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CROSS MATCHING TRIBAL ETHNO MEDICINAL PRACTICES IN DIARRHEA & DYSENTERY BY BHIL- MINA TRIBE OF BANSWARA, RAJASTHAN WITH PUBLISHED PHARMACOLOGICAL RESEARCH

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ABSTRACT

Diarrhea & dysentery is a common and serious disease and principal cause of morbidity and mortality in the developing countries like India. A number of ethno medicinal plants and their constituents are reported as medicaments used to treat Diarrhea & dysentery. The aim of this paper is to document and identify the plants in use as ethno medicine by the tribal. Further, effort was made to assess the scope of promoting ethnomedicine as complementary medicine along with modern medicine by cross matching the perception of the 'Bhil-Mina' tribe of Banswara, Rajasthan along with review of literature. The present study population revealed the use of ten (10) ethno medicines prepared from 12 plant species & used by them for combating diarrhea & dysentery. The plants discussed are *Mangifera Indica, Adhatoda Vasica, Butea monosperma, Moringa concaneinsis, Zizyphus mauritiana, Cassia auriculata, Z.nummularia, Bauhinia racemosa, Delonix elata, Helicteres isora, Tamarindus indica, and Aegle marmelos.*

KEYWORDS: Diarrhea; Traditional medicine; Ethno medicine, Tribal people, Antibacterial and Anti Diarrheal.

BACKGROUND

In India, a large number of Traditional healers (4, 60,000 Traditional Healers) providing their service to large masses of people (Zaman, 1983)[1] based on their indigenous knowledge that they acquired as technical skill from their predecessors, along with dual combinations of a) wisdom emerged after observing specific natural outcome in the light of social phenomenon & b) individual experience of innovative capacity. Despite the wide range of treatment and

prevention modalities available, Diarrhea still remains a major contributor to infant mortality worldwide (Alkizim et al., 2011).[2] World Health Organization (WHO) statistics reflects that 80% of the world population, mostly from developing countries still rely on botanical for health care (Khan2014).[3] A vast majority of conventional drugs and most of the complementary and alternative medicines (CAM) are plant-derived (Mainardi et al.2009).[4]

The use of Ethno medicine has continued to increase despite the rapid development of pharmaceutical products (Dahunakar et al., 2000)[5] Currently used anti diarrheal drugs, are not always free from adverse effects (Hardman & Limberd, 1992).[6]

Ethno medicine among tribal peoples has been part of their cultural heritage for centuries. For most of them ethno medicine was the first choice of treatment to combat commonly occurring ailments. Ethno medicine provided by Traditional healers was used as such. Plants found in the near surroundings have been taken into use by the tribal people as medicine to treat Diarrheal symptoms. Diarrhea (Dia=through; rheo=flow) is described as greater looseness of stool as coined by Hippocrates (Dahiru et al., 2006).[7] Study (Kazim & Henry, 2006)[8] reported *Vibrio cholera*, undigested lactose, too much magnesium, vitamin C, & celiac disease or laxatives as causative factor for Diarrhea. Symptoms of diarrhea may include frequent passage of watery stool, stomach ache, abdominal pain, Nausea (fever), head ache, loss of appetite etc. Shigella is entero-invasive bacteria which causes classical bacillary dysentery.

Bacillary dysentery is far more prevalent in the developing world because of poor hygienic conditions (Tibri 1997, Azmi 1992, AL-Razi MBZ 2000).[9-11] The term dysentery is specifically used for the passage of stool with pain and cramps. Bacillary dysentery results from *Shigella species*, provokes passage of fecal blood and mucus. On reaching the large intestine the organism passes through the cell lining via M cells that superimpose the lymphoid nodules (Keusch & Kopecko 2005, Kumar &Clark 2005, Sansonetti et al 1991).[12,13,14]

Dysentery is of two kinds, one is limited to rectum while the other is confined to transverse colon, which is in contact or proximal to the rectum. Difference in both is obvious as dysentery occurs due to abrasion and muco-purulent discharge. There is no discomfort found in the rectum, tenesmus is less, excretion is possible by least tenesmus and patient remains asymptomatic. In rectal dysentery, defecation is painful with small fecal matter and tenesmus

and patient suffer with fatigue easily (Batzing 2002).[15] It is colonic dysentery; sometimes inner portion of intestinal epithelial lining gets affected. In this case intestinal membrane becomes edematous that results in tissue death. These membranous scales are excreted out in stool (Tortora et al, 2001).[16]

Tribal people prefer to initiate treatment of dysentery first by which the loose motion with pain in abdomen is stopped without delay. They usually opt for quick relief & therefore, they are least bothered to diagnose the kind of helminthic infestation by stool examination.

It was therefore, felt imperative to assess the safety & efficacy of the plants used by the present study population (i.e. Bhil Mina tribe inhabiting Aspur / Dungarpur Tehsil of Dungarpur District & Ghatol Tehsil, Banswara District of Rajasthan) in the light of published Pharmacological Research.

METHODS

Indigenously prepared medicaments can be recommended for use in PHCs or Government health facilities, only when the medicament is scientifically proven, evidence based & supported by solid data. It was therefore felt necessary to cross match the perception of the respondents regarding certain medicaments prepared & used by them to cure commonly occurring 21 health problems including Diarrhea /Dysentery, with the findings from different studies particularly under following three heads:

1) Pharmacological action of the active principles worked out by animal experimentation (Preclinical studies).
2) Medicaments prepared out of single or more than one plant had been tested on patients in hospital (Clinical Trial Studies).
3) Ethno medicine prepared from a particular plant used by the present study population to alleviate an ailment is also reported by other ethnic groups inhabiting different provinces of India, or not.

The present study population revealed the use of ethno medicines prepared from 12 plant species & used by them for combating Diarrhea /Dysentery.

Specimens of all plant species were collected with the help of Traditional Healers & then photographed. Thereafter identification of plants was carried out in consultation with Botanical Survey of India, Govt. of India, Jodhpur & accordingly plant specimen collected

from field were preserved. Following this, review of literature was carried out that revealed that 12 of these plants used have been reported to possess significant activity.

