Ficus Thonningii (Blume) plant: A brief review of its phytochemical properties and pharmacology

ABSTRACT

Background:

Ficus is the most diverse genus of woody species in Senegal's flora. Ficus trees have many and varied uses, giving them a high socio-cultural and economic value. Ficus thonningii, is extensively used in African ethnomedicine for treating a number of disease conditions which include diarrhoea, urinary tract infections, diabetes mellitus, gonorrhoea, respiratory infections, sterility and mental illnesses.

Aim:

A documentary search was carried out using data from Google Scholar, PubMed, Elsevier, ScienceDirect, Sciencedomain and Scifinder to examine published scientific reports, ethnobotanical and ethnopharmacological books on its phytochemical constituents and pharmacological properties.

Results:

The medicinal qualities of *Ficus thonningii* are attributed to a variety of bioactive substances, such as resveratrol glucoside and stilbene glucoside derivatives, tannins, alkaloids, terpenoids, saponins, flavonoids and essential oils have also been identified. *F. thonningii* has been shown to have antibacterial, antidiarrheal, antihelmintic, antioxidant, anti-inflammatory, antiparasitic, antidiabetic and analgesic qualities in both in vitro and in vivo pharmacological investigations.

Conclusion:

The findings of this study would be useful in developing a monograph for the plant. The data collected can also be used to formulate TAMs (Traditional Improved Medicines) in order to propose safe and effective medicines.

Keywords: Traditional uses, phytochemistry, pharmacology, *Ficus thonningii* Blume.

1. INTRODUCTION

Ficus is the most diverse genus of woody species in Senegal's flora. Ficus trees have many and varied uses, giving them a high socio-cultural and economic value [1].

In Senegal, the genus Ficus is the 5th most important genus in its flora, behind the genera Indigofera and Cyperus (44 species), the genera Ipomoea (38 species) and Crotolaria (33 species). Senegal's particular geographical position gives it a relatively high level of plant biodiversity in relation to its status as a Sahelian country.

Ficus are found in all regions of Senegal and have a great ability to colonise quite diverse and sometimes surprising habitats, such as the roofs of buildings. They are trees, shrubs or lianas that can be hemi-epiphytic, terrestrial or strangling [2].

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Ficus thonningii, a multi-stemmed evergreen African medicinal plant belonging to the Moraceae family, typically grows 6 to 21 meters tall in tropical and subtropical Africa's upland forests at elevations of 1,000 to 2,500 meters. It thrives in soils that are deep, light, and well-drained [3,4].

Ficus thonningii, is extensively used in African ethnomedicine for treating a number of disease conditions which include diarrhoea, urinary tract infections, diabetes mellitus, gonorrhoea, respiratory infections, sterility and mental illnesses [5].

The *Ficus thonningii* species specifically contains resveratrol glucoside and stilbene glucoside derivatives. Tannins, alkaloids, terpenoids, saponins, flavonoids and essential oils have also been identified [5, 6, 7, 8, 9 et 10]. Other phytoconstituents of the plants include oxalate, phytate ([5], lignins, lignans, active carbohydrates and proteins [10].

Despite several chemical and pharmacological studies of *F. thonningii*, no thorough analysis of the plant's constituent parts and pharmacological properties has been carried out, according to our bibliographic sources. Thus, the aim of this study was to search the literature in the databases Google Scholar, Elsevier, Scifinder, ScienceDomain, PubMed and ScienceDirect in order to examine the chemical components and pharmacological activity of *F. thonningii*.

2. DESCRIPTION AND USES

2.1. **Common names** [11, 12]

French: Figuier

English: Fig tree

Wolof: Dobalé

Bambara: dubalé

Diola: di kikilit

Sérére:yasul

Synonyms:

Urostigma thonningii

Ficus microcarpa

Ficus schimperi

Ficus dekdekena

Ficus basarensis

Ficus spargueana

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2.2. SYSTEMATIC POSITION

According to APG IV, 2016, *Ficus thonningii* belongs to the Moraceae family [13]. Here is the systematic classification of this species.

