

1.3.6 Investigation of diarrhea

Investigation of stool includes stool analysis, stool culture in bloody diarrhea, serum electrolytes, serum urea and creatinine, and sigmoidoscopy if ulcerative colitis is suspected [23].

1.3.7 Principle of treatment

Immune-enhancing drugs should be prescribed to enhance immunity. Diaphoretic drugs are given to control fever. Antimicrobial drugs are prescribed to

treat bacterial diarrhea. Anti-inflammatory drugs are given in case of cytotoxins. Gastrointestinal antiseptic herbs can be prescribed. Antiprotozoal herbs are given in case of protozoal infection [24].

1.3.8 Treatment

Soups are advised to patients with diarrhea. Patients are encouraged to take fruit drinks. Caffeine, alcohol, milk products, fats, and high-fiber diets are avoided to rest bowel. Fluids are given at the rate of 5–200 mg/kg/d depending on the hydration state. Intravenous fluids are preferred in patients with severe diarrhea. Normal saline or Ringer's lactate is given to restore water and electrolytes [25].

1.3.9 Oral rehydration therapy

Oral rehydration is given to check or prevent fluid and electrolyte losses and disturbances in all cases of diarrhea of all etiologies. It replaces all fluid and electrolytes in continuing diarrhea. Glucose will provide energy to the body. Glucose by coupling mechanism facilitates absorption of sodium and water. In rural areas where glucose is not available, sucrose of ordinary cane sugar may be used in place of glucose though it is no better than glucose. Sodium and water given orally are poorly absorbed in the small intestine in the absence of glucose. Any safe water can be used for oral rehydration fluid. In case of doubtful hygienic water, it should be boiled and cooled before mixing ingredients in it. In rural areas, the shallow well water are always infected water; therefore boiled and cool water sufficiently treated with bleaching powder should be used. Adequate replacement of potassium loss is particularly important in malnourished children. Sodium bicarbonate rapidly corrects acidosis. Sodium bicarbonate is absorbed during diarrhea. Mild transient alkalosis is of little importance. Its absence from oral rehydration solution shall not lead to bicarbonate bound sodium absorption. This will not only delay the correction of acidosis, but in its absence, acidosis may also become irreversible in many cases.

1.4 Antidiarrheal agents

1.4.1 Anti-motility drugs

Antimuscarinics such as atropine, mepenzolate, propantheline, and dicyclomine are effective in diarrhea. Loperamide is prescribed in diarrhea. Loperamide reduces the intestinal motility. Loperamide only reduces the symptoms of diarrhea. Therefore, cause of diarrhea should be sought [26].

1.4.2 Antibiotic therapy

Metronidazole is prescribed to patients with amebiasis and giardiasis [27]. In acute diarrhea, ciprofloxacin at dose of 200–500 mg twice daily is prescribed for 3 days [28].

1.4.3 Octreotide

This is a somatostatin analogue, which inhibits secretion of local hormones of gastrointestinal tract like gastrin, motilin, VIP, glucagon, and serotonin. Octreotides are prescribed in diarrhea caused by carcinoid tumor, VIPoma, vagotomy, dumping syndrome, short bowel syndrome, and AIDs. Adverse effects include nausea and GIT upsets. Prolonged therapy may cause effects of excessive somatostatin like cholelithiasis [29].

1.4.4 Diphenoxylate

It is available in tablets containing diphenoxylate and atropine. Atropine is added to discourage the addiction liability with diphenoxylate. This combination of diphenoxylate with atropine is known as co-phenotrope [30].

1.4.5 Adsorbents

Kaolin, pectin, chalk, ispaghula, methylcellulose, and sterculia can be used in the treatment of diarrhea, but their effect is weak. Ispaghula, methylcellulose, and sterculia are used in cases of diverticular disease, ileostomy, and colostomy [31].

1.5 Medicinal plants with antidiarrheal and related beneficial properties

1.5.1 Careya arborea Roxb

It belongs to family Lecythidaceae. Leaves and stem are used treat diarrhea. Chemical constituents contain flavonoids, tannins, saponins, and triterpenoids. It is used in bronchitis, cancer, wounds, dysentery, jaundice, diarrhea, boil, ulcer, filaria, swelling, fever, ear pain, skin diseases, stomach diseases, smallpox, body pain, rheumatic pain, eye complaints, asthma, and dental disorders. It is anthelmintic, demulcent, tonic, anticancer, antipyretic, antidiarrheal, antioxidant, antileishmanial, hepatoprotective, and analgesic [11]. The methanol extract of this plant was used for study. Mice were selected for study. Castor oil-induced diarrhea was prevented by the use of *Careya arborea* Roxb. bark. This study indicated that plant has antidiarrheal activity [32].

