

***Musa paradisiaca* L. - A Plant Used to Assuage Diarrhea and Dysentery in Bangladesh**

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Abstract

Diarrhea occurs when stools are passed out in liquid form frequently. Dysentery can be considered as severe diarrhea with mucus or blood in the feces accompanied by stomach cramps. Because of unhygienic living conditions and scarcity of potable water supply, diarrhea and dysentery are common problems in Bangladesh. The unripe fruits of *Musa paradisiaca* L. (plantain) are taken in mashed form following boiling or in the cooked form to assuage diarrhea and dysentery, which is a common remedy in Bangladesh going back possibly hundreds or even thousands of years. This review will deal with the anti-diarrheal and anti-dysentery uses of the plant in home remedies, folk medicine (FM) and tribal medicine (TM) of various countries, along with the phytochemicals present in the plant, and pharmacological studies on its anti-diarrheal and anti-dysentery properties.

Keywords: *Diarrhea; Dysentery; Home Remedy; Folk Medicine; Tribal Medicine; Bangladesh*

Abbreviations

FMP: Folk Medicinal Practitioner; FM: Folk Medicine; TMP: Tribal Medicinal Practitioner; TM: Tribal Medicine; WHO: World Health Organization

Introduction

Diarrhea is defined generally as frequent passing of watery stools. Common causes include enteric infections and changes in the digestion and absorption of food. The frequent passing of watery stools can lead to dehydration and electrolyte imbalance, particularly loss of sodium and potassium from the body [1]. Diarrhea can be caused by virus, bacteria, fungus, and parasites and mostly affects children. Acute bloody diarrhea is referred to as dysentery. According to the World Health Organization (WHO), there are 1.7 billion childhood diarrhea cases every year with around 525,000 deaths of children under five years of age. Rotavirus, *Vibrio cholerae* and *Escherichia coli* are three of the most common etiological agents of diarrhea in low income countries [2]. Rehydration therapy, zinc supplementation, and antimicrobials have been recommended by WHO to combat various stages of diarrhea and dysentery [3].

Despite advances in many areas, diarrhea and dysentery are common among all people of Bangladesh, more so among the rural people and urban slum dwellers. Among the reasons are illiteracy, living in unhygienic conditions and lack of potable water system. One-third of total child deaths in rural Bangladesh occur due to diarrhea; every year a rural child, on the average, would suffer from nearly 5 episodes of diarrhea leading to 230,000 children deaths per year. Parents still rely on traditional healers (21.7%) and village doctors (36.5%) [4].

Village doctors in Bangladesh do not have medical degrees or doctor's license. They just apply allopathic medicines or medicines of their choice based on individual experiences and preferences. Another study found that dehydration was more common in urban rather than rural adults, and the causative organisms for adult diarrhea were seen to be *Vibrio cholerae*, rotavirus, *Shigella* and enterotoxigenic *Escherichia coli* [5].

More often than not, diarrhea and dysentery are treated somewhat lightly by all sections of the people in Bangladesh, unless there is a serious deterioration in patient condition. Most diarrheal episodes go away within a day or two (in case of adults) during which one of the many home remedies or remedies administered by folk medicinal practitioners or tribal medicinal practitioners are taken. Such remedies usually consist of plants or plant parts. One of the most common remedy for diarrhea and dysentery is consumption of *Musa paradisiaca* L. (Musaceae) unripe fruits (plantain, see figure 1) in mashed form following boiling or consumed following cooking with the minimum of spices (turmeric, pepper and sometimes coriander) added. Both mashed and cooked forms are taken with rice congee (jau bhat in Bengali, rice boiled in a large amount of water to make it extra soft following boiling). Ripe fruits are seldom used. Along with plantain, a thin soup (again with minimum spices added) of either *Heteropneustes fossilis* (Asian stinging catfish, 'shing' in Bengali, see figure 2) or *Clarias batrachus* (Walking catfish, 'magur' in Bengali, see figure 3) is consumed. Among a large number of catfish species present in Bangladesh, only these two catfish species are used for particularly diarrhea patients, with more importance placed on *Heteropneustes fossilis*. Any reason(s) for this fish selection is unknown but the remedy is highly popular. Partaking of plantain is also very popular and in Bangladesh considered infallible for diarrhea. This review shall examine the ethnomedicinal, phytochemical, and pharmacological aspects of plantain.



Figure 1: *Musa paradisiaca* fruit (plantain).



Figure 2: *Heteropneustes fossilis*.



Figure 3: *Clarias batrachus*.

An overview of plantain

Plantains are fruits of *Musa paradisiaca* L.; the plant belongs to the Musaceae family. It's most common and well-known relative is banana, which are the fruits of *Musa sapientum* and its various cultivars. Plantains are starchier and lower in sugar than bananas and are consumed in the unripe state in the cooked form. Bananas from various cultivars are consumed in the ripe state either directly or added to various dishes like ice cream, puddings, pancakes, muffins, and milkshakes.

Musa paradisiaca can grow up to 3 meters tall. It is cultivated in many tropical and sub-tropical countries like Bangladesh, India, China, Philippines, Brazil, Mexico and Columbia [6]. The principal growing districts in Bangladesh are Barisal, Dinajpur, Faridpur, Khulna, Noakhali, Rangamati and Rangpur [7], see map of Bangladesh (Figure 4) for details. Two types of plantains are grown in India, the horn plantain and the French plantain. In Bangladesh, since plantains are eaten occasionally as vegetable by the general people, plantains are sold in the market as one common variety and any distinctions are not made.



Figure 4: Map showing the various districts of Bangladesh.

