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Plant Review

Phytochemistry and Pharmacological Property of *Musa balbisiana* Colla: A Mini-Review

Ananta Swargiary[1,*], Harmonjit Boro[1], Mritunjoy Kumar Roy[1], Muhammad Akram[2]

ABSTRACT
Plants are known for rich medicinal values because of the presence of several secondary metabolites. *Musa balbisiana* Colla is an important plant native to India and many other Asian countries. Parts of this plant is known to contain rich medicinal and traditional values. The present study attempts to review the phytochemical and pharmacological properties of *M. balbisiana*. Literature survey was carried out using google, google scholar, pubmed, and other reliable resources. Several parts of the plant is known to contain many pharmacological properties such as antidiabetic, antibacterial, anticancer, hepatoprotective properties, etc. Of the several pharmacological properties, antibacterial and antidiabetic property of *M. balbisiana* was abundantly studied while other properties such as anticancer, contraceptive activity were less explored. Phytochemical studies have reported several secondary metabolits from the plant. *M. balbisiana* Colla has numerous phytochemicals and has a substantial pharmacological activity that can help to boost different health issues.
Key words: *Musa balbisiana* Colla, Ethnomedicine, Phytochemicals, Bioactivity, Pharmacological property.

Ananta Swargiary[1,*], Harmonjit Boro[1], Mritunjoy Kumar Roy[1], Muhammad Akram[2]
[1]Pharmacology and Bioinformatics Lab., Department of Zoology, Bodoland University, Kokrajhar, Assam, INDIA.
[2]Department of Eastern Medicine, Government College University, Faisalabad, PAKISTAN.

Correspondence
Dr. Ananta Swargiary
Department of Zoology, Bodoland University, Kokrajhar, Assam, INDIA.
Phone no : +91 8638137477
E-mail: ananbuzoo101@gmail.com

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INTRODUCTION

The natural product plays an important role in the development of drugs and disease treatment. Plants are known for rich medicinal properties and have been used in traditional medicine system since ancient times. In many parts of the world, especially Africa, Asia and parts of America, the use of plant-based medicines is still fairly popular as a source of primary healthcare.[1,2] While in many others, the plant-based ethnomedicine system is integrated into the mainstream healthcare system.[3,4] There are about 3.9 lakh vascular plant species of which about 3.69 species (94%) are flowering plants known to science.[5] However, a very little percentage of plant species (about 28187 species) have been explored for their pharmacological properties.[6] Of the 1562 newly approved drugs from 1981-2014, 396 (about 25%) are directly or indirectly derived from a natural product.[7] Plants are rich in phytochemicals and secondary metabolites for which plants are rich in medicinal properties. Over the last few decades, thousands of phytochemicals such as alkaloids, phenolics, flavonoids, terpenoids, etc., have been isolated and identified from several plants and the mechanisms of action and pharmacological properties have been studied.[8-10]

Musa balbisiana Colla belonging to the family *Musaceae* is a herbaceous plant with rich traditional and medicinal importance. *M. balbisiana* is terrestrial in habitat and occurs in evergreen forests plains and hills of Assam. Geographically, the plant is distributed in Southeast Asian countries including China, India, Indonesia, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, and Thailand.[11] Several parts of the plant are used in the ethnomedicinal systems to cure common diseases.[12,13] The present study reviewed the phytochemistry and pharmacological properties of *M. balbisiana*. Several studies have documented the pharmacological properties of *M. balbisiana* in various sections. However, we found no literature on the plant's corm extract. This research was therefore intended to study *M. balbisiana* Colla phytochemical profile and pharmacological activities.

MATERIALS AND METHODS

A literature survey was carried out using google, google scholar, and PubMed databases. The keywords used were *Musa balbisiana*, phytochemicals, antioxidant, antiproliferative, anticancer, antidiabetic, antibacterial, and pharmacological property.

RESULTS AND DISCUSSION

Traditional knowledge

M. balbisiana Colla belonging to the family *Musaceae* is a wild and cultivated banana plant of Assam, commonly known as '*Bhimkol*' or '*Athiyakol*' in Assamese. Ethnic groups of Assam customarily use parts of the plant as food or in several religious rites. The ash powder and water filtrate of different parts of a plant such as a stem; rhizome, fruit peel, etc. are used to prepare an alkaline solution and use for preparing different dishes. Fruit extract of

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M. balbisiana is traditionally used as a health tonic. Slice of ripe fruit soaked in water and the infusion taken daily for nearly a month gives good health. The ash of ripe fruit and its water filtrate is also consumed to cure a mild cold and cough.[14] Slice of unripe fruit mixed with salt is consumed to cure dysentery and watery defecation. Similarly, the extract of inflorescence stem is consumed in empty stomach to cure stomach ache and helminth infection. Boiled extract of the inflorescence is also consumed for jaundice treatment.[11] Bodo tribe of Kokrajhar district of Assam uses decoction of aerial stem and rhizome of *M. balbisiana* as antidiabetic medicines.[15] Figure 1 showed the various parts of *M. balbisiana* plant and their pharmacological properties.

