TRADITIONAL MEDICINE

Review Article

Review on Phytochemistry, Medicinal Properties, and Toxicities of the Genus *Musa*

***Tesfa Begashaw*[1], *Abebe Dagne*[2], *Desalegn Yibeltal*[2,*]**

[1]Debre Birhan University, College of Medicine and Health Sciences, Ethiopia

[2]Debre Markos University, College of Medicine and Health Sciences, Ethiopia

[*]**Corresponding author:**

Desalegn Yibeltal

Debre Markos University, College of Medicine and Health Sciences, Ethiopia.
Email: desalegy@gmail.com

Received : June 18, 2023
Published : July 22, 2023

ABSTRACT

Herbal medicines are extensively used in developed and developing countries for primary healthcare systems because of their wide biological and medicinal activities, higher safety margins, and lesser costs.

The purpose of this review is to organize information about traditional medicine, morphology, phytochemicals, toxicological, and pharmacological reports of the prominent species of *Musa* (Musaceae) from different studies. This review was done by organizing different information from different articles in the form of PDF that were obtained via PubMed, Sci-Finder, Science Direct, and Google Scholar.

The major finding in this review is that the genus *Musa* is a veritable source for drug bioprospecting that will be of benefit to scientific research and pharmaceutical industries.

The genus comprises seventy-one species in which flavonoids, saponins, cardiac glycoside, phenolic acids, and alkaloids are the major classes of phytoconstituents. Species of this genus have traditional medicinal value; among these *M. sapientum, M. paradisiaca, M. balbisiana, M. troglodytarum, M. acuminata*, and others are extensively used as traditional medicine in tropical and subtropical countries.

Keywords: *Musa*, Ethnopharmacology, Phytochemicals, Pharmacology, Toxicology

INTRODUCTION

Treatment of disease using medicinal plants is as old as mankind itself. In ancient times, humans used medicinal plants simply via decoction, maceration, and infusion. Such a tradition of practice is continued from generation to generation mainly through word of mouth (Petrovska, 2012) [1].

Recently, WHO proposed that 80% of the population around

DOI : https://doi.org/10.35702/Trad.10017

the world depends on traditional medicine systems either partially or totally for their primary healthcare needs. This form of treatment is called ethnomedicine (M. Fawzi Mahomoodally, 2013) [2].

Currently, there is a consensus about the use of medicinal plants and traditional health care systems in solving the health care problems, efficacy and safety of medicinal plants in curing various diseases. This is Because of growing use of traditional medicine (Mohammed Kemal Hossain, 2011) [3].

In the future medicinal plants are a hope for human beings in the drug development process, health promotion, and treatment of diseases, because there are a lot of plants around the world that are not well investigated. Use of traditional remedies increases when conventional medicine is ineffective in treatment of disease such as advanced cancer and infectious disease (Mani, 2017) [4].

Based on the International Union for Conservation of Nature, there are 50,000-80,000 plant species used for medicinal purposes around the world. Medicinal plants are used in herbal remedies, but they rapidly disappear at high speed (Chen et al., 2016) [5].

Among those species, 71 belong to the genus *Musa*, which has various health benefits (Hastuti et al., 2019) [6]. Among the species of *Musa*, *M. sapientum* (Muz in Amharic) is found in Ethiopia which is used as abortion medicine. *M. paradisiaca* (Musi in Oromiffa) is also another species found in Ethiopia, which is highly used as traditional medicine (Admasu Moges & Yohannes Moges, 2020) [7].

A brief review of 80 articles that were written in English through electronic databases like PubMed, Sci-Finder, Science Direct, and Google Scholar was conducted. We use articles for this review that were PDF and with authors, unless and otherwise we didn't not include. Chemdraw software was used to draw the structure of compounds. This review includes the common species' ethnopharmacological, phytochemistry, medicinal properties, and toxicities of species from the genus *Musa*.

THE GENUS *MUSA*

It is the genus of flowering plants grouped under the family Musaceae, which is an angiosperm. It is also one of the most important crops in several countries as a source of enriched food, being responsible for up to 15% of total fresh fruit production and the fourth most relevant crop worldwide after rice, wheat, and maize (Sharrock, 1998) [8].

It has four major groups, which include both seeded and non-seeded types. Two of groups (*Callimusa* and *Australimusa*) contain species with a chromosome number of 2n=20 and they are nonseeded, but the remaining two groups (*Eumusa* and *Rhodochlamys*) contain species with a basic chromosome number of 2n=22 and they are seeded (Daniells etal., 2001) [9].

GEOGRAPHICAL DISTRIBUTION OF THE GENUS *MUSA*

The genus Musa is distributed in the humid tropics and subtropics countries. Of these America, Africa, Asia, Europe, and Australia (Vilhena *et al.*, 2019) [10].

In the tropics, it is distributed from 175° East to 1500 West longitude. Also from 300 North to 230 South latitude (Nayar, 2010) [11].

It is also distributed in some tropical rainforests, wet evergreen forests. Also in the deciduous forests of low rainfall in India (Subbaraya, 2006) [12].

Musa is also distributed in Uganda, Rwanda, Burundi, and Tanzania. In these countries it is distributed at altitudes of 1066-1111m (M.Kmira *et al.*, 2016) [13] (Table 1 Figure 1).

Table 1: Geographical distribution of the common *Musa* species.

Species name	Geographical distribution	Reference
M. sapientum	North America, Southeast Asia, India, Mediterranean, Tropical Africa, Subtropical Africa	(Dixit *et al*., 2014) [14]
M. paradisiaca	India, Burma, Tropical Africa, Egypt, Southern Japan, South Brazil	(Galani, 2019) [15]
M. borneensis	Indonesia	(Sunandar & Kurniawan, 2020) [16]
M. balbisiana	India, Tropical Africa, Southeast Asia, Australia	(Pollefeys *et al*., 2004) [17]
M. acuminata	Indonesia, Sulawesi	(Hastuti *et al*., 2019) [6]
M. ornata	Southeast Asia, Bangladesh, Burma, India	(Häkkinen & Sharrock, 2002) [18]
M. schizocarpa	Indonesia, Papua New Guinea	(Lentfer, 2009) [19]
M. textilis	Southeast Asia, Pacific Islands	(Hapsari, 2014) [20]
M. dasycarpa	India, Myanmar	(Häkkinen & Väre, 2008) [21]

