ABSTRACT
Diarrhoea is the one of the most common cause of morbidity and mortality in many developing countries effecting mainly the infants and children’s. There are many synthetic drug treatments for diarrhea like loperamide, bismuth subsalicylate and racecadotril. But these drugs have more side effects like nausea, abdominal discomfort, headache etc. Many herbal plants available which have anti-diarrhoeal activity with lesser side-effects than the conventional drugs. The review focuses on the various plants which have been proved for their anti-diarrhoeal activity in experimental animal models. This review also focused the in-vivo animal models such as castor oil induced diarrhoea, gastrointestinal motility test, magnesium sulphate induced diarrhoea and serotonin induced diarrhoea.

Key words: Diarrhoea, Baphia nitida, Acacia nilotica Willd, animal models.

INTRODUCTION
Diarrhoea is defined as an increase in the number of stools (3 or more per 24 h), an increase in the fluidity of the stool, and/or the presence of blood and mucus with increased neutrophil polymorphs in the stool1. Diarrhoea is itself not a disease, but it can be the symptoms of several diseases or infections. According to Peter Anton, M.D., a gastroenterologist and researcher with the University of California at Los Angeles, Department of Medicine, Division of Digestive Diseases, diarrhoea is considered to be present if one of the following applies: (1) stool weight of greater than 200 g per day; (2) more than 2 stools per day for more than 30 days; (3) more than 3 stools per day for more than 7 days; (4) more than 3 stools per day, looser than usual, for more than 3 days; or (5) more than 3 stools per day, with a change in frequency or consistency2. The excess loss of water and electrolytes in the stool can lead to dehydration, hyponatraemia and hypokalaemia. According to world health organization, it is the one of the most common cause of morbidity and mortality in many developing countries effecting mainly the infants and children’s3.

Diarrhoea can be either acute or chronic. Acute diarrhoea usually caused by bacterial, parasite and viral infection. It lasts for 1 to 2 days. Chronic diarrhoea is usually related to functional disorders such as irritable bowel syndrome or an intestinal disease such as Crohn’s disease and it lasts for atleast 4 weeks. Diarrhoea can be classified as:-

Non-inflammatory: - This type of diarrhoea caused by enterotoxins such as enterotoxigenic Escherichia coli or by viruses that adhere to the mucosa and disrupt the absorptive and/or secretory processes of the enterocyte without mucosal destruction.

Inflammatory: - Inflammatory diarrhoea caused by bacteria such as E.coli, Clostridium difficile or by non-invasive organisms such as Salmonella, Shigella and Entamoeba histolytica that invade the colon and trigger an inflammatory immune response.

The main cause of diarrhoea is eating wrong food which causes intestinal infection. The other causes of diarrhoea are bacterial infection (Campylobacter, Salmonella, Vibrio cholera, Shigella and enterotoxigenic E.coli etc.), viral infections (noro-virus, rotavirus and adenovirus). Certain medication such as antibiotics, anticancer drugs and non steroidal anti-inflammatory drugs cause diarrhoea. In some cases anxiety or psychological pressures can also lead to diarrhoea. The main symptoms of diarrhoea are abdominal bloating, cramps, loose, watery, unformed stool, urgency of stools, undigested stools4. Diarrhoea of any duration may cause dehydration, which means the body lacks enough fluid and electrolytes, affects the muscle activity, and other important functions. Signs of dehydration in adults are thirst, fatigue, dry skin and tongue. In most of the cases of diarrhoea oral rehydration therapy is used as a treatment for diarrhoea. In this treatment oral rehydration solution which contains the mixture of sodium, chloride, glucose anhydrous and potassium citrate is used to prevent dehydration in patients. Certain supplementation treatment includes folate, vitamin A, zinc sulphate, magnesium and copper which reduce the incidence of diarrhoea. Several adsorbents like kaolin, pectin, activated charcoal and Lactobacillus sporogens are also given in the treatment of diarrhoea. OTC medicines such as loperamide (Imodium®) and bismuth subsalicylate may help stop diarrhoea in adults5.

Various medications are available for diarrhoea such as loperamide, bismuth subsalicylate, racecadotril. But these drugs possess many side effects such as abdominal discomfort, dry mouth, nausea, constipation and headache. There are many herbal plants available that possess anti-diarrhoeal activity with lesser side-effects than the conventional drugs. The plants show anti-diarrhoeal activity by reducing the gastrointestinal motility and secretions. The main chemical constituents in plants that are responsible for anti-diarrhoeal activity are tannins, alkaloids, flavonoids, sesquiterpenes, diterpenes, terpenes and terpenoids. This review focuses on those plants which has been proved for its anti-diarrhoeal activities by using different animal models.

PLANTS WITH ANTI-DIARRHOEAL ACTIVITY

Acacia nilotica Willd

Acacia nilotica Willd belonging to the family Mimosaceae. It is indigenously as babul or kikar. It is broadly scattered in tropical and subtropical countries. The petroleum ether, methanolic, and water extract was evaluated for its anti-diarrhoeal activity. Only methanolic extract showed significant anti-diarrhoeal activity againist castor oil and magnesium sulphate induced diarrhoea and barium chloride induced perstalisis using swiss albino mice6.
Alchornea cordifolia

Alchornea cordifolia belonging to the family Euphorbiaceae. The common names are iporuru, iporoni, iporuro, ipurosa, maccochichua and niana. The English name is Christmas bush. It is widely distributed throughout Africa (7). The anti-diarrhoeal activity of ethanolic extract of Alchornea cordifolia leaf was investigated by castor oil induced diarrhoea in mice. At the doses of 100, 200, 400, and 800 mg/kg, the extract showed a significant (p<0.01) decrease the production of diarrhoeal faeces and also delayed mouse intestinal transit accelerated by castor oil. The extract dose 800 mg/kg being the most effective dose.