1.5.2 Berberis lyceum Royle

It belongs to family Berberidaceae. Roots, fruits, leaves, and stem are used to treat diarrhea. Chemical constituents contain palmitine, berberine, iron, zinc, calcium, and vitamin C. It is used in gonorrhea, chronic diarrhea, piles, broken bones, wounds, acute conjunctivitis, jaundice, and diabetes [33]. Pharmacological activities include antioxidant, antidiarrheal, and wound healer [34]. Arshad et al. reported the ethnomedicinal use of this plant in diarrhea [35].

1.5.3 Punica granatum

It belongs to family Lythraceae. Parts used are twig exudates, fruit, flowers, and stem. Chemical constituents contain copper, potassium, phosphorus, sulfur, carotene, vitamin c, fiber, pectin, pelletierine, isopelletierine, iron, calcium, magnesium, calcium, and carbohydrates. It is used in diabetes mellitus, cancer, and cardiovascular disorders. It is antiviral, antibacterial, antidiabetic, chemopreventive, antioxidant, and cardioprotective [36] reported the antidiarrheal activity of *Punica granatum* seed extract in rats. Methanol extract of this plant was used for antidiarrheal activity. Rat models were selected for study. Castor oil-induced diarrhea was prevented by the use of *Punica granatum* seed extract. Charcoal meal test was also performed in rats. Gastrointestinal motility was decreased in rat by the use of extract. This study indicated that plant has antidiarrheal activity.

1.5.4 Trichodesma indicum

It belongs to family Boraginaceae. Parts used are roots. Chemical constituents contain lanast-5-en-3β-D-glucopyranosyl-21 (24)-olide, stigmast-5-en-3β-ol-23-one,

n-dotriacont-9-one-13-ene, n-pentacos-9-one, stigmast-5-en-3β-ol-21(24)-olide, n-nonacosanyl palmitate, n-tetradecanyl laurate, and n-decanyl laurate. It is used in dysentery, skin diseases, leprosy, and fever. It is diuretic, antimicrobial, and anti-inflammatory [37]. Antidiarrheal activity of *Trichodesma indicum* was investigated in rat model. Diarrhea was induced by castor oil. Castor oil-induced diarrhea was inhibited by *T. indicum*. This study validated its use in diarrheal disease [37].

1.5.5 Mentha longifolia

It belongs to family Lamiaceae. Parts used are dried leaves and young twigs. It is used in diarrhea and dysentery. It is carminative, stimulant, antipyretic, antinociceptive, cytotoxic, insecticidal, calcium channel blocker, and antimicrobial [38]. *M. longifolia* was investigated for its efficacy to treat diarrhea. For this purpose, diarrhea was induced by castor oil. About 100–1000 mg/kg of *M. longifolia* extract exhibited antidiarrheal effect similar to loperamide. High potassium-induced jejunum contraction was inhibited in isolated rabbit jejunum preparations. This indicated its antispasmodic activity through blockage of calcium channels. Calcium concentration curve was shifted rightward with the use of *Mentha longifolia.* This response was similar to verapamil. Inhibition of high K-induced contraction and shifting of calcium concentration curve rightward was also observed by the use of loperamide. Most active fraction was petroleum spirit. This study showed *M. longifolia* antispasmodic and antidiarrheal potential via calcium channel blockade [39].

1.5.5.1 Acacia nilotica Willd

It belongs to family Mimosaceae. Parts used are leaves and pods. It is used in diarrhea, dysentery, gonorrhea, diabetes mellitus, sore throat, and cancer [40]. It is anti-plasmodial, chemopreventive, larvicidal, antidiarrheal, hypotensive, and immunomodulant [41]. Antidiarrheal activity of *Acacia nilotica* was investigated. Aqueous, methanol, and petroleum ether extracts were used. Methanol extract exhibited significant antidiarrheal activity. Diarrhea was induced by magnesium sulfate and castor oil. Peristalsis was induced by barium chloride in Swiss albino mice. Antimicrobial activity of *A. nilotica* was investigated against diarrhea-causing organisms. Extract exhibited antidiarrheal potential against magnesium and castor oil-induced diarrhea. Barium chloride peristaltic movements in mice were also reduced by the use of extract. Extract also showed antimicrobial potential against diarrhea-causing organisms. This study validates its use in diarrhea in traditional system of medicine [38].

1.5.5.2 Alstonia scholaris

It belongs to family Apocynaceae. Parts used are barks. Chemical constituents contain porphyrin, alstonine, echitamine, picrinine, detamine, and strictamine. This plant has been used in diarrhea, dysentery, and hypertension [42]. It is bronchodilator, antimalarial, spasmolytic, antidiarrheal, anticancer, and neuroleptic. Castor oil-induced diarrhea was prevented by the crude extract of *Alstonia scholaris.* Effective dose of extract was 100–1000 mg/kg. The activity of extract was comparable to standard drug loperamide. This study indicated that plant can be used in diarrhea [39].