Sub-genre	Plantae
Class	Magnoliopsida
Family	Moraceae
Genus	Ficus
Species	*Ficus thonningii*

2.3. Distribution and Habitat

The plant is widespread in several tropical African countries. It is found in Guinea, Mali, Sierra Leone, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Chad, Cameroon, Central Africa, Gabon, Congo, DRC, Angola, southern Africa, Ethiopia, Madagascar and Yemen. In Senegal, it thrives especially in slightly humid regions. It is planted in many villages as a palaver and shade tree [11].

2.4. Morphology

F. thonningii is a tree or epiphyte, 8-10(-21) m high, with a short, more or less cylindrical shaft, becoming deeply grooved on older specimens, low branching, with a rounded, dense crown, very often with aerial roots hanging from the trunk and branches.

The bark is smooth, light grey to brown, with a pink edge, exuding abundant latex. The latex is white, often becoming more or less pink. The branches are more or less thick (0.2-0.7 cm in diameter), more or less pubescent or hairless [12,14]. Fig. 1 shows *F. thonningii* tree.

The leaves are alternate, spiral-shaped, relatively coriaceous, oblong, elliptic to obovate, 3-12(-18) x 2-6(-7) cm, with an obtuse to acuminate wedge-shaped apex, a wedge-shaped or rounded base, sometimes subcordate on the larger leaves, glabrous and sometimes pubescent on the midribs below. The petiole is glabrous, canaliculate above. The midrib is pinnate [13]. Fig. 2 shows *F. thonningii leaves.*

The fruits which are borne singly or in pairs are round, 10-20 mm in diameter, usually hairy and turn yellowish and rarely pink when ripe [15]. Fig. 3 shows *F. thonningii* fruit.

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Fig.1. *F. thonningii* tree

Fig.2. *F. thonningii* leaves

Fig. 3. *F. thonningii* fruit

2.5. Traditional Uses

2.5.1. Leaves

Traditional healers have used oral macerations of fresh F. thonningii leaves for treating diabetes mellitus, gonorrhoea, and diarrhoea [16] . *F. thonningii* leaves decoctions are used for treating wounds in Angola. In situations of gingivitis, the leaves are used to rub the bleeding gums. According to Cousins and Huffman (2002)[3], leaf extracts are also used for treating urinary tract infections and bronchitis. In Mali, urinary schistosomiasis is treated with a leaf decoction [17]. In Nigeria, a maceration of the leaves are used for treating gastritis, ulcers, and other stomach disorders in animals [18]. According to Ahur *et al.,* (2010) [10], the leaves can also be used for treating diseases linked to jaundice and liver ailments. The leaves have also been used medicinally for treating ringworm, thrush, scabies, athlete's foot rot, and bone mobility abnormalities [19, 20].

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2.5.2. Stem bark

Traditionally, stem bark is used for treating a wide range of ailments. Table 1 below shows the use of stem bark.

Table 1. Ethnomedicine of *Ficus thonningii* plant

Medicinal use	Parts used	References
Treating influenza, Treating sore throat , Treating colds, Treatment of arthritis and Rheumatism Relieve inflammation	Stem	[21]
Treating ulcer	Stem	[22]
Treating skin diseases Treating cyst Relief for constipation and bowel disolders	Stem	[23]
Healing of wound infections Stem	Stem	[24]

2.5.3. Roots

F. thonningii roots are used for treating many diseases. Table 2 below shows the use of roots.

Table 2. Medicinal use of *F. thonningii* roots

Medicinal use	Parts used	References
Treating pneumonia Treating chest pains	Roots	[22]
Preventing miscarriages Stoping nose-bleeding	Roots	[23]
Healing stomach pains	Roots	[16]

2.5.4. Latex

F. thonningii exudes a white, sticky latex that turns pinkish with time [25]. Latex has been used for treating a wide range of ailments. Table 3 shows the use of latex.