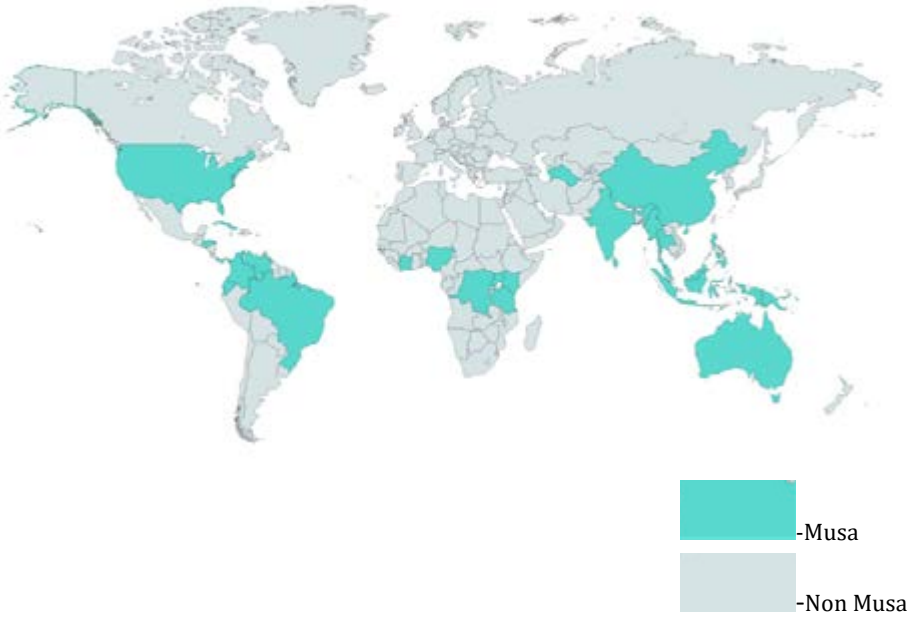


Figure 1: Geographical distribution of the genus *Musa* (Kennedy, 2009) [22].

BOTANICAL DESCRIPTION OF THE GENUS *MUSA*

In the natural habitat, the genus *Musa* has 25-30 suckers in vertical position.

A mature pseudostem of genus *Musa* has a height of 1.1 m with a diameter of 5 cm at the base which makes it swollen. Also, it has a petiole of 25 cm long Häkkinen & Vare, 2008) [23].

The bract and flowers of *Musa* are inserted independently on the peduncle. Also, it has flowers attached to the axial of the bracts, and the basal flowers are either female or male (found at distal hands) (Sulistyaningsih, 2016) [24] (Figure 2).

A B C

Figure 2: Picture showing *M. sapientum* at fruit stage(A), picture showing *M. paradisiaca* at fruit and flowering stage (B), and picture showing *M. troglodytarum* at flowering stage (C) (Nelson et al., 2006) [25].

ETHNO-PHARMACOLOGICAL USE OF THE GENUS *MUSA*

In both tropical and subtropical countries, the flower of genus *Musa* is traditionally used to treat ulcers, dysentery, and bronchitis.

Also cooked flowers are good food for diabetic patients (Ajijolakewu et al., 2021) [26].

In subtropical countries the methanolic, and acetone extractions of the fruits of the genus *Musa* is traditionally used for diarrhea, dysentery, intestinal lesions in ulcerative colitis, diabetes, uremia, nephritis, gout, hypertension, cardiac disease, and excess menstruation disorder. Also the leaf extracts used in eczema as a cool dressing for blisters and burns (Imam & Akter, 2011) [27].

In Ethiopia, the oozing fluid from the stem of *M. paradisiaca* is important for wound healing. It is also important for coagulation and secondary infection (Tuasha et al., 2018) [28].

In Ethiopia, *M. paradisiaca* is important for the management of diarrhea as traditional medicine. It is Also used for ulcers and bronchitis (Kidane et al., 2014) [29].

In Ethiopia, *Musa sapientum* (Muz in Amharic) is traditionally used for abortion. It is also used for blisters and ulcers (Admasu & Yohannes, 2020) [7].

In Asia, the root extract of the genus *Musa* is used as traditional medicine for the management of inflammatory. Also the leaf extracts of the genus *Musa* is used for helminthic complications (Oguntibeju, 2019) [30].

The root extracts of the genus *Musa*, specifically *M. balbisiana* traditionally used as antilipidemic agents. The root, and shoot extract of *M. balbisiana* is also traditionally used for diabetic (Kalita et al., 2016) [31].

The fruit extracts of the genus *Musa* are traditionally used for laxative purposes, constipation in children, and the extracts of the core of the stem are also important for dissolving the stones in the kidney as well as in the urinary bladder. In addition to this, the mixture of the fruit extracts of *Musa* with coconut oil is used for flushing urinary blocks (Bandaranayake, 1998) [32].

In Korea, the air-dried powdered aqueous extracts of the leaves and rhizomes of the genus *Musa* are traditionally used as anti-TB. It is also used against MDR-TB (Molina-Salinas et al., 2019) [33].

In the Philippines, the extracts of leaves of *Musa* basjoo which have natural fibers are traditionally used to decrease their weight. It also has mild laxative properties (Lacuna-Richman, 2002) [34].

The aqueous extract of the fruit of *M. paradisiaca* is used for hair growth-promoting activity. It is also used for epilepsy, leprosy, hemorrhages, renal calculi, hysteria, and analgesic (Mahadeva Rao et al., 2014) (Table 2) [35].

Table 2: Phytochemicals of the genus *Musa* with their ethnopharmacological use.

Phytochemicals	Ethno pharmacological use
Tannic acid	Used for the treatment of burns
Catechin	Enables LDL to oxidation
Gallic acid	Antioxidant and hepatoprotective
Cinnamic acid	As sweetener
coumaric acid	Antioxidant and reduce the risk of stomach ache
Quercetin	Promote cardiovascular health by encouraging blood flow
Ferulic acid	Antioxidant, antimicrobial, anti-inflammatory, antiallergic, and anticancer
Carotene	Reduce the risk of CVD and cancer
Violaxanthin	Used as a food colorant
Cryptoxanthin	Reduce the risk of lung cancer
Serotonin	Increase wellbeing and happiness
Catecholamines	Used to increase blood pressure, glucose level, heartbeat rate
Sitosterol	Used in the management of benign prostate hyperplasia
Campesterol and stigmasterol	Used for the reduction of cholesterol absorption

DOI : https://doi.org/10.35702/Trad.10017

PHYTOCHEMICAL COMPOSITION OF THE GENUS *MUSA*

The most common phytochemically investigated *Musa* species are *M. sapientum*, *M. paradisiaca*, *M. assamica*, *M. aurantiaca*, *M. acuminate*, *M. balbisiana*, *M. basjoo, M. textilis, M. troglodytarum, M. brachycarba, M. cavendishii, M. cavandanaish* and *M. saba.* Major Phytochemicals are alkaloids, saponins, cardiacglycosides, flavonoid, and quercetin 3-O rhamnosyl galactosides (20) are majorly investigated (Obiageli et al., 2016) [36].

Other common phytochemically investigated chemicals from the genus *Musa* is anthocyanins, lutein, α-, β- carotenes, neoxanthin, cryptoxanthin, coumarin, β-sitosterol. Also terpenes are other common phytochemicals that are investigated from the genus *Musa* (Oyeyinka & Afolayan, 2020) [37].

In addition to the above major phytochemicals, *M. sapientum* contains carbohydrates, norepinephrine, serotonin, and dopamine, tryptophan, indole compound, and pectin. *M. paradisiaca* contains serotonin, norepinephrine, tryptophan, indole compounds, starch, iron, vitamin C, vitamin B, albuminoids, fats, and mineral salts (Imam & Akter, 2011) [27].