Phytochemistry

M. balbisiana contains rich phytochemical contents and secondary metabolites. *M. balbisiana* has rich potassium and chloride accumulation which produces high alkalinity in the plant giving potential medicinal uses.[16] *M. balbisiana* Colla produces flavonoids, polyphenols, tannins, monoterpenoids, sesquiterpenoids, quinones, and saponins in different parts of *M. balbisiana*.[17] Figure 2 showed the various phytocompounds reported from different parts of *M. balbisiana*. Tin *et al*.[18] announced three triterpenes extracted from the inflorescence of the plant consisting of 31-norcyclolaudenone, cycloartenol, and (24R)-4a.24-trimethyl-5acholesta-8.25. Carotenoids are a group of compounds with approximately 600 members. Others are precursors to vitamin-A, while some have a good antioxidant potential to scavenge reactive oxygen species. The flesh of *M. balbisiana* fruits contains α-carotene, β-carotene, and β-cryptoxanthin; other carotenoids, such as lycopene and lutein.[19,20] Intake of carotenoid-containing fruit is known to improve immunity and reduces the risk of numerous diseases such as cancer, type-2 diabetes, and cardiovascular problems.[21] *M. balbisiana* seed produces ferulic acid, C16, C18 fatty acid, and polyphenols.[22] Basumatary and Nath[23] reported the calorific value of inflorescence to be 53.048 kcal. GC-MS analysis identified Z-12-pentacosene, stigmasterol, and 10-heneicosene from the inflorescence of *M. balbisiana*.[24] A bioactive compound, apiforol was reported from the acetone extract of seeds.[25] The methanolic root extract of the plant showed the presence of maruchantin-E.[26] The methanolic fruit pulp extract contains chlorogenic acid, (-)-epicatechin, catechol, kaempferol 3-O-sophoroside, quercetin 3-O-[2-O-b-D-glucopyranosyl]-a-L-rhamnopyranoside, rutin, and apigenin-6-C-glucoside-7-O-glucoside.[27] In our recent study, five compounds such as difluoroisocyanatophosphine, 2'-methoxy-2,3',4,4'-tetrabromodiphenyl ether, isophthalic acid, ethyl-6-ethyloct-3-yl-ester, phthalic acid, 2-(4-chlorophenoxy) ethyl hexylester, and pseudodiosgenin diacetate were identified from the methanolic rhizome extract of the plant. Similarly, the elemental analysis revealed a high content of Zn (0.2993 ppm), Ni (0.03 ppm), Cu (0.0124 ppm), and Mn (0.0121 ppm), while the toxic elements, Cd, Pb, and Cr were not detected.[28] In a recent study, rutin was detected as the main flavonoid from the ethanolic extract of banana leaves (*M. balbisiana*).[29] Similarly, HPLC analysis showed that the inflorescence bract extracts of the plant contain a very high amount of cyanidin-3-glucoside and peonidin-3-glucoside.[30] Phenolic and aromatic compounds such as apigenin glycosides, myricetin glycoside, myricetin-3-O-rutinoside, naringenin glycosides, kaempferol-3-O-rutinoside, quercetin-3-O-rutinoside, dopamine, and N-acetylserotonin were identified from the sap of *M. balbisiana* and related species.[31]

Antioxidant

Free radicals are one of the major factors causing several health complications. Phenolics are one of the most common bioactive compounds with antioxidant features and are recognized for their potential health benefits. A variety of banana phenolics were described which include gallic acid, catechin, epicatechin, tannins, and anthocyanin. A banana rhizome is a rich source of phenolic compounds and used as a food for medicinal properties in Southern India.[32] Including the key components like ferulic acid, sinapic acid, salicylic acid, gallic acid, p-hydroxybenzoic, vanillic acid, gentisic acid, and p-coumaric acid, several phenolics in the banana also found.[33] Several parts of *M. balbisiana* have been investigated for antioxidant activity by several researchers. Kalita *et al*.[26] revealed the strongest antioxidant in the aqueous extract of the root (DPPH, IC_{50}, 32.96 µg/ml) compared to shoot and inflorescence. Similarly, the alcoholic extract of inflorescence showed higher phenolic, flavonoid content, as well as antioxidant activity, compared to the aqueous extract. The methanolic extracts of rhizome showed high phenolic and flavonoid content. The extract also showed considerable antioxidant activity.[28]

Anti-bacterial

Parts of *M. balbisiana* has been known to possess promising antibacterial property. Minimum inhibitory concentrations (MICs) are an important antibacterial assay that determines the lowest concentration of an extract

Figure 1: Pharmacological properties of *Musa balbisiana* and its different parts. (a) whole plant, (b) longitudinal section of fruit, (c) cross section of fruit, (d) inflorescence, (e) longitudinal section of inflorescence, (f) flower.