Aristolochia ringens (Vahl.)

Aristolochia ringens is belonging to the family Aristolochiaceae. Aristolochia ringens, an ornamental plant native to tropical America that now grows in a number of African countries. It is a climbing plant with long stems, leaves (17 cm), and flowers (18 cm). The aequous root extract of Aristolochia ringens was investigated for its anti-diarrhoeal activity by different experimental models. The extract (100-400 mg/kg) produced a significant decrease in castor oil induced intestinal transit when compare to control group. This effect was significantly (p<0.001) inhibited by pilocarpine (10 mg/kg, s.c.), phenotamine and propranolol (1 mg/kg, i.p) respectively but neither significantly inhibited by yohimbine (1 mg/kg, s.c) nor significantly enhanced by isosorbide dinitrate (150 mg/kg, p.o.). The extract also increases the onset of time of diarrhoea significantly and reduced the diarrhoeal score, number and weight of wet stools. It also reduced the gastric enteropooling and emptying effects of castor Oil.

Baphia nitida

Baphia nitida (BN) commonly known as camwood, belonging to the family Papilionaceae. It is widely distributed plant commonly found in the interior and coastal regions of tropical Africa. Neuromuscular, chronotropic and ionotropic and anti-inflammatory effect of Baphia nitida have been investigated and reported. The ethyl acetate extract of leaves of Baphia nitida was evaluated for its anti-diarrhoeal activity by several different experimental models. In castor oil induced diarrhoea in mice, the extract at a dose of 400 mg/kg significantly increase the onset of time when compared to control group. When IDN (150 mg/kg), yohimbine (1 mg/kg) and atropine (1 mg/kg) given with extract did not show any increase in the effect of extract on the onset of diarrhoea. BN also produced a dose dependent and significant reduction in the number and weight of wet stools when compared to the control group. The extract also produces a significant reduction in the weight of wet stool when compared with control group and with standard drug morphine. IDN, yohimbine and atropine did not significantly affect the effect of the extract on number and weight of wet stools. BN produced significant and dose dependent reduction in intestinal transit. The most effective dose is 400 mg/kg. IDN (150 mg/kg) significantly enhanced the effect of the extract at the most effective dose, but yohimbine (1 mg/kg) and atropine (1 mg/kg) did not have any significant effect on BN. BN at 400 mg/kg produced an insignificant reduction in the weight and volume of intestinal content. The extract at a dose of 400 mg/kg slightly reduced the quantity of test meal emptied in 1 h but this effect was not significant.

Calotropis gigantean R. BR

Calotropis gigantean R. BR, commonly known as milk weed or swallow-wort, is a common waste land weed in India. It is belonging to the family Asclepiadaceae. The hydroalcoholic extract of aerial part of Calotropis gigantean showed potent anti-diarrhoeal activity against castor oil induced diarrhoea model in rats. At doses of 200 mg/kg and 400 mg/kg, the extract showed significant reduction in faecal output and frequency of drooping when compared to castor oil treated rats. All doses of the plant extract also significantly reduced the castor oil induced enteropooling and intestinal transit. The dose 100 mg/kg (p<0.01), 200 and 400 mg/kg (p<0.001) significantly inhibited weight and volume of intestinal content.

Capparis zeylanica

Capparis zeylanica belonging to the family Capparidaceae. It is a rigid, wiry and branched shrub. It is widely distributed in Bangladesh, India, Sri Lanka and Malaysia. It is used traditionally as stomachic, sedative, antidiuretic and also in cholera, hemiplegia, neuralgia and rheumatism. The methanolic extract of C. Zeylanica leaf was investigated for its anti-diarrhoeal activity by castor oil-induced diarrhoea and small intestine transit method on mice. The methanol extract of C. zeylanica administered at the dose of 100, 150 and 200 mg/kg showed 59.02%, 67.61% and 77.83% protection, respectively. At a dose of 200 mg/kg, the extract showed maximum and significant reduction in diarrhoeal episodes. The extract when evaluated on intestinal transit produced a decrease in intestinal transit (75-97%). The results revealed that the methanolic extract significantly reduced diarrhoea in mice with reduction in weight of stools.

Carum cuminum

Carum cuminum commonly known as ajowan, belonging to the family Umbelliferae. It is grown in the east of India, Pakistan, Iran and Egypt. It is an aromatic, grassy annual plant. Antitussive, hepatoprotective, anti-inflammatory, analgesic, antispasmodic, antihypertensive activities of Carum cuminum seeds have been reported. The anti-diarrhoeal potential of the alcoholic and aqueous extract of seeds of Carum cuminum was evaluated using several experimental models. The alcoholic and aqueous extract at a dose of 100 mg/kg showed a significantly (p<0.001) reduced the faecal drooping in castor oil induce diarrhoea and reduced the secretion of gastrointestinal fluid accumulation in charcoal meal test model. The extract showed a greater inhibitory effect on Na+ level than on K+ concentration on castor oil induced fluid accumulation model.