The percentage content for tannin or flavan-3-ol (9.13%), alkaloid (8.16%), flavonoids other than tannin (4.02%), saponin (3.5%), cardiac glycoside (1.6%), oxalate (0.162%). Also hemagglutinin (1.8814 mg/kg), phytate (1.2967 mg/kg), phenols (5.5743 mg/kg) (Onyema et al., 2016) [38].

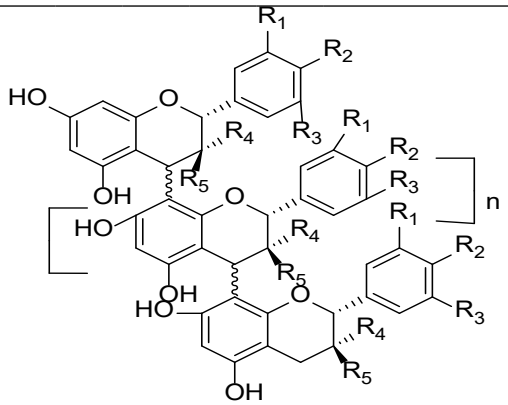
FLAVONOIDS

Flavonoids are active secondary metabolites that enable the genus *Musa* to have antioxidative, antidiabetic, and Anti-Alzheimer. Also it enables the genus *Musa* to have anti-inflammatory activities (Oresanya et al., 2020) [39].

Flavonols (Quercetin 3-O rhamnosyl galactoside (20)), anthocyanidins (cyanidin 3-O glucoside (21), delphinidin (14), peonidin (16), malvidin (17), pelargonidin (15)), flavones heveaflavone (5), Amentoflavone-7, 4-dimethyl Ether (6), Podocarpus flavone (7), flavanols ((+)-catechin (1), (-)-epicatechin (2), (+)-gallocatechin (3), (-)-epigallocatechin (4), isoflavones (daidzein (22), flavanones (naringenin (19)). Also chalcones (18) are the major flavonoids extracted from the aerial parts of the genus *Musa* (Dong et al., 2016) [40].

Flavonoids can be extracted from the aerial parts of the genus *Musa*. These can be performed via the decoction method using distilled water, then allow the decoction product to be filtered and stored at 4°c (Lino et al., 2011) (Table 3) [41].

Table 3: Favonoids isolated from the species of genus *Musa* (Lino et al., 2011) [41].

No.	Name of the compound							Species	Plant parts
		R_1	R_2	R_3	R_4	R_5	Class of compound		
1	Catechin	OH	OH	H	H	OH	Condensed tannin	*M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts

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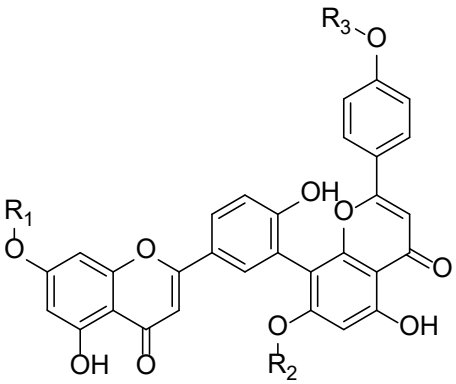
2	Epicatechin	OH	OH	H	OH	H	Condensed tannin	*M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminat* *M.troglodytarum*	Aerial parts
3	Gallocatechin	OH	OH	OH	H	OH	Condensed tannin	*M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.droglodytarum*	Aerial parts
4	Epigallocatechin	OH	OH	OH	OH	H	Condensed tannin	*M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts

No.	Name of the compound					Species	Plant parts
		R_1	R_2	R_3	Class of compound		
5	Heveaflavone	CH_3	CH_3	CH_3	Flavone	*M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts

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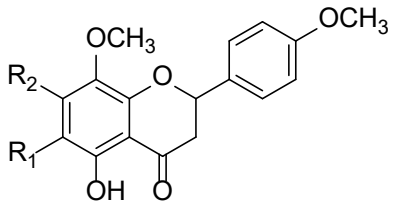
6	Amentoflavone -7,4-dimethyl Ether	H	CH_3	CH_3	Flavone	*M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts
7	Podocarpus flavone	H	H H	CH_3	Flavone	*M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts

No.	Name of the compound				Species	Plant parts
		R_1	R_2	Class of compound		
8	5,7-dihydroxy-4,6,8-trimetoxyflavone	OMe	OH	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts
9	5,6-dimethoxy 4,7,8-trimetoxyflavone	OH	OMe	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts

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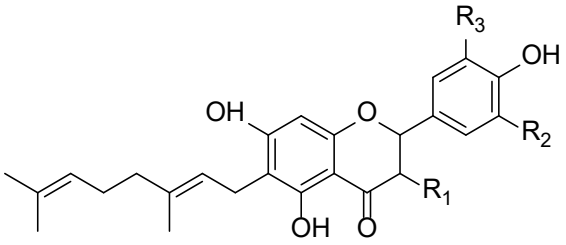
No.	Name of the compound					Species	Plant parts
		R_1	R_2	R_3	Class of compound		
10	3-o methyl-5-hydroxy Diplacone	H	OMe	OH	Flavanone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts
11	3-O-methyl-5-O-methyl diplacone	H	OMe	OMe	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts
12	Mimulone	H	H	H	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts
13	Diplacone	H	OH	H	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts

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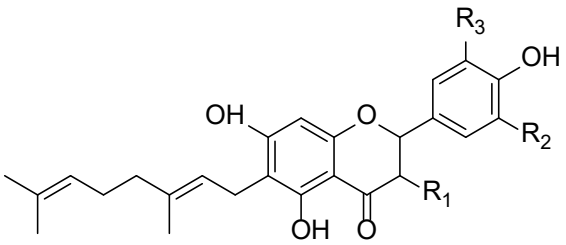
No.	Name of the compound					Species	Plant parts
		R_1	R_2	R_3	Class of compound		
10	3-o methyl-5-hydroxy Diplacone	H	OMe	OH	Flavanone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts
11	3-O-methyl-5-O-methyl diplacone	H	OMe	OMe	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts
12	Mimulone	H	H	H	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts
13	Diplacone	H	OH	H	Flavone	*M.paradisiaca* *M.sapientum* *M.acuminata* *M.balbisiana* *M.troglodytarum*	Aerial parts

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Chalcones (18), naringenin (19), quercetin 3-O-rhamnosyl galactoside (20), cyanidin-3-O glucoside chloride (21), daidzein (22), and petunidin (23) (Figure 3).