RESULTS

1. Plant: *Mangifera Indica*

1.1. Ethnomedicine Practice by Bhil-Mina tribe: Bark of Amba or. Aam (i.e *Mangifera Indica*an evergreen tree under family Anacardiaceae) and gum from the Adusa tree (i.e. *Adhatoda vasica* — the shrubs under family Acanthaceae) all were grinded. A very nominal quantity of juice could be extracted after grinding. A little of the juice was mixed to one spoon full of water and out of that, 2-3 drops were fed to the patients.

1.2. *Mangifera Indica* as Ethnomedicine to cure Diarrhea by other tribes of India: Bark of used against Diarrhea, Dysentery by Santal , Kolha, Bhathudi, Kharia, Mankidias, Gond, and Ho tribes of Mayurbhanj district Odisha, (Kar et al. 2013).[17] Bark grinded with a little limes used against dysentery by Gond Tribe of Bhandara District, Maharashtra (Gupta et al. 2009).[18]

1.3. AntiDiarrheal (Animal Experimental Study)

Study (Mahalakshmi et al.,2014)[19] was conducted to determine the anti Diarrheal effect of methanolic extract of *Mangifera indica* – stem bark and root bark and *Ficus bengalensis* – leaf, using swiss albino mice against castor oil-induced Diarrhea. The methanol plant extracts significantly reduced the total number of stool and number of Diarrheal stool in a dose-dependent manner when compared with the untreated control. This was postulated that the extracts directly acted on the colon and stimulate the absorption of water and electrolyte and decrease the motility of large intestine or might have mediated by anti secretory mechanism. Thus the plants have shown to exhibit potent anti-Diarrheal activity proving its ethno-medicinal usage. Study (De & Pal, 2014)[20] revealed aqueous extract of young leaves of *M. indica* were tested against five gm (-) organisms like *E,coli*TG1;*S.typhi* NCTC 74; *S. typhi* 62; *Vibrio cholera* 1023 and *S. sonnei* NK4010 at concentrations of 300, 200, 100, 50mg/ml. The growths of all the tested organisms are inhibited and the growth inhibition is dose dependent. Hence it could be concluded that the aqueous young leaves extract of *M. indica* could be utilized in the management of gastro-intestinal disorders. Another study (Rajan et al 2012)[21] shows traditional claim on the use of *M. indica* seed kernel for treating Diarrhea in Southern parts of India.

Aqueous and alcoholic extracts of *M. indica* significantly reduced intestinal motility and faecal score in Swiss albino mice. Anti-diarrheal activity of mango kernel aqueous extract at 0.25 to 0.50 mg/ml dose are studied by Alkizim *et al*., (2012).[22]

Efficacy of *M. indica* seed kernel fine powder (MIE) was comparable to loperamide, making it a potential anti-diarrheal agent. Study (Sairam et al, 2003)[23] revealed anti-Diarrheal activity of methanolic (MMI) and aqueous (AMI) extracts of seeds of *M. indica* at the dose of 250 mg/kg (p.o.) has been evaluated in experimental Diarrhea induced by castor oil and magnesium sulphate in mice, and also in small intestine transit time model in mice. Both the extracts exhibited significant anti-Diarrheal activity, comparable to that of standard drug loperamide (3 mg/kg), against castor oil- and MgSO4-induced Diarrhea. The SNS has been shown to enhance gut immunity, and immune responses, by influencing the migration and accumulation of naive and memory lymphocytes in mucosal lymphoid tissue (Ariki and Husband 1998),[24] hence enhancing acquired immune responses. Thus, the possibility of therapeutic use of *M. indica* as an alternative to conventionally used pharmaceutical drugs for the treatment of Diarrhea was affirmed.

1.4. Phytochemistry: Study (Bhubaneswari, 2013)[25] reported pharmacologically active mangiferin was isolated from the leaves of *Mangifera indica* L. var Alphonso family Anacardiaceae and isolated compound was found to be same as evidence by UV, IR and 1H NMR studies.

Mangiferin is a polyphenolic and a glucosylxanthone which has strong antioxidant and antiinflammatory properties. (Oluwole, 2015).[26] Polyphenolics flavonoids, triterpenoids, isomangiferin, tannins & gallic acid derivatives- all proved to be therapeutically useful are reported as the different chemical constituents of *Magnifera indica*. The stem bark is reported to contain protocatechic acid, catechin, mangiferin, alanine, glycine, γ-aminobutyricacid, kinic acid, shikimic acid and the tetracyclic triterpenoids cycloart-24-en-3β. Mangostin, 29-hydroxy mangiferonic acid and *mangiferin* have been isolated from the stem bark together with common flavonoids (Shah et al., 2010).[27] Due to the different cytokines production (i.e. type 2 responses, which seems to be more connected with healing processes and tissues repair) the other type of macrophages exhibit a distinct phenotype which differentiates them at the site of infection. Instead of an increased killing capacity by the innate cell, these alternatively activate type 2 reaction process that express a different set of cellular markers and are associated with healing processes and protective responses to helminth infection, in

place of increased phagocytic function and microbial killing capacity (Voehringer et al 2004; Martinez et al,2009).[28-29]

However, increasing knowledge in the biochemical and molecular bases of inflammation has led to possible clear findings into discovery of newer compounds from plant origin in which some of this plants (e.g. *M. indica*) have been successfully proven to target the progress of systemic inflammatory disorders and with the aid of bioactive polyphenols such as flavoniods, mangiferin, leotulin, naringeenin which may provide beneficiary anti-inflammatory & healing effect (Oluwole, 2015).[26]

2. Plant: *Adhatoda vasica*

2.1. *Adhatoda vasica* as Ethnomedicine to cure Diarrhea by other tribes of India: Study (Rout and Panda 2010)[30] reported ethnomedicinal reports on the use of *Adhatoda vasica* for the treatment of diarrhea and dysentery by the tribals from district Mayurbhanj, Orissa.

2.2. AntiDiarrheal (Animal Experimentation Study): Study (Manoj Kumar 2013)[31] reported anti-Diarrheal property of methanol extract of *Adhatoda vasica*.