Ethnomedicinal uses of plantain in gastrointestinal disorders

In two villages of Khulna district, Bangladesh, two ripe fruits with their skins are boiled in water and mashed or burnt to ashes. The mash or ashes is stirred in a glass of water and the water taken orally 1 - 2 times daily for diarrhea. It is claimed that diarrhea stops within 15 minutes of taking this medication [8]. In combination with seed of *Mangifera indica* L., root of *Musa paradisiaca* is used to control dysentery; along with roots of *Phyllanthus reticulata* Poir., and roots of *Finlaysonia obovata* Wall., the roots are used to treat diarrhea in children in Narsingdi district, Bangladesh [9]. In Tripura State, India, the Halam tribe use extract of the stolon of the plant to treat diarrhea and dysentery [10]. Various ethnic groups use paste of root tuber (to be taken orally) for treatment of dysentery in hilly tract areas of East Godavri district of Andhra Pradesh, India [11]. Fruits are eaten for diarrhea by the Ayta communities in Dinalupihan, Bataan, Philippines [12].

The Tenggerese tribe of Wonokitri Village, Tosari Subdistrict, Pasuruan Regency, Indonesia uses fruits to treat diarrhea [13]. The Ati tribe of Malay, Aklan, Philippines applies leaf on the stomach for stomachache and scrape inner stem and apply on the stomach for diarrhea [14]. Various tribals of Meghalaya in Northeast India orally take plant juice or crushed raw fruit mixed with curd 2 - 3 times daily for treatment of diarrhea and dysentery [15]. In Firozabad district of India, the fruits are taken for dysentery [16]. The Gond tribe of Bhandara District, Maharashtra, India use sap of the leaf, administered orally, to cure diarrhea [17].

Taken together, ethnomedicinal reports indicate that various parts of *Musa paradisiaca* are used in various countries or by various tribal people for treatment of diarrhea and dysentery.

Phytochemicals of *Musa paradisiaca*

Several flavonoids and their derivatives (leucocyanidin, quercetin and its 3-*O*-galactoside, 3-*O*-glucoside, and 3-*O*-rhamnosyl glucoside) were isolated from the unripe pulp of plantain. Acyl steryl glycosides such as sitoindoside-I, sitoindoside-II, sitoindoside-III, sitoindoside-IV and steryl glycosides such as sitosterol gentiobioside, sitosterol *myo*-inosityl- β -D-glucoside have been isolated from fruits of *M. paradisiaca* [18]. Various anthocyanins such as cyanidin-3-rutinoside and 3-rutinoside derivatives of delphinidin, pelargonidin, peonidin, and malvidin have been reported from florets [19].

Various phenolics present in fruits include gallic acid, catechin, epicatechin, ferulic, sinapic, salicylic, *p*-hydroxybenzoic, vanillic, syringic, gentisic and *p*-coumaric acids [20]. Rutin has been found in fruit peels [21].

Pharmacological activities

Anti-diarrheal activity was measured in rats using castor oil-induced diarrheal, castor oil-induced enteropooling, and gastrointestinal motility models with sap obtained from *Musa paradisiaca*. In the castor oil-induced diarrheal model, the sap significantly prolonged the onset time for diarrhea; in the enteropooling model, sap inhibited the increase in intestinal fluid; and in the gastrointestinal motility model, sap decreased charcoal meal transit [22].

Ethanol extract of fruit peels was found to increase stool consistency in castor oil-induced diarrheal rats. The increase in stool consistency was attributed to the high pectin content in fruit peels [23]. Aqueous fraction of ethanol extract of leaves was inhibitory to *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Vibrio cholerae* and *Shigella dysenteriae* [24] suggesting that the leaf extract can be useful against some enteric pathogens. Among other groups of compounds, the leaf extract contained tannins, which has been shown to confer anti-diarrheal properties in plants [25]. Notably, leaves are traditionally used to treat diarrhea in Nigeria [26].

In a number of studies in Bangladesh, Rabbani and others found that partaking of green banana in diet or by itself reduces the persistency of diarrhea, improves small intestinal permeability and reduces fluid loss in children with diarrhea [27-29]. In the first study, boys

(age 5 - 12 months with persistent diarrhea of 14 days) were randomly given a diet based on rice and 250 g/L of cooked green bananas or 4 g/kg pectin or the rice diet alone and beneficial effects observed with the green banana and rice diet [27]. In the second study, boys (age 5 - 12 months with persistent diarrhea of 14 days) received a week's treatment with rice containing cooked green bananas or pectin or rice diet alone and improvement of small bowel mucosal permeability noted [28]. The third study was conducted with 2968 Bangladeshi rural children 6 - 36 months old with diarrhea, and addition of cooked green bananas to diet reduced the time of the diarrheal episode [29]. A caveat of these studies was it was not mentioned whether green bananas meant plantains or not. In a study in Pennsylvania, USA, enterally fed patients with diarrhea were randomized to receive either banana flakes or drugs. Both groups had reductions in the severity of diarrhea; however, banana flake-fed group had lesser diarrhea clinically [30]. However, it was not mentioned in the study whether the banana flakes were made from bananas (fruits of *Musa sapientum*) or plantains (fruits of *Musa paradisiaca*).

Conclusion

Various parts of *Musa paradisiaca* L. are used traditionally for treatment of diarrhea and dysentery. Although the introduction of oral saline has reduced largely the number of fatalities, oral saline is not always available in rural areas of countries like Bangladesh and some productions sold can be of inferior quality. On the other hand, at least in Bangladesh villages *Musa paradisiaca* is a very common plant. Although one plant bear fruits only once every year following maturity and then dies, fruits are borne by other plants throughout most of the year. Since the leaves and sap are also used to treat diarrhea and dysentery in different parts of the world, these parts of the plant are available on a constant basis and can serve as a convenient means to assuage diarrhea and dysentery in both children and adults of Bangladesh.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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