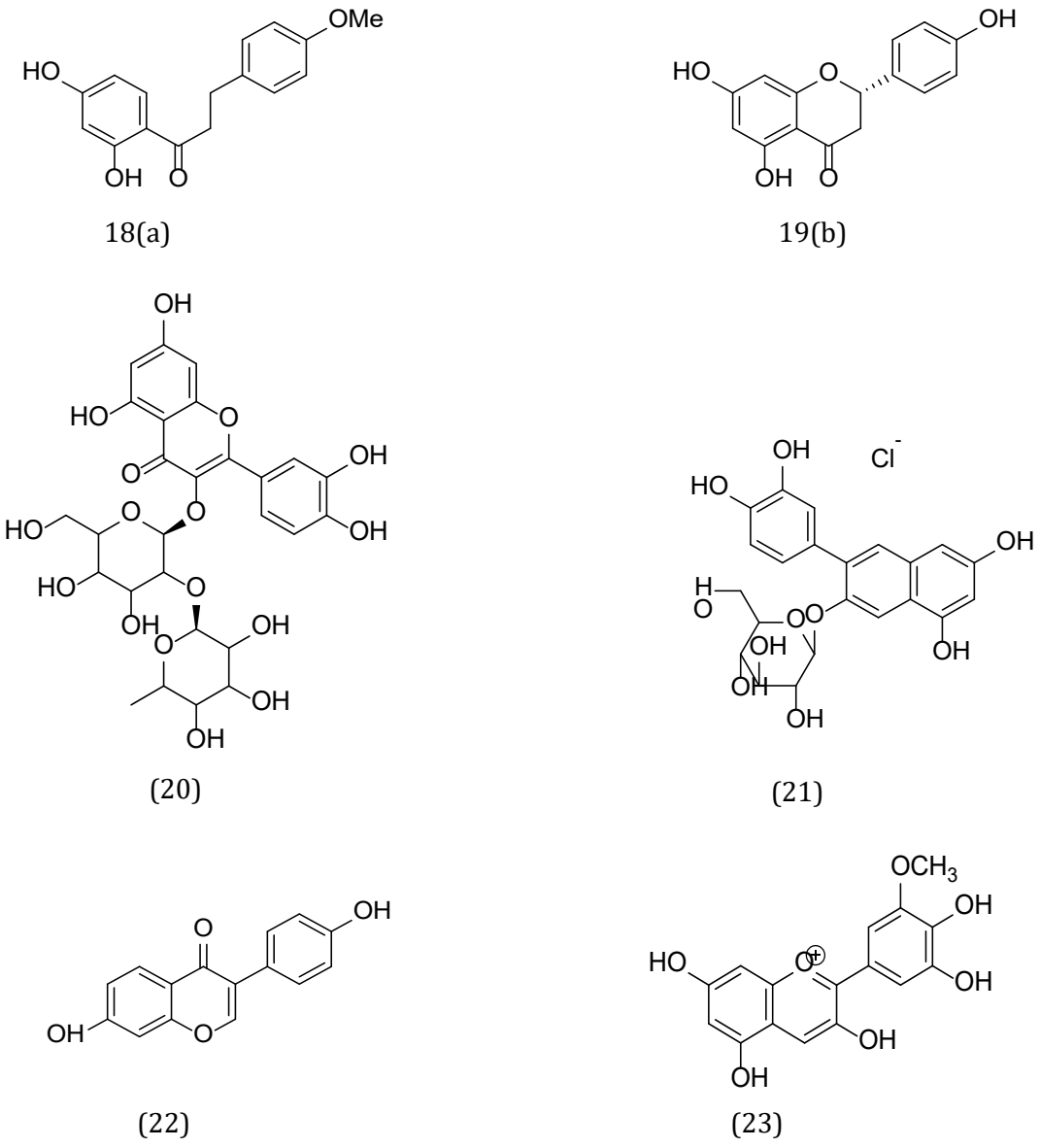

Figure 3: Structural formula of flavonoids isolated from the species of genus *Musa*.

SAPONINS

Saponins are secondary metabolites that enable the genus *Musa* to have antiulcer activity, wound healing activity, antidiabetic activity, an antidote for Crotalidae venoms, antilithiatic activity. Also it enables the genus *Musa* to have skeletal muscle contraction activities (Jayakumari et al., 2018) [42].

Saponins are extracted from the aerial parts of the genus *Musa*. These can be performed via maceration using 70% ethanol solvent Steroid and triterpenoid saponins are the major classes of saponins found in the genus *Musa* (Nofianti et al., 2021) [43] (Table 4).

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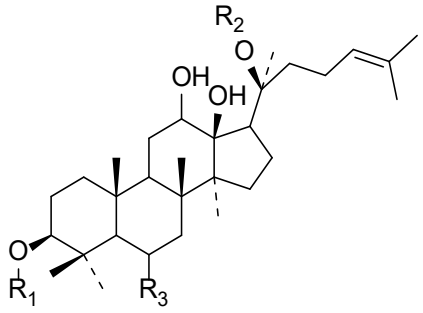
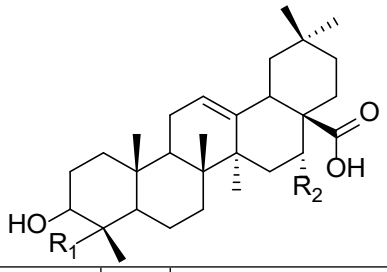
Table 4: Saponins isolated from the species of genus *Musa* (Nofianti et al., 2021) [43].

No.	Name of the compound					Species	Plant parts
		R_1	R_2	R_3	Class of compound		
24	Protopanaxadiol	Sugar	Sugar	H	Steroidal saponin	*M.acuminata* *M.paradisiaca* *M.balbisiana* *M.saba* *M.sapientum*	Aerial parts
25	Protopanaxatriol	H	Sugar	O-sugar	Steroidal saponin	*M.acuminata* *M.paradisiaca* *M.balbisiana* *M.saba* *M.sapientum*	Aerial parts

No.	Name of the compound				Species	Plant parts
		R_1	R_2	Class of compound		
26	Gypsogenin	CHO	H	Triterpenoid saponin	*M.acuminata* *M.paradisiaca* *M.balbisiana* *M.saba* *M.sapientum*	Aerial parts
27	Gypsogenic acid	COOH	H	Triterpenoid saponin	*M.acuminata* *M.paradisiaca* *M.balbisiana* *M.saba* *M.sapientum*	Aerial parts

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28	Quillaic acid	CHO	OH	Triterpenoid saponin	*M.acuminata* *M.paradisiaca* *M.balbisiana* *M.saba* *M.sapientum*	Aerial parts
29	Hederagenin	CH_2OH	H	Triterpenoid saponin	*M.acuminata* *M.paradisiaca* *M.balbisiana* *M.saba* *M.sapientum*	Aerial parts

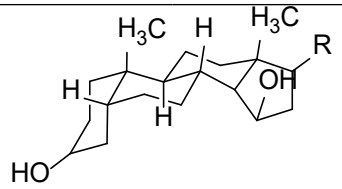
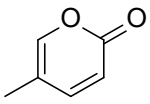
CARDIAC GLYCOSIDES

Cardiac glycosides are secondary metabolites that enable the genus *Musa* majorly to treat congestive heart failure. It is also enables the genus *Musa* to treat cardiac arrhythmias. (Nascimento, 2019) [44].

Cardiac glycosides are isolated by soaking the air-dried powdered material of the genus *Musa*. These can be performed by using 70% alcohol for 2 hours and then filtered. Then lead acetate is added to the filtrate to precipitate out resin, tannin, and pigments, and then add distilled water and then filter. And many other further purification processes take place.