The *A.vasica* showed highest activity against *E.coli, Staphylococcus aureus, Klebsiella pneumonia* and *Proteus vulgaris* than *Streptococcus pyogenes* and *Pseudomonas aeruginosa.* The ethanol extract of *A.vasica* showed maximum activity against *Staphylococcus aureus, Streptococcus pyogenes* and *Klebsiella pneumoniae* than *Proteus vulgaris* and *Pseudomonas aeruginosa*. The least activity against *E.coli*. Acetone extract of *A.vasica* showed highest activity against *Staphylococcus aureus, Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* than *Streptococcus pyogens, Escherichia coli, and Proteus vulgaris.* Chloroform extract of *A.vasica* showed maximum activity *Staphylococcus aureus, Klebsiella pneumoniae, E.coli* than *Pseudomonas aeruginosa*. Least activity was showed against *Streptococcus pyogens* and *Proteus vulgaris*. Diethyl ether extract of *A.vasica* showed maximum activity against *Staphylococcus aureus, Streptococcus pyogens, E.coli* and *Klebsiella pneumoniae* than *Proteus vulgaris* and *pseudomonas aeruginosa*. Aqueous extract of *A.vasica* showed no activity in 100µg. Then the maximum activity was reported against *Staphylococcus aureus* and *Klebsiella pneumoniae* than *Pseudomonas aeruginosa, Streptococcus pyoge*.

2.3. Phytochemistry: Study (Manoj Kumar 2013)[31] revealed high content Alkaloid (11.3 ± 0.1), Tannin (61.3 ± 0.8), Phenols (1.3 ± 0.1), Flavonoids (2.1 ± 0.1), Saponin(20.9 ± 1).

3. Plant: *Butea monosperma*

3.1. Ethnomedicine Practice by Bhil-Mina tribe: Root of Khakra or Dhak (i.e:, *Butea monosperma* – a tree under family Fabaceae) and gum of Hargura (i.e. *Moringa concaneinsis*- the large trees under family Moringaceae) both were mixed into water and fed for two days to stop loose motion.

Therapeutic use of *B. monosperma* as medicinal plant was reported in the ancient Sanskrit literature like Atri-Samhita (Sensharma, 2000).[32]

3.2. *Butea monosperma* as Ethnomedicine to cure Diarrhea by other tribes of India: Bark of *Butea monosperma* (Local Name – Palasa) used against Diarrhea by Santal, Kolha, Bhathudi, Kharia, Mankidias, Gond, and Ho tribes of Mayurbhanj district Odisha, (Kar et al. 2013).[17] Crude leaf extract used internally twice a day to cure Diarrhea by Gond Tribe of Bhandara District, Maharashtra (Gupta et al. 2009).[18]

3.3. Clinical Trial: Study by Agarwal et. al., 1994[33] reported remarkable potentiation of antigiardial effect from 77% inhibition of 'Pippali Rasayana' an Ayurvedic preparation comprised of ash of *Butea monosperma* and fruit powder of *Piper longum.* It produced up to 98% recovery from the infection. The rasayana had no killing effect on the parasite *in vitro*. It induced significant activation of macrophages as evidenced by increased macrophage migration index (MMI) and phagocytic activity. Enhancement of host resistance could be one of the possible mechanisms contributing towards the recovery of animals from the giardial infection.

3.4. Phytochemistry: Study by Mishra et. al., 2002[34] enumerated four compounds isolated from the flowers of *Butea monosperma* have been characterized as butrin, butein, 3', 4'-7-trihydroxy flavone and stigmasterol — 3, beta-D-glucopyranoside by spectral and chemical methods. Isolation of anthelmintic principle 'palasonin' was referred by Rastogi & Mehrotra, 1993.[35]

3.5. Antidiarrheal (Animal Experimentation Study): The anti-Diarrheal potential of the ethanolic extract of stem bark of *Butea monosperma* (Lam) Kuntz was evaluated using several experimental models in Wistar albino rats. The extract inhibited castor oil induced

Diarrhea and PGE(2) induced enteropooling in rats & also reduced gastrointestinal motility after charcoal meal administration. The results obtained establish the efficacy and substantiate the use of *Butea monosperma* as a nonspecific treatment for Diarrhea practised as ethno medicine. Study (Sharma et al 2012)[36] reported flowers of *B .monosperma* were screened for their anti-Diarrheal activity by castor oil induced model and gastro intestinal motility test model & methanol extract of the flower of *Butea monosperma* (MEBM) were used at two dose level (200 mg / kg and 400 mg / kg p.o) against several experimental models of Diarrhea in rats. MEBM treated animals showed significant inhibitory effect against castor oil induced Diarrhea & gastrointestinal motility test in rat tissue & chicken illeum.

3.6. Antimicrobial (Animal Experimentation Study): Fifty four plant extracts (methanol and aqueous) were assayed for their activity against multi-drug resistant *Salmonella typhi*. Moderate antimicrobial activity was shown by *Butea monosperma, Picorhiza kurroa, Acacia catechu, Acacia nilotica, Cichorium intybus, Embelia ribes, Solanum nigrum, Carum copticum, Apium graveolens, Ocimum sanctum,* and.*Peucedanum graveolens* (Rani & Khuller, 2004, Rana & Mazumder, 2012).[37-38]

4. Plant: *Moringa concaneinsis*

4.1. Ethnomedicine practice by Bhi-Mina tribe: Gum procured from stem of *Moringa concaneinsis* (local name:-Hargura) belonging to family Moringaceae. was used to prepare decoction for feeding patients having loose motion. '*Moringa concanensis* Nimmo'-the tree commonly known as Horseradish tree, Never die tree, West Indian ben tree, and Radish tree which is native through the sub- Himalayan tracts of India widely used since the Ayurveda and Unani medicinal systems for the treatment of several ailments (Anbazhakan,2007).[39]

4.1. *Moringa concaneinsis* as Ethnomedicine to cure Diarrhea by other tribes of India:

M. concaneinsis is commonly known as Kattumurungai by tribal peoples of Nilgiri hill region in Tamil Nadu for the treatment of several ailments (Arora 2013)[40] & other parts of the country as well (Anbazhakan *et al.*, 2007[39] Anwar *et al.*, 2007.[41] Mormitsu *et al.*, 2000[42]). *M. concanensis* has a strong central trunk that is covered with an extremely distinct ive layer of very furrowed bark that can be more than 15 cm thick. The horseradish odour of *M. concanensis* is more intense than *M. oleifera* (Balamurugan and Balakrishnan,2013).[43] The history of *Moringa* dates back to 150 B.C.where ancient kings and queens used *Moringa* leaves and fruit in their diet to maintain mental alertness and healthy skin. Ancient Maurian

warriors of India were fed with *Moringa* leaf extract in the warfront to add them extra energy and relieve them of the stress and pain incurred during war.