Catharanthus roseus Linn

Catharanthus roseus also known as Vinca rosea, belonging to the family Apocynaceae. It is a medicinal plant assumed to have originated from Madagascar. Pharmacological uses of C. roseus include wound healing, anti-diabetic, analgesic, vasodilatory, hypoglycaemic and anti-Alzheimer’s disease. The anti-diarrhoeal potential of ethanolic extract of C. Roseus leaf was evaluated by castor oil induced diarrhoea and gastro intestinal motility test. The extract at a dose of 200 mg/kg (p<0.05) and 500 mg/kg (p<0.001) significantly reduced the number and weight of wet faecal pellets as compared to control group. C. roseus extract at a dose of 500 mg/kg exhibited inhibitory effect on gastrointestinal transit \textit{in vivo} indicated by reduced mean distance travelled by charcoal.

Cayratia Pedata Lam

Cayratia Pedata (English-Woolly heart vina) belonging to the family Vitaceae. It is climber and grown mostly in shrubberies of India, Andaman Islands, Ceylon and Malaya. The chloroform extract of Cayratia pedata leaves showed potent anti-diarrhoeal activity against castor oil and magnesium sulphate induced diarrhoea in rat model. At a dose of 200mg/kg (P<0.05) and 400mg/kg (P<0.01) showed...
significant reduction in number and weight of faeces as compared to control group.\textsuperscript{16}

**Ceratotheca sesamoides**

*Ceratotheca sesamoides* belonging to the family Pedaliaceae. It is found in tropical African like the open savanna woodlands across the region from Senegal to Northern and Southern part of Nigeria. It is an erect or sub-erect herb of about 60 cm tall. The aqueous extract of leaf of *C. Sesamoides* was evaluated for its anti-diarrhoeal activity in different experimental models. The extract at a dose of 25 mg/kg significantly (p<0.05) prolonged the onset of time and significantly (p<0.05) reduced the number of faeces, total number of faeces, fresh weight of faeces when compared to control group. The extracts at the doses of 50 and 100 mg/kg showed no diarrhoeal episodes in castor oil induced diarrhoea in rats when compare to standard drug (loperamide). The extract (25, 50 and 100 mg/kg) significantly decreased the volume and mass of intestinal fluid of castor oil-induced enteropooling in rats. The extract at a dose of 100 mg/kg reduced the volume of the intestinal fluid more than the reference drug (atropine sulphate) treated animals. The extract at 25, 50 and 100 mg/kg significantly reduced the distance travelled by the charcoal meal.\textsuperscript{17}

**Cinnamomum Zeylanicum Linn**

*Cinnamomum zeylanicum* belonging to the family Lauraceae. It is commonly known as cinnamon. It is widely grown in southern India and Sri Lanka. It is a small evergreen tree growing from sea level to 900 meters. The tree has a thick, reddish brown bark and small yellow flowers. The leaves are ovate-oblong in shape and 7-18 cm long. It has a mild astringent action and aromatic properties. The anti-diarrhoeal potential of the aqueous extract of bark of cinnamon has been evaluated using several experimental models in mice. The extract at the doses of 100 and 200 mg/kg inhibited castor oil induced diarrhoea and magnesium sulphate induced diarrhoea in mice. The extract significantly (P<0.05) decreased the number of faecal dropping when compared to control group. There was also significant reduction in the gastro-intestinal motility which was observed by using the charcoal meal test in mice.\textsuperscript{18}

**Clerodendrum indicum**

*Clerodendrum indicum* belonging to the family Verbenaceae. Vernacular name of this plant is banunhatti, nuli gach. The species occurs variably in India, Nepal, Myanmar, Malaya, Indo-China, Indonesia, Java and Bangladesh. The methanolic extracts and its different partitioning fractions of leaves of *Clerodendrum indicum* were evaluated for its anti-diarrhoeal activity by castor oil induced diarrhoea model. The chloroform fraction of the crude extract exhibited significant anti-diarrhoeal activity. The methanolic extract showed moderate anti-diarrhoeal activity. The percentage of inhibition of defecation produced by the chloroform fraction of the crude extract was 26.96%, while methanolic crude extract showed 21.74% inhibition at a dose of 400 mg/kg. The results compared to the standard drug loperamide. The carbon-tetrachloride soluble fraction and pet-ether soluble fraction of the methanolic crude extract exhibited poor anti-diarrhoeal activity.\textsuperscript{19}

**Combretum sericeum**

*Combretum sericeum* belonging to the family Combretaceae. It is a shrub that is abundant in the savannah region of West Africa. It is commonly known as Taru in Hausa and Nyangbimsa in Jaba. Aqueous extract of *Combretum sericeum* root was evaluated for its anti-diarrhoeal activity by castor oil induced diarrhoea, Castor oil induced fluid accumulation and gastrointestinal motility. The extract at the doses of 25 and 50 mg/kg showed significant (p<0.05) reduction in diarrhoea in castor oil induced diarrhoea model as well as both the doses showed decreased intestinal transit length by 62.72% and 53.38% when compared to control group 87.58%. The extract at the doses of 25 mg/kg and 50 mg/kg showed significant (p<0.05) inhibition of fluid accumulation in castor oil induced fluid accumulation model.\textsuperscript{20}