Major cardiac glycosides found in the genus *Musa* are cardenolide (30), bufadienolide (31), isocardenolide (32), digitoxigenin (33), digoxigenin (34), gitoxigenin (35), strophanthidin (36). Also ouabagenin (37) (Sahaa et al., 2013) (Table 5) [45].

Table 5: Cardiac glycosides isolated from the species of genus *Musa* (Sahaa et al., 2013) [45].

No.	Name of the compound			Species	Plant parts
		R	class of compound		
30	Cardenolide		Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts
31	bufadienolide		Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts

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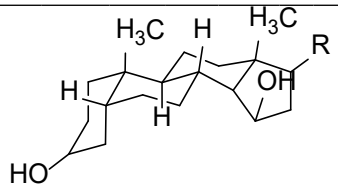
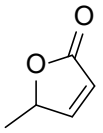
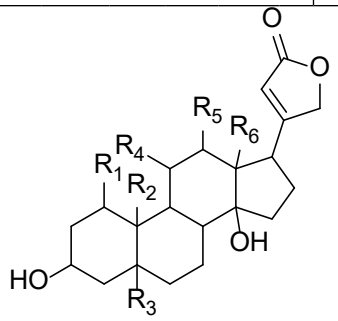
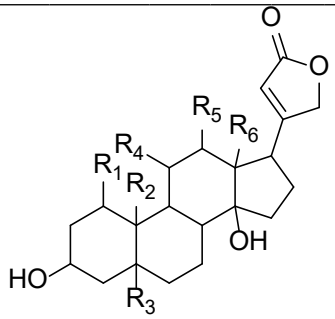
No.	Name of the compound			species	Plant parts
		R	Class of compound		
32	Isocardenolide		Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts



		R_1	R_2	R_3	R_4	R_5	R_6	Class of compound		
33	Digitoxigenin	H	CH_3	H	H	H	CH_3	Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts
34	Digoxigenin	H	CH_3	H	H	OH	CH_3	Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts

No.	Name of the compound								Species	Plant parts
		R_1	R_2	R_3	R_4	R_5	R_6	Class of compound		

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35	Gitoxigenin	H	CH_3	H	H	H	CH_3	Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts
36	Strophanthidin	H	CHO	OH	H	H	CH_3	Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts
37	Ouabagenin	OH	CH_2OH	OH	OH	H	CH_3	Cardiac glycoside	*M.cavendishii* *M.paradisiaca* *M.sapientum* *M.balbisiana* *M.acuminata* *M.troglodytarum*	Aerial parts

ALKALOIDS

Alkaloids are active secondary metabolites that enable the genus, *Musa*, to have antibacterial, antispasmodic, stimulant, anesthetic, anticancer, and analgesic effects. Many alkaloids in the genus *Musa* are extracted from leaves and constituents for most drugs (Dele et al., 2019) [46].

Alkaloids can be extracted by soaking the dried powdered leaves or flowers of the genus *Musa*. These can be performed by using ethanol or methanol for 48 hours with continuous shaking and can be purified with acid-base extraction methods (Asuquo & Udobi, 2016) [47].

Indole alkaloids are the major alkaloids with therapeutic importance in the genus *Musa*. These include Tryptamine (38), Serotonin (39), Physostigmine (40), β-carboline (41), Harmine (42), Canthinone (43), Ajmalicine (44), Catarantine (45), Tabersonine (46), Voacamine (47), and Villalstonine (48) (Hamid et al., 2017) (Figures 4, 5) [48].

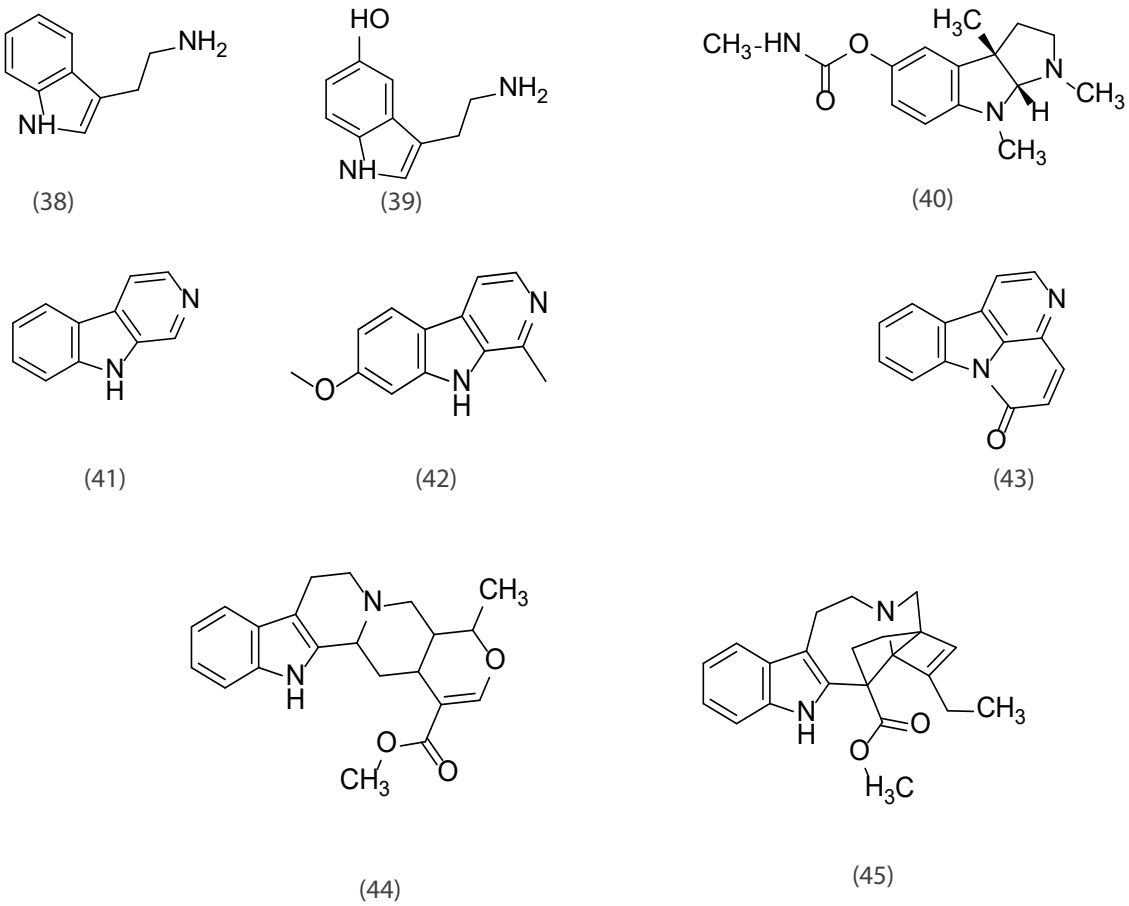

Figure 4: Structural formula of Alkaloids isolated from the species of genus *Musa*.