4.2. Antidiarrheal (Animal Experimentation Study): A number of Laehiums prepared by herbal venders in South India was tested for antimicrobial activity & ethanol, petroleum ether, hexane (prepared in 1000 ppm) and aqueous extracts (20%) resins of *Moringa concanensis* (which were traditionally used for treatment of fire burns), exhibited antimicrobial activity against *Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and *Candida albicans* (Chitravadivu, 2009).[44]

4.3. Antibacterial: The antibacterial activity of aqueous extract of *Moringa concanensis* showed maximum zone of inhibition (9 mm) against *E.coli* showed the minimum inhibitory zone (4 mm) against *Pseudomona* sp. 8, 8, 7, 5, 5 and 4 mm inhibition zone was observed. against *Lactobacillus brevis, Micrococcus luteus, Lactobacillus bulgaricus, Staphylococcus* sp., *Lactobacillus brevis*, V*ibrio cholera, Pseudomons* sp. Zone of inhibition for aqueous extract against test bacteria varied significantly. The antibacterial activity of, acetone extract of maximum inhibitory zone (8 mm) against *Proteus vulgaris* 7,7,6,6,6 and 5 mm inhibition zone was observed against *Pseudomons* sp., *Lactobacillus brevis, Staphylococcus* sp., *Bacillus* sp., *Lactobacillus bulgaricus, E.coli* (Balamurugan and Balakrishnan, 2013).[43] Most *E.coli* strains are harmless, but some serotypes can cause serious food poisoning in humans. Symptoms depend largely on the virulence of the infecting *E.coli* strain. They range from vomiting and a few loose bowel movements, to profuse watery diarrhea, to severe cramps and bloody diarrhea. (Ojeaga et al, 2014).[45]

4.4. Phytochemistry: The different solvent extracts of *Moringa concaneinsis* bark revealed that aqueous extract shown presence of saponins, tannins, xanthoprotein, carbohydrates. Methanol extract revealed presence of alkaloids, emodins, flavonoids, steroids triterpenoids, tannins, carbohydrates, amino acid, reducing sugar. Acetone extract reported presence alkaloids, Steroid Triterpenoids, Saponins, tannins, carbohydrates, reducing sugar. (Balamurugan and Balakrishnan, 2013)[43]

5. Plant: *Zizyphus mauritiana: Ziziphus mauritiana* is reportrd to have originated from Indo-Malaysian region of South – East Asia & grown in various parts of the world which includes Nigeria (Verma et al, 2011).[46]

5.1. Ethnomedicine practice by Bhi-Mina tribe: Bark powder of *Zizyphus mauritiana*— evergreen small trees (Local name: Bor) & bark powder of *Cassia auriculata* - a bushy shrub (Local name: Anwal) both mixed and fed to cure diarrhea.

5.1. *Zizyphus mauritiana* as Ethnomedicine to cure Diarrhea by other tribes of India: Bark of *Z. mauritiana* (Local Name – Borkoli) used against Diarrhea & Dysentry by Santal, Kolha, Bhathudi, Kharia, Mankidias , Gond, and Ho tribes of Mayurbhanj district Odisha, (Kar et al. 2013).[17] Fruit pulp *Z. mauritiana* (Local Name – Bor) along with curd, pomegranate juice and sesamum oil is taken orally to cure blood dysentery by Gond Tribe of Bhandara District, Maharashtra(Gupta et al. 2009).[18] The leaves are helpful in liver troubles, asthma, fever and diarrhea (Swain, 1968).[47]

5.2. Antidiarrheal (Animal Experimentation Study) Studies (Dahiru et al., 2005; Dahiru et al., 2006)[48-49] reported AntiDiarrhea activity of the methanol root extract of *Z. mauritiana*. Study (Hamiduzzaman et al, 2014)[50] revealed that methanolic crude extract of *Z. mauritiana* leaves at a dose of 400 mg/kg body weight revealed statistically significant antidiarrheal activity by reducing 52.02% of diarrhea comparing with standard drug loperamide (50 mg/kg body wt) having 67.24% of reduction of castor oil induced diarrhea in mice. The study concluded that crude extract of *Z. mauritiana* possessed secondary metabolites that could manage diarrhea by inhibiting the mechanism specifically induced by castor oil. Aqueous leaf extract of *Ziziphus mauritiana* has antidiarrheal activity against castor oil – induced diarrhea in Wistar strain albino rats at the doses of 200, 400 and 800 mg/kg body weight, the fecal droppings decreased and percentage inhibition was 51.05%, 54.48% and 58.10% respectively which was dose – dependent and statiscally significant at ($p < 0.05$).(Shettima et al.,2016).[51]

5.3. Antimicrobial (Animal Experimentation Study): Study (Priyanka et al, 2015.)[52] reported *Z. mauritiana* extracts had good antimicrobial activity. Ethyl acetate extracts of *Z. mauritiana* leaves caused the maximum zone of inhibition against *S. aureus* (31 ± 2 mm) and the lowest against *E.coli* (13.67 ± 1.53). Methanol extract of leaves caused the maximum zone of inhibition against *P. vulgaris* (20.33 ± 1.53 mm) and the lowest against *S. typhi* (10.33 ± 1.53 mm).