1.5.5.3 Capparis zeylanica L

It belongs to family Capparaceae. Parts used are flowers and leaves. It is used in diarrhea, cardiovascular disorders, and pyrexia. It is antidiarrheal, antipyretic, antimicrobial, anti-ulcer, and immunostimulant [43]. Methanolic extract of this plant

was used for antidiarrheal activity. The activity of plant extract was investigated in castor-induced diarrhea. Mice were selected for study. There was significant reduction in diarrhea in mice. Three level doses (100, 150, and 200 mg/kg) of extract were used for activity. Extract prevented castor oil-induced diarrhea. This activity of plant was comparable to loperamide-treated animals. Intestinal transit was decreased up to 75.97%. This study indicated that plant is effective in diarrhea [44].

1.5.5.4 Celosia argentea Linn

It belongs to family Amaranthaceae. Parts used are seeds. It is used in hypertension, inflammation, jaundice, ulcer, skin eruption, and diarrhea. It is antioxidant, antidiarrheal, immunomodulant, antimetastatic, antidiabetic, and wound healer [45]. Alcoholic extract of plant was used for study. Different experimental models were used. Diarrhea was induced by castor oil and PGE (2). Loperamide at dose of 2 mg/kg and atropine at dose of 0.1 mg/kg were used as standard drugs. Two level doses (100 and 200 mg/kg) of extract were used for antidiarrheal activity. Antidiarrheal activity of extract was dose-dependent. This study indicated that plant has antidiarrheal activity [46].

1.5.5.5 Pentaclethra macrophylla

It belongs to family Leguminosae. Parts used are leaves and roots. Chemical constituents contain fatty acids, iodine, oil, and carbohydrates. It is used in pruritis, worms, dysentery, cancer, and inflammation. It is antidiarrheal and antidiabetic. Akah et al. reported the antidiarrheal properties of *Pentaclethra macrophylla* leaf extracts. Aqueous and ethanolic extracts of this plant were used for study. Experimental animal models were selected for study. There was significant reduction in fecal output. Extract-treated rats were protected from castor oil-induced diarrhea. Propulsive movements of gastrointestinal contents were significantly decreased in mice. Contractions induced by histamine, nicotine, and acetylcholine were significantly reduced by the use of this extract on isolated tissue preparations. Growth of common pathogenic microorganisms was inhibited. This study showed that plant has antidiarrheal activity [47].

1.5.5.6 Ficus hispida

It belongs to family Moraceae. Parts used are leaves. Chemical constituents contain wax, tannin, caoutchouc acid, glucoside, beta-sitosterol, hispidin, bergapten, and psoralen latex. It is used in ulcer, psoriasis, anemia, piles, jaundice, hemorrhage, vitiligo, diarrhea, diabetes, epilepsy, and hepatitis. It is antidiuretic, antibacterial, anti-inflammatory, hypolipidemic, memory enhancer, hepatoprotective, and anticancer [48]. Methanol extract of this plant was used for study. Diarrhea was induced by castor oil. Enteropooling was induced by PGE (2). This study was conducted in rats. Extract prevented diarrhea and enteropooling induced by castor oil and PGE (2). Charcoal meal test was also performed. Gastrointestinal motility was also reduced by the use of this extract. This study indicated that plant has antidiarrheal activity [49].

1.5.5.7 Terminalia bellirica

It belongs to family Combretaceae. Parts used are fruit. Chemical constituents contain tannins, beta-sitosterol, chebulagic acid, ethyl gallate, ellagic acid, and gallic acid. It is used in jaundice, tuberculosis, and inflammation. It is antidiarrheal,

antioxidant, antispasmodic, hypoglycemic, and bronchodilator [50, 51]. Antidiarrheal activity of plant was investigated. The activity of this plant was also investigated against *E. histolytica*. The activity of plant was investigated against bacteria that cause dysentery and diarrhea. Initially in vitro studies were performed. Furthermore, plant activity was evaluated in clinical trial. Patients having acute and chronic diarrhea and dysentery were selected for study. This study was performed by five medical practitioners. These practitioners were practicing at different clinics. This study was conducted in urban areas of Pune. Clinical trial protocol was given to practitioners. Maximum duration of treatment was 14 days. Bioactive fractions of this plant were used for clinical trial. Tablet was made from bioactive fractions. Tablet was given three times a day at dose of 150 mg. Improvement was observed on second day of treatment. This drug was found effective in diarrhea. Seven patients having amebic dysentery were also recovered attend of treatment. This study indicated that plants are useful for diarrhea and dysentery.

2. Conclusion

This review has revealed that medicinal plants continue to play a vital role in the primary health care of the people. More than half of the people in the world use medicinal plants regularly to treat many ailments, including diarrhea. Hence, further work should be done on the characterization and pharmacological validation of the use of medicinal plants for the treatment of diarrhea. Medicinal plants have potential to treat diarrhea and are prescribed by Unani physician all over the world. Improving hygienic condition prevents diarrhea. Documentation of medicinal plants used to treat diarrhea will help the physician in their practice. There is only description of medicinal plants, but further study should be carried out to find the active constituents responsible for efficacy to treat diarrhea.

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