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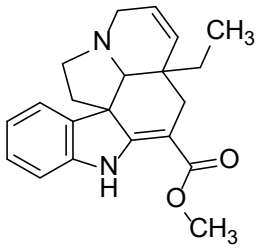
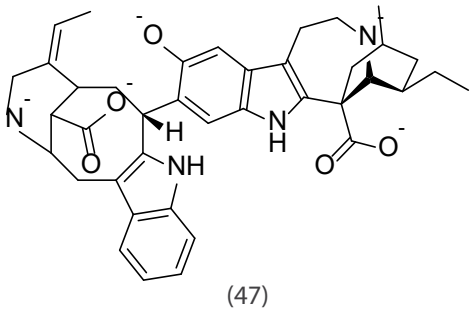
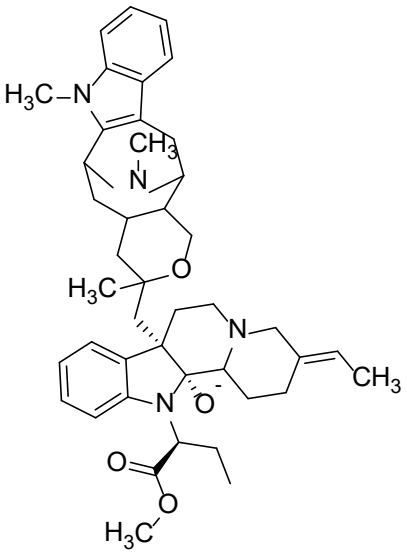


(46)



(47)



(48)

Figure 5: Structural formula of alkaloids isolated from the species of genus *Musa*.

PHENOLIC ACIDS

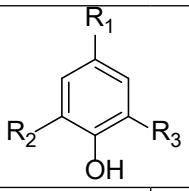
Phenolics are active secondary metabolites that enable the genus *Musa* is majorly to have antifungal, antioxidant. Also enables the genus *Musa* to have antibacterial activities (Peel et al., 2019) [49].

Hydroxybenzoic acid derivatives (gallic acid (49), vanillic acid (52), syringic acid (53), hydroxycinnamic acid derivatives (p-coumaricacid (51), caffeic acid (50), are the major phenolic acids extracted from the genus *Musa* (Oyeyinka & Afolayan, 2020) [37].

Phenolics can be extracted by soaking fresh or dried material of the genus *Musa*. These can be performed by using the solvent hexane, chloroform, and 80% methanol (v/v) (K.Phillips et al., 2011) [50] (Table 6).

DOI : https://doi.org/10.35702/Trad.10017

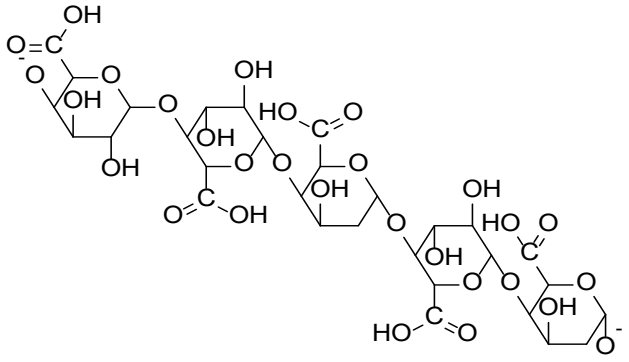
Table 6: phenolic acids isolated from the species of genus *Musa* (K.Phillips et al., 2011) [50].

No.	Name of the compound					Species	Plant parts
		R_1	R_2	R_3	Class of compound		
49	Gallic acid	CO_2H	OH	OH	Phenolic acids	*M.sapientum* *M.paradisiaca* *M.acuminata* *M.troglodytarum* *M.balbisiana*	Aerial parts
50	Caffeic acid	$CH=CH-CO_2H$	OH	H	Phenolic acids	*M.sapientum* *M.paradisiaca* *M.acuminata* *M.troglodytarum* *M.balbisiana*	Aerial parts
51	P-coumaric acid	$CH=CH-CO_2H$	H	H	Phenolic acids	*M.sapientum* *M.paradisiaca* *M.acuminata* *M.troglodytarum* *M.balbisiana*	Aerial parts
52	Vanillic acid	CO_2H	H	OCH_3	Phenolic acid	*M.sapientum* *M.paradisiaca* *M.acuminata* *M.troglodytarum* *M.balbisiana*	Aerial parts
53	Syringic acid	CO_2H	OCH_3	OCH_3	Phenolic acid	*M.sapientum* *M.paradisiaca* *M.acuminata* *M.troglodytarum* *M.balbisiana*	Aerial part

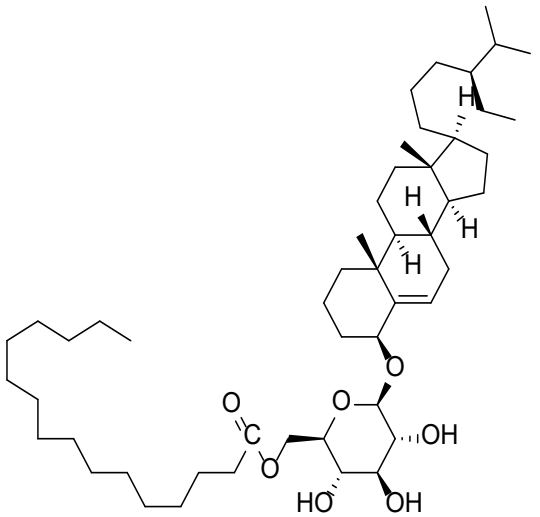
DOI : https://doi.org/10.35702/Trad.10017

MISCELLANEOUS COMPOUNDS ISOLATED FROM THE GENUS *MUSA*

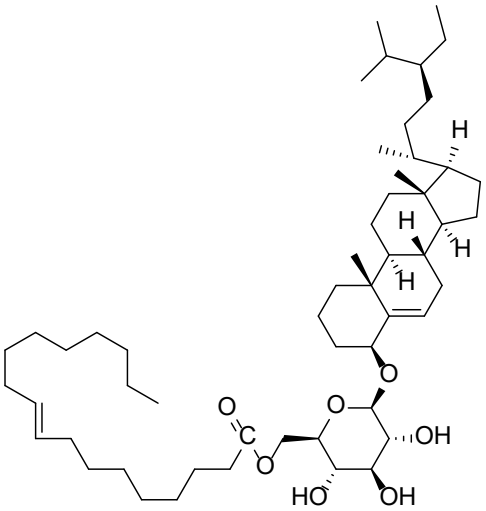
Norepinephrine (54), dopamine (55), L-tryptophan (56), pectin (57), acyl steryl glycosides (58), triterpenes (59), arginine (60), aspartic acid (61). And also glutamic acid (62), leucine (63) (Md.Saidul Islam, 2013) [51] (Figures 6,7).



(57)



(58 a)



(58 b)

Figure 6: Structural formula of miscellaneous compounds isolated from the species of genus *Musa*.