Another study (Abalaka et al., 2010)[53] revealed that ethanolic extracts of leaves of *Ziziphus mauritiana & Ziziphus spinachristi* (L.) was useful in the treatment of travelers' diarrhea, infantile gastroenteritis, as *Z. mauritiana* was active against *E. coli, S. pyogenes* and *S.*

aureus. *Z. mauritiana* showed stronger activity against the organisms compared with *Z. spinachristi*. The standard antibiotics used as control showed higher activity on the organisms than the extracts.

5.4. Phytochemistry: Presence of five different constituents Cardiac glycosides, polyphenols, Resins, Saponins and Tannins were identified in *Z. mauritiana* which have variously been reported to have antimicrobial activity & could be the reason for activities against *E. coli*, *S. pyogenes* and *S. aureus* (Abalaka et al., 2010).[53] The phytochemicals identified were cardiac glycosides, polyphenols, saponins and tannins. The study (Rathore et al 2012)[54] of the phytochemical screening of fruits extract of *Ziziphus mauritiana* Lam showed the presence of different types of secondary metabolites such as flavonoids glycoside, phenol, lignin, saponins, sterols and tannins were present while alkaloids was absent in *Ziziphus mauritiana* Lam. Tannins have general antimicrobial and antioxidant activities (Rievere et. al., 2009)[55]

6. Plant: *Cassia auriculata* Linn

6.1. *Cassia auriculata* Linn as Ethnomedicine to cure Diarrhea by other tribes of India: *Cassia auriculata* Linn (Caesalpiniaceae) is a shrub with large bright yellow flowers, growing wild in Central Provinces and Western peninsula and cultivated in other parts of India. The plant has been reported to possess microbicidal activity (Prakash, 2006).[56]

6.2. Antidiarrheal (Animal Experimentation Study): Study (Doshi et al, 2011)[57] reported methanolic extract of flowers of *Cassia auriculata* was found to have higher inhibitory activities against *Staphylococcus aureus, Bacillus subtilis,Escherichia coli* and *Salmonella typhi*. The minimum inhibitory concentration ranged between 12.5mg/mL and 75mg/mL depending on microorganism and extract were reported.

7. Plant: *Ziziphus nummularia*

7.1. Ethnomedicine practice by Bhi-Mina tribe: Extract of root of *Z. nummularia- a* prickly shrub under family Rhamnaceae (Local name: Pala-bor) was crushed and filtrated and fed to cure loose mot ion. Dur ing the per iod of this ethnomedicine administration, intake of sour food, extra sour buttermilk, chilies etc., were prevented.

7.2. *Ziziphus nummularia* as Ethnomedicine to cure Diarrhea by other tribes of India:

Ziziphus nummularia and their parts such as root, leaves and seed is widely used in traditional medicine for curing many diseases diarrhea, ulcers, and fevers, allergy, scabies, eczema and pyorrhea etc (Chanda et al.2011).[58] The filtrate of crushed roots in Banswara district is given orally to cure Diarrhea (Singh & Pandey 1998).[59]

7.3. Antidiarrheal (Animal Experimentation Study): Study (Saima et al 2013)[60] reported Zizyphus leaves extracts were individually tested against a panel of microorganisms including three bacteria, *Escherichia coli, Pasturella multocida* and *Staphylococcus aureus* and four pathogenic fungi, *Aspergillus niger, Aspergillus flavus, Alternaria alternata* and *Ganoderma lucidum.* The results of the antimicrobial assay of the methanolic extract of *Ziziphus mauritana* indicated that the plant exhibited antimicrobial activity against the tested microorganisms at three different concentrations of 50, 100 and 200 µg/µl and the zone of inhibition was recorded. Another study (Abalaka et al 2010)[53] reported *Z. mauritiana* showed an MIC of 1 mgml-1against S. pyogenes, 5 mgml-1 against *E. coliand* 40 mgml-1 against S. *aureus*.

8. Plant: *Bauhinia racemosa*

Different species of *Bauhinia* are known and used as *Kanchnara* in Indian system of Medicine. Studies (Watt, 1972, Shri Bhavamisra, 2006)[61-62] has described *Bauhinia variegata* Linn. as *Rakta Kanchnar* and *Bauhinia racemosa* Linn. as *Shveta Kanchnar* (Charak, C.S. Chi. 4/39,70, 57) while in Bhavaprakash, besides *Bauhinia variegata* Linn., *Bauhinia purpurea* Linn., *Bauhinia tomentosa* is also mentioned under *Peeta Kanchnar*. (Charak, C.S. Ka. 5/8,58). The juice of the bark of *Bauhinia variegata* Linn. is used in the treatment of amoebic dysentery, Diarrhea and other stomach disorders (Tewari et al,2015).[63]

8.1. Ethnomedicine practice by Bhi-Mina tribe: Decoction of bark from Haithro (i.e. *Bauhinia racemosa.* a small tree under family Caesalpiniaceae), Khakra (i.e., *Butea monosperma* of family Fabaceae) were fed to check loose motion, along with root of Ber (i.e., *Ziziphus mauritiana*- an evergreen small tree under family Rhamnaceae).

8.2. *Bauhinia racemosa* as Ethnomedicine to cure Diarrhea by other tribes of India: Bark of *Bauhinia racemosa* (Local Name – Kuliari) used against Dysentery by Santal, Kolha, Bhathudi, Kharia, Mankidias, Gond, and Ho tribes of Mayurbhanj district Odisha, (Kar et al. 2013).[17] Chopra et. al. (1996)[64] reported it's leave decoction used against headache, and

malaria and bark in diarrhea and dysentery. *Bauhinia* species were called "Dwipatra", trees were having deeply 2-lobed leaves (Majumdar, 1927).[65] *Bauhinia racemosa*is a tree, in it's colloquial term reported as "Jhinjhua" or "Haitra" by the tribal of Banswara and Dungarpur districts.