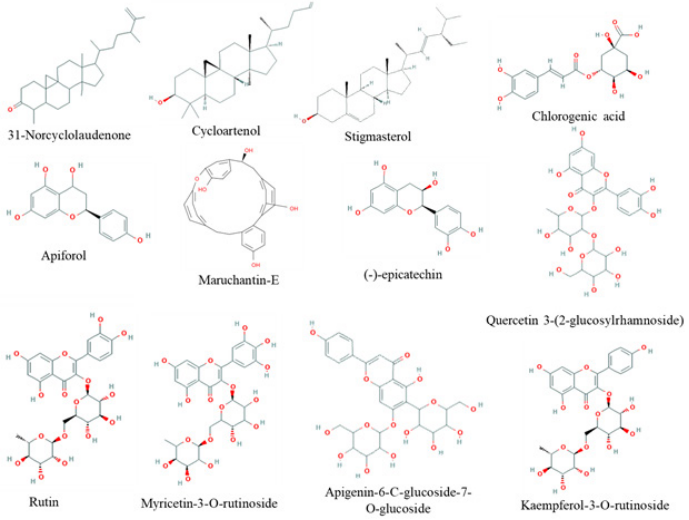

Figure 2: Stuctures of phytochemicals reported from different parts of *Musa balbisiana*.

or compounds that inhibit the visible growth of microorganisms after overnight incubation.[34] Tin *et al*.[18,35] investigated the antibacterial activity of *M. balbisiana* inflorescence against bacterial species *Staphylococcus aureus, Bacillus cereus, Listeria monocytogenes, Vibrio parahaemolyticus, Yersinia enterocolytica,* and *Brohroctrix termosphacta*. MIC values were found to be 6 to 13 mm while high polarity methanol and ethanol extract showed the strongest antibacterial activity compared to other solvent extracts. *In vitro* susceptibility study showed that at 20 to 40% w/v the methanolic extract of *M. balbisiana* fruit extract showed strong antibacterial activity against *Shigella dysenteriae* with a zone of inhibition (ZOI) ranging from 12-14 mm.[17] Emphasize was given by several researchers to study the antibacterial activity of nanoparticles synthesized from several parts of *M. balbisiana*. The nanoparticles synthesized from the leaf extract of *M. balbisiana* showed potential bactericidal activity against *E. coli* and *S. aureus* at 1.0 and 2.0 nM MIC.[36] Similarly, the pseudostem of the plant was found to be an excellent antibacterial agent against *E. coli, S. aureus, B. subtilis*, and *P. aeruginosa*.[37] Bag *et al*.[38] declared the antibacterial activity of nanoparticle synthesized from peel extract of *M. balbisiana* fruit. The unripe fruit peel extract is declared to possess antibacterial activity against *Shigella dysenteriae* acknowledging the anti-dysenteric activity of the plant.[17]

Anti-diabetic

Diabetic control exhibited a significant increase in blood glucose, serum cholesterol, triglycerides, low-density lipoprotein, serum MDA levels and decreased serum CAT, and high-density lipoprotein levels which were significantly reverted by flower and inflorescence stalk ethanolic extracts of *M. balbisiana*.[39] The acetone seed extracts demonstrated a high level of inhibition of α-amylase and α-glucosidase enzymes with IC_{50} values 36.67 and 100.61 µg/ml.[25] The root extract of the plant has been found to promote the glucose uptake in an *in-vivo* experiment conducted by Kalita *et al*.[26] Ara *et al*.[40] found that the hydro-alcoholic extract of *M. balbisiana* flower showed significant recovery in parameters like fasting blood glucose, serum insulin, glycated haemoglobin, antioxidative enzymes in hepatic and renal tissue, and carbohydrate metabolic enzymes in hepatic and skeletomuscular tissue along with proapoptotic gene *Bax* and anti-apoptotic gene *Bcl-2*, glycemic genes like *Hex-I*, and *GLUT-4* in hepatic tissue of streptozotocin-induced diabetic rat. In another study, the basal diet supplemented with dried banana fruit or peels extracts showed a significant decrease ($P<0.05$) in the elevate level of serum glucose, urea, uric acid, creatinine, triglycerides, total cholesterol, low-density lipoprotein, very low-density lipoprotein, aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase levels, and significantly increased ($P<0.05$) the concentrations of high-density lipoprotein and insulin activity as compared to the control diabetic rats indicative hepatoprotective and hypoglycemic effects of the plant.[41] Salsabila *et al*.[42] reported a reduction in blood glucose level in rats after treatment with *M. balbisiana* flour powder. The rhizome extract was found to have strong inhibitory activity against α-amylase and α-glucosidase enzymes, key enzymes related to type-2 diabetes.[9]