**Coriandrum sativum Linn**

*Coriandrum sativum* belonging to the family Umbelliferae. The common name of this plant is dhania. It is a small strongly aromatic annual herb with odorous finely cut upper leaves, slender stems and small white or pink flowers producing little round fruits, cultivated as a spice plant throughout the country. The ethanolic extract showed potent anti-diarrhoeal activity against castor oil induced diarrhoea model in mice. At the dose of 250 mg/kg and 500 mg/kg, the extract showed a significant (p<0.01 and p<0.001) decrease in the frequency of defeation and increased the mean latent period in castor oil induced diarrhoea model in mice.\textsuperscript{21}

**Cyperus rotundus**

*Cyperus rotundus* also known as purple nutedge or nutgrass, belonging to the family Cyperaceae. It is a common perennial weed with slender, scaly creeping rhizomes, bulbous at the base and arising singly from the tubers which are about 1-3 cm long. The methanolic extract of rhizome of *Cyperus rotundus* was investigated for its anti-diarrhoeal activity against castor oil induced diarrhoea in mice. The extract at the doses of 250 mg/kg and 500 mg/kg body weight showed significant anti-diarrhoeal activity in castor oil induced diarrhoea in mice. Among the fractions, tested at 250 mg/kg, the petroleum ether fraction (PEF) and residual methanol fraction (RMF) were found to retain the activity, the latter being more active as compared to the control. The ethyl acetate fraction (EAF) did not show any anti-diarrhoeal activity.\textsuperscript{22}

**Dalbergia lanceolaria**

*Dalbergia lanceolaria* belonging to the family Fabaceae. The vernacular name of this plant is chakemdia, siristi. It is a tall tree with drooping branches. Leaves imparipinnate, 7.5-18 cm long, leaflets are 2-3.8 cm long, elliptic or oblong, obtuse. Flowers small, in copious axillary and terminal panicles. Pods 3.8-5 cm long, thin flexible. The ethanolic extract of the bark of *Dalbergia lanceolaria* was evaluated for its anti-diarrhoeal activity by several experimental models. The ethanolic extract showed activity against castor oil, magnesium sulphate induced diarrhoea in albino mice. The extract was also studied for castor oil induced intraluminal fluid accumulation as well as charcoal transit in normal and barium chloride treated animals. The extract reduced significantly intraluminal fluid accumulation and intestinal motility.\textsuperscript{23}

**Delonix regia**

*Delonix regia* commonly known as royal poinciana, belonging to the family Leguminosae. Anti-inflammatory, analgesic, antimicrobial activities reported on *Delonix regia* flower. The ethanolic extract of *Delonix regia* flower showed potent anti-diarrhoeal activity against castor oil induced diarrhoea, prostaglandin-E\textsubscript{2} induced enteropooling model and Gastro-intestinal motility test model. At a dose of 500 mg/kg, the ethanolic extract showed significant reduction in the frequency of defecation, faecal droppings and mean weight of faeces when compared to control group and also when compare to standard drug loperamide in castor oil induced
diarrhoea model and prostaglandin-E2 induced enteropooling model. The extract showed significantly decreased the intestinal propulsive movement in charcoal meal test when compared to control group and standard drug atropine sulphate.25

*Ficus hispida*  
*Ficus hispida* is commonly known as devil fig, belonging to the family Moraceae. It is widely distributed throughout India, Sri Lanka, Myanmar, Southern region of the republic of China, Australia. It is a coarsely hairy shrub or medium sized tree, up to 10 m tall, grows in secondary forests, open lands and river banks, up to 1200 m in altitude.26 The methanolic extract of *Ficus hispida* leaf was investigated for its anti-diarrhoeal activity by castor oil induced and PGE2-induced enteropooling model in rats. The extract showed significant inhibitory activity against castor oil induced diarrhoea and PGE2-induced enteropooling in rats. It also showed a significant reduction in gastro-intestinal motility on charcoal meal test in rats.27

*Ficus religiosa*  
*Ficus religiosa* belonging to the family Moraceae. It is commonly known as peepal. The anti-diarrhoeal activity of hydroalcoholic extract (using soxhlet extraction method), acetone extract (using ultrasonication assisted extraction method) and acetone extract (using microwave assisted extraction method) of stem bark of *Ficus religiosa* were investigated using castor oil induced diarrhoea model in rats. All these extracts significantly (p<0.001) reduced the total number of faeces and total weight of faeces when compared to control group. The hydroalcoholic extract showed more effect than the other two extracts.28

*Geranium incanum* Burm. f.  
*Geranium incanum* Burm. f. commonly known as Carpet Geranium, belonging to the family Geraniaceae. It occurs naturally in the southwestern and eastern parts of the country. The anti-diarrhoeal activity of aqueous extract of leaves of *Geranium incanum* Burm. f. was evaluated by castor oil induced diarrhoea and gastrointestinal tract transit of charcoal meal test. The extract significantly reduced the faecal output and also reduced the number of diarrhoea episodes in castor oil induced diarrhoea in mice. The extract significantly delayed the onset of diarrhoea and reduced the number of animals exhibiting diarrhoea. Loperamide, a standard anti-diarrhoeal drug produced similar effects as that produced by extract on castor oil induced diarrhoea. Both extract and loperamide significantly reduced the intestinal propulsion of charcoal meal in mice.29

*Gymnosporia emerginata*  
*Gymnosporia emerginata* commonly known as mytenus emerginata. It is belonging to the family Celastraceae. It is found abundance in India mainly in Tirupati hills. The methanolic extract of leaf of *Gymnosporia emerginata* was evaluated for its anti-diarrhoeal activity by castor oil induced diarrhoea in rats. The extract at a dose of 300 mg/kg showed reduction in frequency of defection and total weight of wet stools when compare to control group. The percentage of inhibition of diarrhoea showed by atropine sulphate was more than the extract drug.30