8.3. Antidiarrheal (Animal Experimentation Study): The methanol extract showed a broad spectrum of antimicrobial activity as it inhibited Gram negative bacteria (*Escherichia coli*, *Micrococcus luteus*, and *Pseudomonas aeruginosa*), Gram positive bacteria (*Bacillus subtilis*) and fungi (*Candida albicans* and *Aspergillus niger*). Both extracts showed maximum relative percentage inhibition against *A. niger*. MIC values for methanol extract varied from 1.5-25 mg/ml (Kumar et al, 2010).[66]

Study (Kumar et al, 2005)[67] reported that MEBR showed antibacterial activity of methanol extract of *Bauhinia racemosa* stem bark against *E.coli, Salmonella typhi, Shigella dysteriae* & *Vibrio cholarae* and other fungal strains, as tests was carried out in triplicate after 24-72 hrs of inhibition at 37ºC MEBR. Data are reported as the means of three tests each carried out in triplicate after 24-72 h of inhibition at 37ºC. MEBR. The petroleum ether extract, chloroform extract, ethylacetate extract and methanol extracts of leaves of *B.racemosa* Linn. were prepared and antibacterial activity were studied by disc diffusion method against certain enteric bacterial pathogens such as *Escherichia coli, Staphylococcus aureus, Klebsiella pneumonia, Enterobacter aerogenes, Pseudomonas aeruginosa, Salmonella typhimurium, Salmonella typhi, Staphylococcus epidermidis* and *Proteus vulgaris*. The Methanol extracts had wide range of antibacterial activity against enteric bacterial pathogens than the petroleum ether extract, where as ethyl acetate extract were slightly higher antibacterial activity than chloroform extract (Dahikar et al 2011, Ali et al 1999)[68-69] *Bauhinia vahlii* grows on undisturbed moist and sub tropical areas & as an important non timber forest product (NTFP) plant of forest in Uttrakhand state. Tribal people of many part of India such as Madhya Pradesh, Uttrakhand used the different parts of plant extract for fever, diarrhea, dysentery, bone fracture, tonic and vermifuge (Iuri de França Bonilha et al., 2015).[70] The antibacterial activity of this plant was carried out using agar disc diffusion method at different concentrations of crude extracts against nine bacterial strains pathogenic to human beings. Among the antibacterial assayed, ethyl acetate and acetone were found to be most active against most of the studied bacterial strains. Therefore, Minimum Inhibitory Concentration (MIC) of ethyl acetate and acetone extract was determined against the selected bacterial

strains showing zones of inhibition≥10 mm. The results indicate the potential of *B. vahlii* in treating bacterial infections. Thus, justifying their traditional uses in the treatment of urinary tract infection, diarrhea and food poisoning which are of infectious origin (Singh & Singh, 2014).[71] *Bauhinia tomentosa* is commonly known as yellow bauhinia, yellow orchid tree and yellow bell orchid tree. It is an erect, branched shrub belonging to the family Fabaceae. The anti-Diarrheal activity of aqueous extract of *Bauhinia tomentosa* was evaluated in castor oil induced Diarrhea, prostaglandin induced enteropooling and charcoal meal test at doses of 5, 50,100 & 200mg/kg using albino rats. The aqueous extract of *Bauhinia tomentosa* reduces diarrhea at dose of 200mg/kg i,p by inhibiting gastrointestinal motility and prostaglandin E2 induced enteropooling.(Mythreyi et al.,2012).[72]

8.4. Phytochemistry: The bark of the plant contains ß-sitosterol and ß-amyrin and the leaves contain flavonols (kaempferol, quercetin) and coumarins (scopoletin and scopolin). Stilbene (resveratrol) was isolated from the heartwood of *B. Racemosa.*

9. Plant: *Delonix elata*

9.1. Ethnomedicine practice by Bhi-Mina tribe: Bark decoction of *Delonix elata* –a large deciduous trees under Family Caesalpiniaceae (i.e. Sandera) tree was fed by Bhil Mina tribes of Banswara & Dungarpur, Rajasthan. *Delonix elata* (Syn. *Poinciana elata*) commonly known as 'white gold mohur' and family Leguminosae[8]; subfamily Caesalpiniaceae, Commonly known as ''Sandesaro" in Gujarati.

9.2. *Delonix elata* as Ethnomedicine to cure Diarrhea by other tribes of India: Kathodi tribes of Udaipur District, Rajasthan use the leaves after warming as local application to cure injury (Singh & Pandey, 1998).[61]

9.3. Antidiarrheal (Animal Experimentation Study): Study (Srinivasan et al 2005)[73] revealed antibacterial activity of *D. Elata*'s methanol extract against *E. coli, B. subtilis* and *P. aeruginosa.* Chloroform and methanol extracts of *D. elata* inhibited gram-positive strains *B. subtilis, S. aureus,* gram-negative strains *K. pneumoniae* and *E. coli* with MIC ranging from 0. to 3.125 mg/ml and 12.5 to 25 mg/ml, respectively (Pavithra *et al* 2010).[74]

Another species is *Delonix regia Rafin &* the 70% ethanolic extract of *Delonix regia* flowers shows the dose dependent antiDiarrheal effects in the all the treated groups. The experimental models were castor oil induced Diarrhea, prostaglandin-E2 induced enteropooling and

charcoal induced gastrointestinal motility test in wistar albino rats (Shiramane Rajabhau S et al,2011)[75]

10. Plant: *Helicteres isora*

10.1. Ethnomedicine practice by Bhi-Mina tribe: Fruit powder of *Helicteres isora* (Local Name., Marorphali)-the shrub belonging to family Sterculiaceae. was fed against Diarrhea by Bhil -Mina tribe of Rajasthan.