Table 3. Medicinal use of latex

Medicinal use	Parts used	References
treating fever, tooth decay and ringworm	Latex	[20,25]
Treating cataract in the eye	Latex	[20]
Vermifuge	Latex	[26]

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2.6. Phytochemical composition

A phytochemical study of the stem and root bark of *Ficus thonningii* revealed the isolation of two previously unreported compounds, thonningiiflavanonol A(1) and thonningiiflavanonol B(2), as well as 16 known compounds. These 18 compounds include: six flavanonols, two flavanones, two isoflavones, one flavone, two steroids, two triterpenes, two benzoic acid derivatives and one benzoic acid ester.

These compounds are as follows:

- shuterin(4), naringenin(3), syringic acid(6), p-hydroxybenzoic acid (7), genistein(8), 5,7,3',4 “,5”- pentahydroxyflavanone (9), luteolin (10), methylparaben (5), aromadedrin (12), garbanzol(13), dihydroquercetin(11), 5,7,3'- trihydroxyflavanone(14), β-sitosterol (15), sitosterolglucoside(18) lupeol acetate(16) and taraxerol(17) according to Ango *et al .,* 2016 [27].
- Flavone-C-glycosides were shown to be present in the leaves of *F. thonningii* and these were subsequently identified as orientin, vitexin and isovitexin.
- Of the Ficus species used in a phylogenetic evaluation, *F. thonningii* was the only species to contain stilbenes identified as resveratrol, resveratrol glucosides and stilbene glucosides.
- Stilbenes are a particular type of flavonoid produced by plants in response to pathogens and other abiotic stresses such as UV radiation [5]. The structures of these compounds are shown in Fig. 4, numbered 1 to 18.

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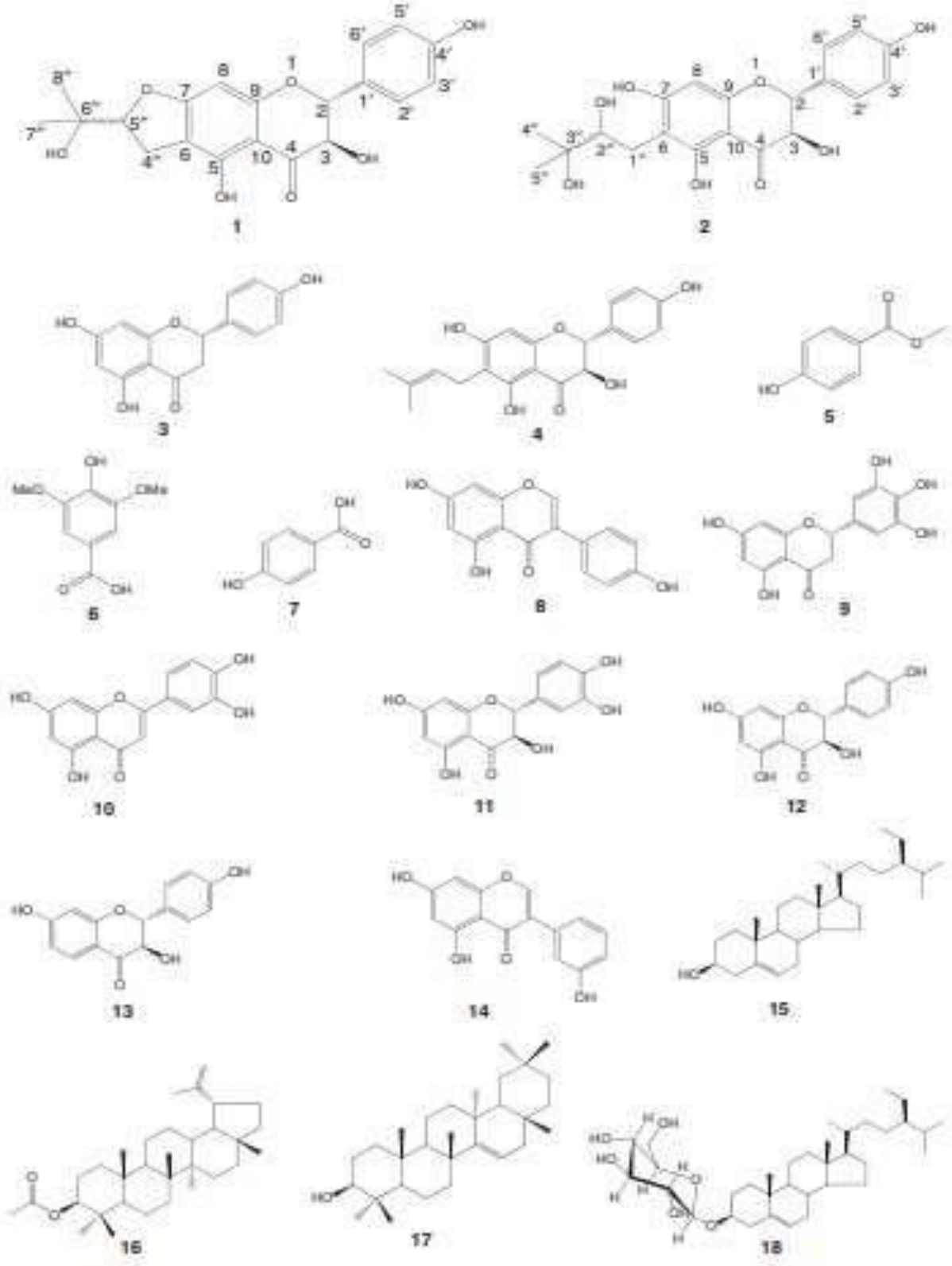