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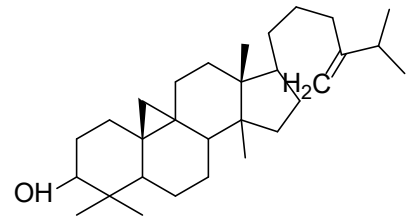
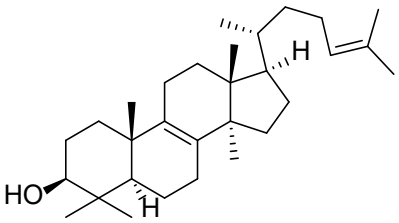
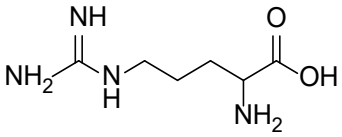


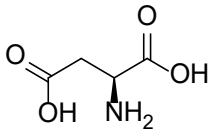
(59 a)



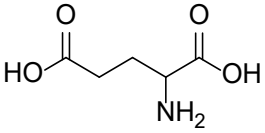
(59 b)



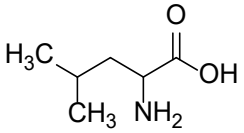
(60)



(61)



(62)



(63)

Figure 7: Structural formula of miscellaneous compounds isolated from the species of genus *Musa*.

PHARMACOLOGICAL REPORTS FROM THE GENUS *MUSA* SPECIES

Pharmacological studies have been reported from different *Musa* species which are important as medicinal plants. According to my literature search from 71 *Musa* species, pharmacological reports are mostly available for *M. sapientum*, *M. paradisiaca*, M. acuminata, *M. troglodytarum*, M. cavendishii, M. saba and *M. balbisiana*, *M. basjoo, M. ornata, M. schizocarpa, M. textilis, and M. dasycarpa*. Pharmacological activities such as anticancer, antihypertensive, antimicrobial, antidiabetic, antiulcer, diuretic, and other below-mentioned activities are reported from this genus.

ANTICANCER ACTIVITY

Based on *in vitro* studies of the aqueous methanol extracts, ethanol extracts, and hexane extracts of *M. sapientum*, *M. paradisiaca*, M. cavendishii, M. acuminata, and *M. balbisiana* peel, fruit, leaf, and stem show significant anti-tumor activity. It is against MCF-7 breast cancer, cervical cancer, colon cancer, liver cancer, oral cancer, prostate cancer, and skin cancer via concentration-dependent apoptosis (Mondal et al., 2021) [52].

In vivo anticancer activity of methanolic and ethanolic extracts of the flower f rom M. a cuminata w as i nvestigated i n male rats. It is performed with minimum and maximum inhibitory concentrations of 200 mg/kg and 500 mg/kg respectively (Liu et al., 2018) [53].

ANTIHYPERTENSIVE ACTIVITY

A study was done on 20 respondents with stage 1 and stage 2 hypertension who are characterized by gender, age, and working area in Karanganyar, after an intervention with potassium-rich *Musa* species (*M. paradisiaca*. *M. acuminata* and *M. cavendishii*) results in inhibition of the renin-angiotensin system also decreases aldosterone secretion, then reabsorption of sodium and water in the kidney tubules are decreased. After that diuresis is increased and blood pressure is decreased. According to this study recommended potassium intake is 351 mg/day which can be fulfilled by the above species of genus *Musa* (435 mg/day) (Susanti et al., 2019) [54].

ANTIMICROBIAL ACTIVITY

An acetone extracts of the leaves of M. cavendishii (IC50=53 microgram/ML), M. acuminata (IC50=61 microgram/ML) and M. saba (IC50=99 microgram/ML) show strong inhibitory activity against gram-positive bacteria (Bacillus cereus, Micrococcus luteus, Staphylococcus aureus, Streptococcus faecalis). Also against gram-negative bacteria (Aeromonashydrophila, Escherichia coli, Salmonella enterica, Shigellasonnei). Also, two ethanol extracts of leaves of (M. cavendishii and M. acuminata) show strong inhibitory activity against B. cereus (Jouneghani et al., 2020) [55].

ANTIDIABETIC ACTIVITY

Ethanolic extracts of *M. paradisiaca*, *M. sapientum*, M. acuminata, and *M. balbisiana* leaves, and peel show lowering of blood glucose level at 500 mg/kg body weight in diabetic-induced rats. This study also shows an increase in protein and albumin with decreased serum urea and creatinine levels which plays a role in the management of renal dysfunction in diabetic causes (Edition SC, 2019) [56].

ANTIULCER ACTIVITY

In vivo antiulcer activity of aqueous and ethanolic extracts of peels of *M. paradisiaca* was studied in Wistar albino rats using ethanol, aspirin, indomethacin, and pyloric ligation-induced ulcer. The fresh peels of *M. paradisiaca* were extracted using hot water and then lyophilized. Standard drugs, distilled water, and extracts were injected intraperitoneally before inducing ulcers. Lethality tests and quantitative phytochemical analysis were carried out using standard methods. Results showed that the extract at 50, 100, and 200 mg/kg has 73.87, 80.18, and 81.98% protection respectively against ethanol-induced ulcers, but cimetidine (50 mg/kg) has 72.07% ulcer protection benefits. Also, the extract inhibits aspirin-induced ulcers. Similar to cimetidine, the extract does not inhibit indomethacin-induced ulceration. But the extracts at 50, 100, and 200 mg/kg and cimetidine at 50 mg/kg inhibit pyloric ligation-induced ulcers by 100 and 75% respectively. This study suggests the antiulcerogenic ability of the extract supports ethnomedicinal use as an antiulcer. Up to 5000 mg/kg of the extract does not cause mortality of animals; this indicates the safety of the extract. The extract was rich in flavonoids (1.40 ± 0.02 mg/100 g) (Chinwe N et al., 2014) [57].

DIURETIC ACTIVITY

In vivo diuretic activity of the aqueous extracts of the leaves from *M. sapientum*, *M. paradisiaca* and M. acuminate show an increase in urine volume and K+ as well as other electrolytes excretion than normal saline in a study in rats. Continuous ethanolic extracts of *M. sapientum* also give this diuretic effect. Phytoconstituents like saponin, flavonoids, and terpenoids are responsible for this effect (Imam & Akter, 2011) [27].

ANALGESIC ACTIVITY

In vivo analgesic activity of the aqueous and ethanolic leaf extracts from *M. sapientum* and *M. paradisiaca* (both extracts at 400 mg/kg i.p.) significantly increases reaction time in the hot plate method in comparison to the vehicle-treated group. The maximum analgesic effect of *M. sapientum* extracts was observed at 2 hours (Barua & Das, 2013) [58].