10.2. *Helicteres isora* as Ethnomedicine to cure Diarrhea by other tribes of India: Root & Bark of *H. isora* (Local Name – Murimurika) used against Diarrhea & Dysentery by Santal, Kolha, Bhathudi, Kharia, Mankidias , Gond, and Ho tribes of Mayurbhanj district Odisha, (Kar et al. 2013).[17]

10.3. Clinical Trial: A clinical trial study (Srivastava et al, 1988)[76] was carried out on 260 patients with Diarrhea having loose motions, three to six times a day. 260 patients were maintained on three different therapies. The first group of 92 patients was given Diarex tablets (Ayurvedic remedy) & *e*ach tablet contained activated carbon made from *Helicteres isora* 60 mg, *Holarrhena antidysenterica* 0.24 g *Symplocos racemosa* 80 mg, *Pavonia odorata* 40 mg *Punica granatum* rind 0.10 g *Shorea robusta* resin 40 mg *Butea frondosa* resin 40 mg Processed in *Aegle marmelos*, *Plantago major*, *Holarrhena antidysenterica*, *Phyllanthus emblica*, *Achyranthes aspera* and *Embelia ribes*. The second group was kept on metronidazole suspension or tablets (Allopathic remedy), while the last group received podophyllum (Homeopathic remedy). All the patients were divided into three age groups: (a) 5 months to 2 years. (b) 2 years to 10 years. (c) Above 10 years. It was observed that the cure rate was at its maximum (75%) with Diarex alone in the age group of 2 to 10 years with negligible side effects. It was 60% in the age group of above 10 years. Diarex produced almost immediate reduction in the frequency and amount of stools.

10.4. Antibacterial: The ability of organic extract of the fruits of *Helicteres isora* was investigated to cure R-plasmids from certain clinical isolates. The active fraction could cure plasmids from *Enterococcus faecalis*, *Escherichia coli*, *Bacillus cereus* and *E. coli (RP4)* at curing efficiencies of 14, 26, 22 and 2 per cent respectively. Acetone fractions of *H. isora* may be a source to develop antiplasmid agents of natural origin to contain the development and spread of plasmid borne multiple antibiotic resistance. (Shrirama, f, 2010).[77]

11. Plant: *Tamarindus indica*

11.1. Ethnomedicine practice by Bhi-Mina tribe: Intake of bark powder of *Tamarindus indica* (Local Name - Amli) - a tree under family Caesalpiniaceae to stop diarrhea.

11.2. *Tamarindus indica* as Ethnomedicine to cure Diarrhea by other tribes of India: Tender leaves of *T. indica* (Local Name -Chinch) macerated to paste and taken directly to check dysentery. Also powder made from dried flowers taken orally with sugar in blood dysentery by Gond Tribe of Bhandara district, Maharashtra(Gupta et al. 2009).[18]

11.3. Clinical Trial: Thirty-six patients (58.33% girls) were fed Xyloglucan extracted from the seeds of *Tamarindus indica* [developed and received European approval -MED class III] for restoring the physiological functions of the intestinal walls, formulated as capsules for adults and powder for pediatric use for reduction of symptoms related to diarrheal events of different etiologies, such as abdominal tension and frequent emissions of feces. Patients receiving xyloglucan plus ORS had better symptom evolution than ORS-only recipients, with a faster onset of action. At 6 hours, xyloglucan produced a significantly greater decrease in the number of type 7 stools (0.11 versus 0.44;). At days 3 and 5, xyloglucan also produced a significantly greater reduction in types 6 and 7 stools compared with ORS alone. Xyloglucan plus ORS was efficacious and safe option for the treatment of acute gastroenteritis in children.

11.4. Antibacterial: In Puerto Rico out of 172 plant species commonly used by people were investigated for antibacterial activity, *T .indica* possessed a strong activity against the tested bacteria (Melendez & Capriles, 2006).[78]

Another study (Uchechukwu et al,2011)[79] reported that to validate the medicinal use of *T. indica* as mentioned in northern Nigerian folklore fruits, leaves and stem bark of *T. indica* from Sokoto State of Nigeria were evaluated, *in vitro*, against 13 Gram negative and 5 Gram positive bacterial strains. The fruit pulp extracts exhibited a wide spectrum of activity; the cold water extract against 95.5% of the test bacterial strains; and the hot water and ethanolic extracts against 90.9% and 86.4%, respectively. In contrast the cold water extract of the leaves and stem bark, each was active against 16.7%; while the ethanolic extract of each was active against 75% of the test strains. The MIC ranged from 7.81 mg/mL against *Bacillus subtilis* ATCC 6051 to 31.25 mg/mL against *Escherichia coli* ATCC 11775; and MBC

ranged from 125 mg/mL against *Pseudomonas aeruginosa* ATCC 10145 to 250 mg/mL against *Bacillus subtilis* ATCC 6051.

12. Plant: *Aegle marmelos.*

12.1. Ethnomedicine practice by Bhi-Mina tribe: In case there is 'passage of frequent loose stools- with mucus associated with griping abdominal pain then Green unripe fruits of *Aegle marmelos*- the deciduous tree under family Rutaceae cut into slices, dried & powdered. The powder was suggested to feed Twice or thrice a day along with water. Intake of dal (i.e.Pulses), milk and fried foods were avoided usually.

12.2. *Aegle marmelos* as Ethnomedicine to cure Diarrhea by other tribes of India: Leaf & Fruits of *Aegle marmelos* used against Diarrhea, Dysentery by Santal, Kolha, Bhathudi, Kharia, Mankidias, Gond, and Ho tribes of Mayurbhanj district Odisha, (Kar et al. 2013), Fruit pulp is given internally to cure Diarrhea for 3-5 days by Gond Tribe of Bhandara District, Maharashtra (Gupta et al. 2009),[18] Ripe fruit juice used in Diarrhea at Karnal District. Haryana (Kaur & Vashistha,2014).[80]