*Hippocratea africana*  
*Hippocratea africana* is belonging to the family Hipppocrateaceae. The plant is well distributed in tropical Africa. It is a green forest perennial climber without hairs (glabrous) and reproducing from seeds. The anti-diarrhoeal activity of ethanolic extract of root of *hippocratea africana* was evaluated by castor oil induce diarrhoea model, castor oil induced fluid accumulation model and small intestinal propulsion model in rats. The extract (200-600 mg/kg) reduced the castor oil-induced diarrhoea in a dose-dependent manner significantly (p<0.01). The effect of the extract was comparable to that of the standard drug, atropine. The extract when given with standard drug atropine, the effect was also enhanced. The extract significantly (p<0.001) reduced intestinal fluid accumulation due to castor oil administration when compared to control group. The extract inhibited the intestinal propulsion relative to control group.31

*Hypstis suaveolens*  
*Hypstis suaveolens* belonging to the family Lamiaiceae. It is commonly known as chan, Chinese mint, mint weed, and pignut. This species originated in Central America and tropical South America. It is a bushy erect plant with fragrant hairy corotate, opposite leaves hairy stem and small blue or purple flower in auxiliary and terminal cymes and small black mucilaginous seeds. The ethanolic extract of *Hypstis suaveolens* leaves showed potent anti-diarrhoeal activity against castor oil induced diarrhoea model. The extract at the doses of 250 mg/kg and 500 mg/kg showed significant (p<0.01) and dose dependent inhibitory activity against castor oil induced diarrhoea model. The extract showed delayed onset of diarrhoea induced by castor oil when compared to control group. The result also compared with standard drug loperamide (50 mg/kg).32

*Indigofera Pulchra*  
*Indigofera Pulchra* belonging to the family Papilionaceae. It is commonly known as Bakin buunu in Hausa. It belongs to the family Papilionaceae. It is an annual non climbing herb or shrub that can grow up to 1m tall. It is widely distributed throughout West- Africa. The hydromethanolic extract (75:25) of aerial part of *Indigofera pulchra* was evaluated for anti-diarrhoeal activity against castor oil induced diarrhoea in mice. The extract produced a dose dependent protection against the castor oil- induced diarrhoea with the highest protection (80%) obtained at the highest dose tested (500 mg/kg) comparable to that of loperamide, the standard anti diarrhoeal agent.33

*Ipomea obscura* Linn.  
*Ipomea obscura* belonging to the family Convolvulaceae. It is found throughout India and much seen in Nilgiris, Tamil Nadu. The ethanolic extract of leaf of *Ipomea obscura* was evaluated for its anti-diarrhoeal activity by castor oil induced diarrhoea in mice and gastrointestinal motility in mice. The extract at the doses of 250 mg/kg and 500 mg/kg significantly reduced the number of faeces when compared to the control group in castor oil induced diarrhoea in mice. The extract at the doses of 250 mg/kg and 500 mg/kg significantly (p<0.01) reduce the propulsion of charcoal meal through gastrointestinal tract as compared to control group.34

*Ixora coccinea* Linn.  
*Ixora coccinea* belonging to the family Rubiaceae. In English, it is known as flame of wood, rangan in hindi, kisukare in kannada. It is a small shrub cultivated throughout India. The aqueous extract of flowers of *Ixora coccinea* was evaluated for its anti-diarrhoeal activity against several experimental models in rats. The plant-extract showed significant (P<0.001) inhibitor activity against castor oil induced diarrhoea and castor oil induced enteropooling in rats at the dose of 400 mg/kg. The extract significantly decreased the number of defection and weight and volume of intestinal content. There was also significant reduction in gastrointestinal motility in the charcoal meal test.35
Khaya senegalensis

*Khaya senegalensis* belonging to the family Meliaceae. It is commonly known as acajou caiceladr (French) or Senegal mahogany (English). It is most indigenous tree for timber production in Burkina faso, it is growing up to 35 m in height and 1.5 m in diameter on fertile soil. The aqueous and methanolic extract of leaves of *Khaya senegalensis* has been evaluated for its anti-diarrhoeal activity by different experimental models. In castor oil induced diarrhoea model, the aqueous and methanolic extracts at the doses of 100, 200, 300 mg/kg showed significant (p<0.05) and dose dependent reduction in diarrhoeal dropping. The aqueous extract at a dose of 300 mg/kg showed more significant effect than the methanolic extract. The aqueous extract at a dose of 300 mg/kg significantly (p<0.05) inhibited the fluid accumulation in castor oil treated rats. The methanolic extract not significantly showed the effect. The aqueous extract at the doses of 100, 200, 300 mg/kg showed significantly inhibited the intestinal propulsion in charcoal meal treated rats. The methanolic extract showed less effective.