Fig. 4. Structure of chemical compounds isolated from *Ficus thonnigii*

- **Tannin** concentrations in *F. thonningii* leaves have been determined to be about 90 mg/100 g dry matter using the vanillin assay [27]. The presence of tannins in methanolic, n-butanolic, and aqueous extracts of *F. thonningii* leaves has been confirmed by the ferric chloride and tannic acid tests [8,24].

- **Alkaloids:** According to Ramawat et al., (2009), alkaloids are nitrogen-containing, low molecular weight substances with significant physiological effects. As a result, they are now used as narcotics, stimulants, and medications[28]. Although *F. thonningii* includes alkaloids [8, 10], there are few reports in the literature of particular alkaloids that have been isolated from the plant.
- **Triterpenoids** are extracted from squalene through a biosynthesis process [29] and yield a number of pharmacologically active compounds, including cardiac glycosides, steroids, and saponins [28]. Saponins and anthraquinone glycosides are two examples of triterpenes that have been identified in F. thonningii stem bark extracts [8, 10]. It was shown that the quantities of saponin in F. thonningii leaves might reach 300 mg/100 g dry matter [27].
- **Essential oils:** *F. thonningii* leaves contain essential oils composed mainly of 6, 10, 14 trimethyl-2-pentadecanone (18.8%), phytol (14.7%), acorenone (7.6%) and β-gurjunene (6.3%) [30].
- **Other phytochemicals:** Phytate and oxalate are two phytochemicals found in *F. thonningii* that have antinutritional effects. Despite the presence of antinutritional elements, *F. thonningii* leaves have a high feed value, as shown by their palatability and digestibility when used as fodder.Other secondary metabolites found in *F. thonningii* leaves include lignins, lignans, active carbohydrates, and proteins[10].

2.7. Pharmacological activity

2.7.1. Antimicrobial activity

Antibiotics have shown remarkable efficacy for treating infectious diseases. However, antibiotic-resistant, infectious strains have emerged as a result of improper usage and abuse of antibiotics. Searching for alternative, plant-based medications with antibacterial properties is therefore very popular. The genus Ficus has a well-established antibacterial action [30, 31 and 32].