12.3. Clinical Trial: A comparative study was undertaken to determine the efficacy of Shigel Dysent (Test drug) in comparison with Ciprofloxacin (Control drug) in alleviating the clinical sign and symptoms of *Shigellosis* recorded in 250 patients (age group 25-45 years during 2010-2013) dividing them into two parallel arm groups; 125 for test and 125 for control group for 7days. The ciprofloxacin dose management consists of 500mg ODS for five days is the first line of diarrheal diseases. In the present study the predominate species was found to be *Shigella sonnei* due to contaminated drinking water, then *Shigella flexneri* and lastly *Shigella boydii*. Etiological and clinical features elaborated with shigella infection consist of blood and mucus in stool, cramps, abdominal pain, tenesmus, fever and chills. The major clinical manifestation of Shigellosis is the increase of stool frequency and disturbance in stool consistency. Inflammatory diarrhea occurs with inflammation of bowel mucosa, which limits its ability to reabsorb fluid and it can occur with *Shigella*. Plants included in Test Drug were *Phyllanthus emblica* L. (Fruit of Aamla in powder form)-75mg, *Aegle marmelos* L. (Fruit of Belgiri powder)-100mg, *Holerrhena antidysenterica* L. (Maroor phalli powder)-50mg, *Myrtus communis*L. (Fruit of Hub-ul-Aas powder)-150mg, *Polygonum bistorta* L. (Bikh Anjibar powder)-75mg & *Citrus aurantifolia* L(Post Turang powder)-50mg. All these phyto-pharmaceutical ingredients were grinded and aqueous alcoholic extract were filled in the capsule. All the plant products mentioned were separately weighed as per dosage in 500 mg

capsule & thereafter cleaned and examined for their impurities and adulterations. Results showed that the medicinal plant coded formulation 'ShigelDysent' exhibited significant ($p<0.029$) efficacy in relieving the clinical features for sign and symptoms of *Shigellosis* comparable with that of standard drug Ciprofloxacin. (Qureshi et al., 2015).[81]

12.4. Antidiarrheal & Antibacterial (Animal Experimentation Study)**:** Methanolic and aqueous extract of unripe fruit of *A. marmelos* at the doses of 3 mg/kg, 7.5 mg/kg and 15 mg/kg exhibited anti Diarrheal potential against castor oil induced Diarrhea in mice. The methanolic plant extract was found to be more effective than the aqueous extract. The methanolic extract significantly ($p<0.001$) reduced the induction time of Diarrhea and the total weight of the faeces (Shobha, et al., 2001).[82] Leaf extracts have shown activity against *Escherichia coli* (George et al 1947, Joshi & Magar 1952).[83-84] Ethanolic extract of root has shown activity against *Vibrio cholerae, Salmonella typhimurium, Klebsiella pneumoniae, Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis* and *Staphylococcus aureus* (Pitre & Srivastava 1987, Valsaraj et al 1997).[85-86] MIC value of the methanolic extract of *A.marmelos* fruit s against mult i drug resistnt *Salmonella typhi* is around 256 g/ml. The unsaponifiable matter of the seed has shown considerable *in vitro* activity against *Escherichia coli, Salmonella typhi, Salmonella paratyphi, Proteus vulgaris, Streptococcus faecalis, Vibriocholerae, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Neisseria gonorrhoeae* (Singh, Bhatt & Sthapak,1983).[87]

12.5. Antimicrobial (Animal Experimental Study)**:** Fifty four plant extracts (methanol and aqueous) were assayed for their activity against multi-drug resistant *Salmonella typhi*. Strong antibacterial activity was shown by the methanol extracts of *Aegle marmelos* & some other 8 plants (Rani & Khuller, 2004).[37] The anti-diarrheal effect of ethanol extract of the dried fruit pulp of *Aegle marmelos* was studied on various intestinal pathogens. It showed excellent activity against *Shigella boydii, S. sonnei* and *S. flexneri* whereas the activity was found to be moderate against *S. dysenteriae*. The minimum inhibitory concentration against the strains of Shigella was recorded between 250 to 500 µg/ml (Rani, Vasisht & Khullar 2013).[88] Aqueous extract of *Aegle marmelos* enhanced the susceptibility of beta-lactam resistant *Shigella flexneri* and *Shigella dysenteriae* towards beta-lactam antibiotics by altering poring channels. Antimicrobial activity has been shown in the leaves of *Aegle marmelos* and this study is in consistence with the differential expression of ompC and ompF in multi-drug resistant *Shigella dysenteriae* and *Shigella flexneri* (Rahman & Parvin 2014).[89] As cited the research

work performed in vitro and in vivo anti-diarrheal potential of chloroform extract of the root of *Aegle marmelos* and was found that the extract was comparable to that of ciprofloxacin and mostly active against the strains of *Vibrio cholerae*, followed by *Escherichia coli (E. coli)* and *Shigell*a spp (Liu P 2012).[90]

The isolated lectin from the fruit pulp of *Aegle marmelos* exhibited its effect against *Shigella dysenteriae* infection. The effect of *Aegle marmelos* fruit lectin on the adherence of *Shigella dysenteriae* to human colonic epithelial cells (HT29 cells) was evaluated by Enzyme Linked Immune Sorbent Assay and invasion was analyzed. The protective nature of the *Aegle marmelos* lectin was assessed by analyzing apoptosis through dual staining method. *Aegle marmelos* lectin significantly inhibited hemagglutination activity of Shigella and its minimum inhibitory concentration is 0.625 µg/well (Joshi, Patil, Maheshwari,2009).[91]

12.6. Phytochemistry: Tannin in unripe fruit is antiDiarrheal (Ghosh & Playford, 2003). Compound namely Marmelosin from Fruit of *Aegle marmelos* reported as Antihelminthic & antibacterial (Nagashima,1989, Nagababu & Lakshmaiah,1992, Ghosh & Playford,2003).[92,93,94] The ant ibacter ial act ivity of leaf ext ract s may be due to presence of Eugenol (Katayama & Nagai 1960)[95] & Cuminaldehyde (**7**) (C10H12O) (Duke1992).[96]

DISCUSSION

Plant mater ials are cheap and signif icant ly contr ibute to the improvement of human health in terms of cure and prevent ion of diseases (Okoko and Oruambo, 2008).[97]

Anti Diarrheal treatment in patient is achieved through the objective of the therapy which includes increasing resistance to flow (segmental contraction and decrease propulsion) and increased mucosal absorption or decreasing secretion (Burks,1991).[98] This is indicative of the ability of the plant to alter normal peristaltic movement and hence decrease the movement of materials in the intestinal tract allowing greater time for absorption. In the fluid accumulation test, the extract significantly reduced both the weight and volume of intestinal content.

CONCLUSION

Findings from present paper may augment the process of consideration to pursue certain selected leads up to product stage.

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