Murraya koenigii

*Murraya koenigii* commonly known as curry leaf or kari patta, belonging to the family Rutaceae. The plant is distributed and cultivated throughout India. It is found wild from Sikkim to Garhwal, Bengal, Assam and Western Ghats. It is also available in other part of Asian region like in moist forests of 500-1600m height in Guangdong, S Hainan, S Yunnan (Xishuangbanna), Bhutan, Laos, Nepal, Pakistan, Sri Lanka, Thailand, Vietnam. The anti-diarrhoeal activity of aqueous and alcoholic extract of leaves of *Murraya koenigii* evaluated by castor oil induced diarrhoea, charcoal meal test and PGE2 induced diarrhoea. The aqueous extract (200 mg/kg) and alcoholic extract (400 mg/kg) both significantly decreased the total number of faeces, total number of diarrhoeal faeces and delay in defecation time, which was compared with the effect of loperamide (P<0.05). Both the extracts and the the anti-muscarinic drug, atropine (0.1 mg/kg) significantly decreased the propulsive movement in the charcoal meal test, atropine being less potent than the alcoholic extract (p<0.05). The extracts significantly decreased volume of intestinal fluid (P<0.05). The extract also showed a significant reduction in the weight of the faeces as compared to control group.

Pterocarpus erinaceus

*Pterocarpus erinaceus* belonging to the family Fabaceae. It is commonly known as Senegal mahogany (English). It is most indigenous tree for timber production in Burkina faso, it is growing up to 35 m in height and 1.5 m in diameter on fertile soil. The aqueous and methanolic extract of leaves of *Khaya senegalensis* has been evaluated for its anti-diarrhoeal activity by different experimental models. In castor oil induced diarrhoea model, the aqueous and methanolic extracts at the doses of 100, 200, 300 mg/kg showed significant (p<0.05) and dose dependent reduction in diarrhoeal dropping. The aqueous extract at a dose of 300 mg/kg showed more significant effect than the methanolic extract. The aqueous extract at a dose of 300 mg/kg significantly (p<0.05) inhibited the fluid accumulation in castor oil treated rats. The methanolic extract not significantly showed the effect. The aqueous extract at the doses of 100, 200, 300 mg/kg showed significantly inhibited the intestinal propulsion in charcoal meal treated rats. The methanolic extract showed less effective.

Rauwolfia serpentina

*Rauwolfia serpentina* commonly known as Indian snake root, belonging to the family Apocynaceae. It is widely grown in Southeastern United States. *Rauwolfia serpentina* is an evergreen, perennial, glabrous and erect shrub. The methanolic extract of *Rauwolfia serpentina* leaves at dose of 200 mg/kg and 400 mg/kg was found to possess anti-diarrhoeal potential against castor oil induced diarrhoea in mice and castor oil induced enteropooling in mice. The methanolic extract showed the significant reduction in the weight of the faeces as compared to control group.

Saraca asoca

*Saraca asoca* is commonly known as ashoka, belonging to the family Caesalpiniiaceae. It occurs almost throughout India up to an altitude of 750 m, in the central and eastern Himalayas and in the Khali, Gao and Lushai hills. The hydroalcoholic extract (soxhlet extraction method), acetone extract (ultrasonication extraction method) and acetone extract of (microwave extraction method) of stem bark of *Saraca asoca* were evaluated for its anti-diarrhoeal activity by castor oil induced diarrhoea in rats. The all extracts at the doses of 200 mg/kg showed significant reduction in total number of diarrhoeal faeces and total weight of diarrhoeal faeces and also increase the percentage of protection of diarrhoea when compared to control group. The acetone extract prepared by Ultrasonication assisted extraction, showed significant anti-diarrhoeal property in castor-oil induced diarrhoea in albino rats at a dose of 200 mg/kg, as compared to standard drug loperamide at a dose of 3 mg/kg, while the other two extracts showed less effectiveness.

Securinega virosa

*Securinega virosa* belonging to the family Euphorbiaceae. The common vernacular names of *S. virosa* include Tseauawun karee, Gussu, Gwiiwar karee (Hausa), Iranje (Yoruba), Njisi nta (Ibo), Shim shim (Kanuri), kartfi-kartfi (Shuwa arabs) and Camal, cambe, came (Fulani). It is widely distributed throughout tropical Africa, Malaya, China, and Australia and also in India. The methanolic extracts of the leaves, stem bark and root bark were investigated for its anti-diarrhoeal activity, using castor oil-induced diarrhoeal model in mice. The methanolic extract of root bark of *S. Virosa* produced a dose dependent protection against diarrhoea with the highest protection (100%) produced at a dose of 100 mg/kg when compared with control group and standard agent (loperamide) treated group. The methanolic leaf extract also produced protection, but was not dose dependent. The highest protection (60%) obtained by leaves extract at a dose of 50 mg/kg. The methanolic stem bark extract did not protect the animal against diarrhoea.