The efficacy of the extraction method appears to affect the antibacterial activity of plant medicines, and the solvent utilised is crucial [33]. When making cures in traditional medicine, palm wine is occasionally substituted for water [34]. Since most antimicrobial bioactive substances are aromatic or saturated organic molecules, ethanol or methanol can be used for extracting these compounds with easily. The different antibacterial properties of *F. thonningii* extracts are summarised in Table 4. There are more phytochemicals in *F. thonningii* that have antimicrobial properties.

Table 4. Antibacterial activity of *Ficus thonningii* extracts on bacterial strains [5]

Plant part	**sensitive microorganisms**	**Minimum Inhibitory Concentration**	**Most diseases associated to the specific bacteria.**
Ethanolic leaf extracts	Streptococcus pyrogènes (Group A)	23µg /ml	Tonsilitis, septicaemia, rheumatic fever

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	Beta- haemolytic	47µg /ml	
Ethanolic leaf extracts	Enterococcus faecalis (aminoside resistant)	94µg /ml	Urinary tract infections
n-butanolic stem -bark extracts	Escherichia coli	1.25 µg/ml	Urinary tract infections, neonatal meningitis
Methanolic stem-bark extract	Bacillus subtilis	12.5 mg/ml	Generally non-pathogenic
Methanolic stem-bark extract	Providencia stauti	6 mg/ml	Nosocomial infections, urinary tract infections, respiratory tract infections and wounds

2.7.2. Anti-protozoal activity

A study carried out to assess the anti-plasmodial activity of *F. thonningii* against Plasmodium falciparum, the protozoan parasite responsible for malaria, reported no significant anti-plasmodial activity [35]. *F. thonningii* may just have good insect repellent properties and therefore reduces the vector's contact with humans, thereby minimising the incidence of malaria transmission [35, 36]. Using mice inoculated with *Trypanosoma brucei* gambiense, Youan et al (1997) reported that *F. thonningii* had neither trypanocidal nor trypanostatic activity against the parasite. They reported a 0% survival rate in mice after three days of inoculation compared with 100% for controls, melarsoprol and pentamidine, both of which are commercial drugs used in the treatment of human African trypanosomiasis [37]. However, *F. thonningii* was shown to have high amoebicidal activity against *Entamoeba hystolytica* at a concentration of 100 µg/ml compared with the control metronidazole, a commercial drug [38].

2.7.3. Antifungal activity

The traditional use of *F. thonningii* in the treatment of athlete's foot suggests the presence of antifungal compounds. Oyelana et al., (2011) showed that extracts *of F. thonningii* leaves (25 and 50 mg/ml) had antifungal activity against *Aspergilus niger, Aspergilus flavus, Botryodiploidia theobromae, Fusarium oxysporum*, *Fusarium solani*, *Penicillium chrysogenum*, *Penicillium oxalicum* and *Rhizopus stolonifera* [39]. It has also been reported that the extracts significantly stopped the growth of the mycelium.

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2.7.4. Antioxidant activity

According to Grossi et al. (2010), flavonoids are effective antioxidants that scavenge and reduce the production of free radicals [40]. The antioxidant-rich glucosylflavonoids (orientin, vitexin, and isovitexin) that were isolated from *F. thonningii* have been found in a variety of medicinal plants, including linseed oil (*Linum usitatissimum*), pigeon pea (*Trollius ledebouri* Reichb), and rooibos tea (*Aspalathus linearis*) [41,42]. Despite of the absence of an OH on the C ring, vitexin and isovitexin have also been shown to have antioxidant properties, though to a lesser extent than orientin. The antioxidant activity of the stilbenes found in *F. thonningii* is in addition to that of flavonoids. According to Olas et al. (2008) and Olas et al. (2003), resveratrol and its methylated derivative trans-3.3', 5.5- tetrahydroxy-4-methoxystilbene have antioxidative properties against oxidative stress brought on by reactive oxygen and nitrogen species [43, 44]. *F. thonningii* has been shown to possess protective effects on the erythrocyte membrane against acetaminophen-induced membrane peroxidation due to its antioxidant activities [10]. Its antagonistic activity against glutathione depletion and, consequently, inhibition of the production of free radicals that induce oxidative stress may be the basis of its antihaemolytic and haematinic potential [10].