ANTI-ALLERGIC ACTIVITY

The pseudo-stem powder of *M. paradisiaca* was suspended with acacia 10 mg/ML for experiments. Acute oral toxicities were seen in both sex rats. Female mice were sensitized against ovalbumin. Single-dose powder (60 mg/kg b.w.) or ketotifen preparation (3 mg/kg b.w.) were administered 1 hour before the induction system anaphylaxis by I.V. injection of ovalbumin. Overall the test product, (0, 6; 2; 6 and 20 mg/kg b.w. x per day) was given to mice during the immunization period, then followed by the induction of systemic anaphylaxis or the measurement of passive cutaneous anaphylaxis titers of mice antisera in rats. There were neither deaths nor any sign of toxicity among the rats treated with powder of *M. paradisiaca*. Unlike ketotifen preparation, a single oral dose of this product was unable to inhibit systemic anaphylaxis in mice. However, a daily oral treatment produced a significant reduction of active and passive anaphylaxis. This study suggests that a pseudo-stem powder of *M. paradisiaca* has an antiallergic ability (Garcia Mesa et al., 2019) [59].

HYPOLIPIDEMIC ACTIVITY

In vivo hypolipidemic activity of aqueous extracts of leaf from *M. sapientum* and *M. paradisiaca* were studied on hyperlipidemic-induced Wistar rats in Nigeria. Results showed that *M. sapientum* extract (100 mg/kg b.w.) has a lipid-lowering effect and reduce other cardiovascular complication similar to the standard drug atorvastatin (70 mg/kg b.w.) (C. Edenta et al., 2014) [60].

ANTILITHIATIC ACTIVITY

In vivo antilithiatic activity of methanolic extracts of powder

DOI : https://doi.org/10.35702/Trad.10017

from *M. sapientum*, *M. paradisiaca* and M. acuminata was studied on renal calculi induced albino rats in Asia, results showed that there was an observation of a significant decrease in the size of kidney stones under *in vitro* conditions. This is due to the presence of organic constituents like β-sitosterol, quercetin, tannins, and saponins. This result suggests that the above *Musa* species powder extract was a good natural formulation for kidney stones (Prasobh & Revikumar, 2014) [61].

ANTIDIARRHEAL ACTIVITY

In vivo antidiarrheal activity of aqueous and methanolic extracts of leaves from *M. sapientum*, pseudo-stem powder of *M. paradisiaca* and M. acuminate were studied on castor oil and magnesium sulfate-induced diarrheal mice in Bangladesh, the result showed that the extract (at doses of 100 mg/kg and 200 mg/kg of b.w. respectively) decrease the frequency and severity of diarrhea. Not only this but also the extract has the potential to decrease the frequency and severity of bacterial strain-induced diarrhea (Sarowar Hossain et al., 2011) [62].

MUSCLE RELAXANT ACTIVITY

In vivo muscle relaxant activity of aqueous and ethanolic extracts of leaves from *M. sapientum*, pseudostem powder of *M. paradisiaca*, and M. acuminata was studied on directly and indirectly evoked contractions of isolated phrenic nerve hemidiaphragm preparation of mouse in India, Result showed that the extract first augments both the evoked contractions then block them. The two major constituents responsible for this activity are potassium nitrate and magnesium nitrate (Barua & Das, 2013) [58].

WOUND HEALING ACTIVITY

In vivo wound healing activity aqueous extracts of leaves from *M. paradisiaca* was studied on streptozotocin (STZ 60 mg/kg via I.P)-induced diabetic rats (fasting) in Chinese, The application of topical super green ointment (SG 1%) obtained from *M. paradisiaca* result in decreasing of wound area in diabetic rats. This is also effective for burning wounds (Cheng et al., 2020) [63].

ECOLOGICAL USES

The genus *Musa* is important to maintain soil fertility via dust and young leaves cut from *Musa* tree has domestic uses, like conservation of food and meat. Also, it important to prevent soil erosion (Mapongmetsem et al., 2012) [64].

NUTRITIONAL VALUE

M. sapientum and *M. paradisiaca* (banana) are important food crop in the humid forest and mid altitude agro-ecological zones of sub Saharan Africa and one of the major source of carbohydrate in Asia, Oceania, Africa and central Americas. The edible part of *M. sapientum* and *M. paradisiaca* is the fruit (finger) that is formed at the maturity of rhizomes (Wariboko C. and Alamene A., 2017) [65].

TOXICOLOGY

In vivo toxicological study of aqueous extracts of dried powder from *M. sapientum*, *M. paradisiaca* and M. acuminata was done on Wistar albino rats in Nigeria for kidney and liver toxicities, the orally administered extracts from 2000-5000 mg/kg results in changes of ALT, AST, total protein and albumin which documented as hepatotoxic and nephrotoxic. At a dose of above 5000 mg/kg the rats died (LD50 >5000 mg/kg) (Chidi Edenta et al., 2017) [65].

CONCLUSION

The genus *Musa* is a veritable source for drug bioprospecting that will be of benefit to scientific research and pharmaceutical industries.

There are approximately 71 recorded species of the genus *Musa* worldwide, but only 18% of them have been studied for their medicinal properties, phytoconstituents, and toxicities.

This review demonstrates that 63 secondary metabolites have been isolated and identified from the genus *Musa*. Flavonoids (23), saponins (6), cardiac glycosides (8), alkaloids (11), phenolic acids (5), and other compounds (10). Almost all secondary metabolites are isolated from the aerial parts of the genus *Musa* while few are from other plant parts.

Among the genus *Musa*, most ethnopharmacological reports are available for *M. sapientum*, *M. paradisiaca*, M. acuminata, M. cavendishii, M. ornate, *M. troglodytarum*, M. assamica, M. aurantiaca, *M. balbisiana*, and M. saba. The reports on pharmacologic activities of the species and isolated compounds include: anticancer (*M. sapientum*, *M. paradisiaca*, M. acuminata and *M. balbisiana*), antihypertensive (M.paradisiaca, M. acuminata and M. cavendishii), antimicrobial (M. acuminata and M. cavendishii), antidiabetic (*M. paradisiaca*, *M. sapientum*, M. acuminata and *M. balbisiana*), antiulcer (*M. paradisiaca*), diuretic (*M. sapientum*, *M. paradisiaca* and M. acuminata), analgesic (*M. sapientum* and *M. paradisiaca*),

antiallergic (*M. paradisiaca*), wound healing activity (*M. paradisiaca*), hypolipidemic (*M. sapientum* and *M. paradisiaca*), antiurolithiatic (*M. sapientum*, *M. paradisiaca* and M. acuminta), antidiarrheal (*M. sapientum*, *M. paradisiaca* and M .acuminta) and muscle relaxant (*M. sapientum*, *M. paradisiaca* and M. acuminta). Toxicities were also studied on *M. sapientum* and *M. paradisiaca* which are widely used as traditional medicine in Ethiopia, so individuals should be careful of the traditional use of these two species.

ACKNOWLEDGMENTS

First of all, we would like to say thanks to GOD who helps us in every moment of our life with his grace and kindness. Our great appreciation and thanks go to all our colleagues and Addis Ababa University instructors for their valuable comments.

DECLARATION OF INTEREST STATEMENT

We all the authors declare as there is no any conflict of interest.

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Citation: Begashaw T, et al. (2023). Review on Phytochemistry, Medicinal Properties, and Toxicities of the Genus *Musa*. Traditional Medicine. 4(2):17.

DOI : https://doi.org/10.35702/Trad.10017