Strychnos potatorum

*Strychnos potatorum* belonging to the family Loganiaceae. It is a moderate sized tree found in southern and central parts of India Sri Lanka and Burma. The anti-diarrhoeal activity of the methanolic extract of the dried seeds of *Strychnos potatorum* has been evaluated using different models (castor oil-induced diarrhoea, effects on gastrointestinal motility and on PGE2-induced gastric enteropooling). The extract at the doses of 100, 200 and 400 mg/kg showed significantly (p<0.001) inhibited the frequency of defecation and reduced the wetness of faecal dropping in castor oil induced diarrhoea model. The extract also decreased the propulsion of charcoal against castrol-oil induced diarrhoea and PGE2 induced enteropooling in rats. The extract also showed a significant reduction in gastro-intestinal motility in charcoal meal test in rats.
meal through the gastrointestinal tract and also reduced the PGE$_2$-induced enteropooling$^{45}$. *Trilepisium madagascariense* *Trilepisium madagascariense* belonging to the family Moraceae. It is usually found in riverine ground lowlands and submontaneous forest in tropical Africa and Madagascar. It is a forest tree that grows to a height of about 30 m. The methanolic extract from the leaves of *T. madagascariense* was reported to inhibit the growth of *Staphylococcus aureus*. The methanolic extract from the stem bark of *T. madagascariense*, its fractions (n-hexane, ethyl acetate, n-butanol and aqueous residue) and compound (obtained from further column chromatography of the ethyl acetate fraction) were evaluated for the antidiarrhoeal activity in rats by castor oil induced diarrhoea model. Gastrointestinal transit and castor oil-induced enteropooling assays and Shigella-induced diarrhoea assay. The methanolic extract, fractions ions (n-hexane, ethyl acetate, n-butanol and aqueous residue) and compound (obtained from further column chromatography of the ethyl acetate fraction) from *T. madagascariense* stem bark significantly prolonged the onset time of diarrhoea. At a dose of 400 mg/kg, the methanolic extract showed significant inhibition of defecation. The ethyl acetate fraction was the most active fraction while the n-hexane fraction displayed the least anti-diarrhoeal activity. The purging indices, faecal frequencies and intestinal enteropooling decreased with an increase in the dose of test samples. The blood cell counts, serum creatinine and faecal Shigella load decreased significantly (P < 0.05) in the extract treated rats when compared to the control group$^{46}$. *Typhonium trilobatum* L. Schott *Typhonium trilobatum* L. Schott belonging to the family Araceae. The common name of this plant is Benagal arum in Bangladesh. It is widely grown in India, Bangladesh, China, Malaysia and Sri Lanka. It is a small to moderate sized perennial herb. Traditionally, the rhizomes of this plant are used to treat gastric ulcer, asthma, rheumatism, headache, lymph tuberculosis. The ethanolic extract of *Typhonium trilobatum* L. Schott leaves at the doses of 250 mg/kg and 500 mg/kg body weight was found to posses anti-diarrhoeal activity against castor oil induced diarrhoea in mice. The ethanolic extract significantly (P < 0.05) decreased the frequency of defecation and increased the mean latent period as compared to control group$^{47}$. *Valeriana hardwickii* Wall *Valeriana hardwickii* Wall commonly known as valerian and locally as bal-charr. It is belonging to the family Valerianaceae. It is native to Pakistan, Burma and Ceylon. It is considered useful as a diaphoretic, antiperiodic, stimulant, cephalic tonic, antiepileptic, antihelmenthic, sedative, diuretic, aphrodisiac, emmenagogue, deobstruent, cephalic tonic, antiepileptic, antihelmenthic, sedative, diuretic, aphrodisiac, emmenagogue, deobstruent, spasmyloitic and anti-diarrhoeal. The crude aqueous-methanolic extract of *Valeriana hardwickii* rhizomes are investigated for its anti-diarrhoeal activity by castor oil induced diarrhoea model. The extract at the doses of 100 mg/kg showed 20% protection against diarrhoea and 300 mg/kg showed 60% protection against diarrhoea (p < 0.05) when compared to control group. Loperamide which is the standard drug for treatment of diarrhoea showed 80% protection against diarrhoea at a dose of 10 mg/kg$^{48}$. *Verbena hastate* *Verbena hastate* commonly known as vervain, belonging to the family Verbenaceae. The plant is used in southern Nigeria for the treatment of fever, dysentery and diarrhoea. The ethanolic extract of leaves of *Verbena hastate* was evaluated for its anti-diarrhoeal activity against castor oil induced diarrhoea, gastrointestinal motility and castor oil induced enteropooling model. The extract at the doses of 100, 200 and 400 mg/kg significantly inhibited both the frequency as well as wetness of the faecal dropping. The extract at a dose of 400 mg/kg showed 100% inhibition of diarrhoea as showed by the standard anti-diarrhoeal drug (loperamide). The extract showed significant reduction in gut motility. The extract at the doses of 200 mg/kg and 400 mg/kg showed more antimotility effect than the standard antimotility drug (atropine sulphate 5 mg/kg). The extract significantly decreased the castor oil induced fluid accumulation in the intestine$^{49}$. *Vincetoxicum stocksi* *Vincetoxicum stocksii* belongs to the family Asclepiadaceae. It is distributed throughout the tropical American continent, Europe and Asia. It is a group of perennial climbing leafy vines. The anti-diarrhoeal activity of crude extract of *Vincetoxicum stocksii* was evaluated by castor oil induced diarrhoea model in mice. The extract at the doses of 300 mg/kg and 1000 mg/kg showed a significant (p < 0.05) inhibition of frequency of defecation and wetting of faeces when compared to control group or entreated group$^{50}$. *Xanthium indicum* *Xanthium indicum* locally known as ghagra, belonging to the family Compositae. It is a course unarmned annual herb with alternate lobed leaves, bur-like flower-heads, and small oblong fruits covered with curved hooks. The plant is reported to have diaphoretic, diuretic, sudorific, CNS depressant and styptic properties. The hydroalcoholic extract of *Xanthium indicum* leaves was evaluated for its anti-diarrhoeal activity against castor oil induced diarrhoea, magnesium sulphate induced diarrhoea and gastrointestinal motility model. In castor oil induce diarrhoea model, maximum inhibition of characteristic diarrhoeal faeces was observed at 400 mg/kg dose of the extract, which was found to be statistically significant (p < 0.05). Similarly, the extract at 400 mg/kg dose level significantly (p < 0.05) reduced the extent of diarrhoea in test animals in magnesium sulphate-induced diarrhoeal experiment. The extract, at the doses of 200 mg/kg and 400 mg/kg, retarded the intestinal transit of charcoal meal in mice when compared to the control group$^{51}$. **IN VIVO ANIMAL MODELS FOR ANTI-DIARRHOEAL ACTIVITY** *Castor oil induced diarrhoea model*: - Ricinoleic acid, an active component of castor oil which is liberated from the action of lipases on castor oil in the upper small intestine. This being poorly absorbed which causes changes in the mucosal permeability, electrolyte transport and intestinal peristalis, leading to hypersercretory response and diarrhoea. Ricinoleic acid produces local irritation and inflammation of the intestinal mucosa that causes release of prostaglandins and which causes increases in the net secretion of water and electrolytes in the small intestine. Also, ricinoleic acid forms ricinoleate salts with potassium and sodium in the lumen of intestine. These salts inhibit the sodium-potassium ATPase enzyme which increases the intestinal permeability and produces a cytotoxic effect on enterocytes. It may also stimulate epithelial cell of adenyl cyclase leading to prostaglandinds release and other metabolites of arachidonic acid. Nitric oxide could lead to increase the levels of cAMP and cGMP leading to increases the secretion which causes diarrhoea$^{52}$. Rats (150-250g) are used after overnight food deprivation for experimental model. Animals are divided into
four groups of six animals each. 1 ml of castor oil administered to the animals which causes diarrhoea. The potential anti-diarrhoeal agents are administered orally by gavage in various doses to the animals. The animals in control group receive 2% Acacia suspension. Group II receive standard drug loperamide (3 mg/kg p.o.). Test drug is administered to III and IV group. 1 hour after dosage, 1 ml castor oil administered orally to each animal. Following their administration53, each animal housed separately in plastic cages with suitable provision to collected faecal matter on filter paper. The filter paper changed every hour. The severity of diarrhoea is recorded every hour for four hours. The onset of diarrhoea, total weight of faecal matter is recorded and compared with control group. The results are expressed in terms of percentage of inhibition.