Anti-cancer

Parts of *M. balbisiana* have been reported by many studies to possess anticancer and anti-proliferative property. Cytotoxicity study on the inflorescence of *M. balbisiana* on human normal endothelial cells and four cancer cell lines namely, MCF-7 (human breast cancer), HeLa (human cervical carcinoma), HT-29 (human colorectal adenocarcinoma), and HCT 116 (human colorectal carcinoma) showed considerable cytotoxicity of the plant. The IC_{50} ranged from 5.25 to 114.08 µg/ml.[24] The strongest activity was reported in the HT-29 colon cancer cell line. Quantitatively, the effect of *M. balbisiana* peel extract on T-47D cells shows that at concentrations of 1000 and 500 µg/ml, the percentage of viable cells remained at 3.74% and 3.94%.[43]

Anti-ulcer activity

The anti-ulcer potential of unripe fruit extract was evaluated by stress-induced cold water immersion method by Zubair *et al*.[44] *M. balbisiana* extract administered in a dose of 500 mg/kg orally caused a decrease in ulcer index. It showed 73.15% ulcer protection compared to the ulcer control group, which was comparable to the standard drug Omeprazole. So, the aqueous extracts of unripe fruits of *M. balbisiana* were effective in the healing of gastric ulcers induced by cold water immersion method.

Contraceptive activity

Extracts of *M. balbisiana* has been traditionally used to control birth. Ghosh *et al*.[45] prepared a 'Contracept-TM' by mixing aqueous extract of *M. balbisiana* seeds and *Terminalia chebula* fruit which showed potential contraceptive activity in male rats. 'Contracept-TM' resulted in a significant decrease in the count of spermatogonia A (36.36–49.09%), pre-leptotene spermatocyte (19.11–55.30%), mid-pachytene spermatocyte (28.65–47.28%), and step 7 spermatid (29.65–51.59%). Activities of testicular 17β-hydroxysteroid dehydrogenases, catalase, and peroxidase, levels of testosterone, testicular cholesterol, conjugated diene, and thiobarbituric acid reactive substances were elevated compared to the control. The ED50 and LD50 values were 40 mg and 5.8 g (*T. chebula*), 48 mg and 6.3 g (*M. bulbisiana*), 40 mg and 6.0 g ('Contracept-TM'), respectively. Improved thermostability and humidity tolerance of polymeric polymer composite pseudostem banana suggest that *Musa balbisiana* Colla fibres could be used as implementing substances in PVC composites, which will see applications in structural components such as glass profiles, windows, tabletops, dividing walls.

Hepatoprotective activity

Parts of *M. balbisiana* have also been reported to have hepatoprotective activity. Zakaria *et al*.[41] showed that the basal diet supplemented with dried banana fruit or banana peels at the two studied levels (5% and 10%) caused a significant decrease ($P<0.05$) in the elevate level of serum glucose, urea, uric acid, creatinine, triglycerides, total cholesterol, low-density lipoprotein, very low-density lipoprotein, aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase levels, and significantly increased ($P<0.05$) the concentrations of high-density lipoprotein and insulin activity as compared to the control diabetic rats. The present study demonstrates that banana fruit and its peel have hepatoprotective, hypoglycemic effects against diabetic hepatotoxic rats. Similarly, the whole plant extract of *M. balbisiana* var. vittata is reported to possess hepatoprotective activity in CCl_4 induced hepatotoxicity in rats.[46] In another study, Sarma *et al*.[47] studied the white banana stem of *M. balbisiana* obtained after removal of few layers of base of the leaves and were allowed to feed ad-libitum as curative therapy along with Anistamine and Intalyte injections as supportive therapy. The result revealed that all cows responded well to the given treatment regimen showing therapeutic potential as hepatoprotective and strong antioxidant properties.

CONCLUSION

In recent years, medicinal plants have drawn tremendous global interest. *Musa balbisiana* Colla (Bananas) are commonly consumed for medicinal purposes as well as food staples across the world because of their nutritional and rich secondary bioactive metabolites. There has been a lot of interest in the pharmacological and phytochemical studies of bananas since the occurrence of pharmacological activity in *Musa* sp.

In the production of new functional foods, more research is needed to find ways to use *Musa balbisiana*.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

Authors' contributions

AS designed the work and prepared the final manuscript, MKR involved in literature collection, HB was involved in literature collection, MA involved in manuscript drating and final proofreading.

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