2.7.5. Analgesic activity

According to reports, *F. thonningii* shows analgesic qualities that are on par with aspirin for both centrally and peripherally produced pain. Otimenyin (2004) showed that methanolic extracts of F. thonningii (500 mg/kg) administered intraperitoneally had a percentage inhibition (79.7%) comparable to aspirin (80%) using the acetic acid-induced screaming reflex model in mice. This suggests that *F. thonningii* has analgesic effects that can be useful in the management of peripherally induced pain. Otimenyin (2004) also used the hot plate test method on mice to report the plant's analgesic effects on central pain [45].

2.7.6. Anti-inflammatory activity

Rats' oedema induced by egg albumin and carageenan has been used to confirm *F. thonningii's* anti-inflammatory qualities [9, 45].According to Ogunlesi et al. (2009), phytol, an aliphatic diterpene present in *F. thonningii*, has anti-inflammatory properties and may be used as a medicinal agent for treating rheumatoid arthritis and perhaps other chronic inflammatory diseases such as asthma [46]. It is thought that the side group responsible for tocotrienols' higher antioxidative benefits over tocopherols is unsaturated phytol, which demonstrates antioxidant activity [47].

2.7.7. Antidiarrheal activity

According to Njoronge and Kubunga (2007), *F. thonningii* is widely used for treating human and animal diarrhoea [16]. The antibacterial, anti-inflammatory, and antisecretory actions of tannins and astringent phenolics include triterpenoids and saponins are typically what provide their antimicrobial qualities. By denaturing the intestinal mucosa's proteins resulting in protein tannates, tannins and tannic acid reduce secretion and improve the mucosa's resistance to chemical change.

2.7.8. Cardioprotective activity

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Ficus thonningii has hypotensive and cardio-suppressive qualities. It has been showed that ethanolic stem bark extracts of F. thonningii have good chronotropic and inotropic effects on atrial muscle strips that beat both spontaneously and electrically [48]. Additionally, this study revealed that *F. thonningii* extracts (120 mg/kg b.w. administered for 5 weeks) reduced mean arterial pressures. Resveratrol may be responsible for *F. thonningii's* cardioprotective benefits. According to reports, resveratrol helps prevent and reduce the progression of a number of illnesses, including cardiovascular and cancer [49].

2.7.9. Hypoglycemic activity

Rats tested for hypoglycemic effects from ethanolic extracts of *F. thonningii* [50]. When *F. thonningii* stem bark ethanolic extracts were administered to diabetic and non-diabetic rats, oral glucose tolerance tests revealed a dose-dependent hypoglycemic effect that was equivalent to that of metformin, which was employed as a positive control [48]. The stilbene resveratrol, which is also included in F. thonningii extracts, has been shown to have hypoglycemic effects via increasing muscle cell absorption of glucose and by activating hepatic AMPK [51].

2.7.10. Cytotoxicity activity

Musabayane *et al.,* (2007) researched into the cytotoxicity of *Ficus thonningii* stem-bark ethanolic extract on kidney cell lines. Both proximal and distal tubule cell lines showed no toxicity following treatment with plant extracts (600–100 µg/ml). The viability and metabolism of distal tubule cell lines increased in a dose-dependent manner [48].

3. CONCLUSION

Examining available scientific reports on the pharmacological traits and chemical compositions of *F. thonningii* was the aim of the current study. Studies have identified a range of pharmacological activities. It has been shown that the pure components and extracts from this plant possess a variety of pharmacological actions.The effects of *F. thonningii* on the endocrine and neurological systems, as well as whether it interacts with the immune system to combat illness, may also be explored by research. The nutritional and phytochemical content of *F. thonningii* fruits can be better characterised, and their potential as a dietary and therapeutic supplement will be evaluated.

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