**Magnesium sulphate induced diarrhoea:** - Magnesium sulphate produces diarrhoea by osmotic imbalance, increasing electrolyte secretion and preventing reabsorption of water ions which causes increasing the volume of intestinal content. Magnesium sulphate also increases the liberation of cholecystokinin from the duodenal mucosa which increases the secretion and motility of small intestine that causes diarrhoea and also it prevent the reabsorption of sodium chloride and water44. A similar protocol as for castor oil-induced diarrhoea is generally followed. The magnesium sulphate is given at a dose of 2 g/kg orally after 1 hour of drug treatment.

**Gastrointestinal motility by charcol meal:** - The method of Yegnanarayan and Shroti (1982) was used for study. This model describes the effect of drug on the motility of intestine. Animals are divided into six groups of five animals each (mice). Group I receives 5ml/kg vehicle (1% gum acacia p.o.). Group II to V receive different doses of test drug and group VI receives standard drug atropine sulphate (5 mg/kg i.p) which decreases gastrointestinal tract motility. After 45 min 25 ml/kg charcol meal (10% activated charcol suspended in 0.6% gum acacia) is administered to all animals. After 15 min all animals are sacrificed and the intestine is removed without stretching and placed lengthwise on moist filter paper. The length of the intestine (pyloric sphinceter to caecum) and the distance travelled by the charcoal as a percentage of that length were evaluated for each animal, and group means compared with control group and standard group and expressed as percentage inhibition44.

**PGE2 induced enteropooling:** - PGE2 inhibit the absorption of glucose, a major stimulus to intestinal absorption of water and electrolytes. PGE2 causes stimulation of gut motility and accumulation of fluid in intestinal lumen. Animals (rats) are divided in to four groups of six animals each. 1 ml of 5 % (v/v) ethanol in saline intraperitoneally is administered to group I and II. The test drug administered to group III and IV. Group I is then administered with normal saline (1 ml/ rat) orally and utilized as control group. Except group I, PGE2 (100 μg/kg in 5 % v/v ethanol in normal saline) is administered to each rat. After 30 min under deep ether anaesthesia all the animals are sacrificed. Small intestines (from pylorus to the ileoceocal junction) of each animal are removed surgically and its content is measured55.

**Serotonin induced diarrhoea:** - Serotonin itself is a diarrheogenic hormone, which causes intestinal smooth muscle. Animals (rats) are divided into four groups of six animals each. Group I is treated with saline and group II is treated with standard drug diphenoxylate hydrochloride (5 mg /kg). Group III and IV are treated with different doses of drug. After 30 min serotonin (600 μg/kg i.p.) is administered to all animals. After this each animal is kept in separate cage and examined for diarrhoea for every 30 min up to 6 hours55.

**CONCLUSION**

The present review article is focused on different medicinal plants having anti-diarrhoeal activity. As herbal drugs have hardly any side effects as compared to conventional drugs, thus anti-diarrhoeal drugs with herbal origin have greater demand than their synthetic counterparts. All of the plants described in this review have been tested for their anti-diarrhoeal potential and shows positive results and no side effects. These results indicate that medicinal plants have a good anti-diarrhoeal potential and these could be a safe substitute for synthetic drugs for the treatment of diarrhoea.

**REFERENCES**


Source of support: Nil, Conflict of interest: None Declared.