REVIEW ARTICLE

A C G publications

Rec. Nat. Prod. X:X (202X) XX-XX

records of natural products

Traditional Uses, Phytochemistry and Pharmacological Activities of *Tradescantia spathacea*

Siow-Ping Tan [1*], Xin-Yi Keng [1], Bryan Chi-Wah Lim [1] and Hui-Yin Tan [2]

[1]*Department of Physical Science, Faculty of Applied Sciences, Tunku Abdul Rahman University of Management and Technology, 53300 Kuala Lumpur, Malaysia*

[2]*Faculty of Applied Sciences, Tunku Abdul Rahman University of Management and Technology, 53300 Kuala Lumpur, Malaysia*

(Received November 29, 2023; Revised January 10, 2024; Accepted January 11, 2024)

Abstract: *Tradescantia spathacea* has been traditionally employes for treating various conditions, including coughs, fevers, wounds, inflammation, and oxidative-related diseases. This paper presents a comprehensive review of its traditional uses, alongside an examination of phytochemical and pharmacological studies aimed at validating ethnopharmacological practices. A systematic search across electronic databases using relevant keywords yielded 845 articles, of which 70 articles were reviewed. *T. spathacea* exhibits a broad spectrum of pharmacological activities, as evidenced by *in vivo* studies demonstrating hepatoprotective, anti-diabetic, anti-inflammatory and anticancer effects. *In vitro* studies further support its medicinal properties, including antimicrobial, anti-viral, antioxidant, anti-helminthic, antimutagenic, antigenotoxic and cytotoxic activities. While these modern pharmacological properties substantiate traditional uses, further research is essential to validate them and develop safe and effective therapeutic formulations. Further investigations should focus on bioassay-guided isolation of bioactive compounds, extensive pharmacological, clinical, and toxicological studies, incorporating adequate data replication, proper standardization and control groups, and the selection of reasonable doses or concentrations of extracts and controls.

Keywords: Commelinaceae; *Tradescantia spathacea*; traditional uses; phytochemistry; pharmacological properties.

1. Introduction

The genus *Tradescantia*, commonly known as "Spiderwort", encompasses approximately 75 herbaceous species, making it the second-largest genus within the Commelinaceae family [1]. They are native to the southern United States, Mexico, and Asia [2]. They are primarily distributed in tropical and temperate regions [3-5]. Many *Tradescantia* species, including *Tradescantia spathacea* Sw. (*T. spathacea*), *T. zebrina* Bosse, *T. pallida* (Rose) D.R.Hunt, *T. gracillima* Standl, *T. occidentalis* (Britton) Smyth, *T. ohiensis* Raf, *T. roseolens* Small, *T. subacaulis* Bush, *T. subaspera* Ker Gawl, *T. rozynskii* Matuda, *T. leiandra* Torr., *T. pygmaea* D.R.Hunt, *T. llamasii* Matuda, *T. andrieuxii* C.B.Clarke, *T. cerinthoides* Kunth, *T. zanonia* (L.) Sw. and *T. soconuscana* Matuda, have been successfully cultivated in Malaysia [1, 6].

* Corresponding author: E-Mail: tansp@tarc.edu.my

The article was published by ACG Publications
http://www.acgpubs.org/journal/records-of-natural-products Month-Month 202x EISSN:1307-6167
DOI: http://doi.org/10.25135/rnp.436.2311.2983
Available online: Jauar 27, 2024

Traditional uses, pharmacological properties of *Tradescantia spathacea*

T. spathacea, commonly known as “Daun Kepah” in Malaysia and recognized by its Chinese name “紫背万年青”, serves a dual purpose as both an ornamental plant and herbal medicine. According to Kew’s taxonomic resources at mpns.science.kew.org, *T. spathacea* Sw. is the accepted name for this versatile plant. It boasts various common names, such as Moses in a cradle, three men in a boat [2], Moses in a boat, boat lily and oyster plant [7]. It is native to southern Mexico, and has distributed across the Caribbean, the coast of Central America, Belize [3, 8], and the West Indies [2, 7]. In the southeastern region of Mexico, the locals commonly refer to it as ‘Maguey Morado’ or ‘Purple Maguey’ [9-10]. It invades Texas, Hawaii, the southeastern United States [7, 11], Tonga, Niue, India [12], China [13], Myanmar [14], Malaysia [15] and Thailand [16], and continues to thrive year-round in forests and urban areas [3, 17].

Due to its adaptability, vibrant colour and distinctive texture, *T. spathacea* has become a popular ornamental house plant. It can grow and reach a height of 30 cm [5, 17]. Its sessile, sword-shaped rosette leaves exhibit a uniform green upper surface and a striking red or dark purple underside [3, 17]. The plant produces oval-shaped in white and reddish-purple hues, with the potential for self-pollination or pollination by insects [2, 17, 18]. Notably, the inflorescence takes the shape of an axillary boat, and the flowers bloom, resembling men emerging from a boat [2, 6].

Although the genus *Tradescantia* has been the subject of five review articles [1-2, 7, 17, 19], the specific focus on *T. spathacea* in these publications remains sparse. Notably, the reviews by Golczyk [2] and Prajapati et al. [17] have covered *T. spathacea*, but their coverage was limited to cytogenetics and some pharmacological aspects. Given the incomplete data from previous reviews, a comprehensive assessment of *T. spathacea* in the existing literature remains urgently needed. This article aims to fill the gap by presenting the first thorough assessment of the traditional uses, phytochemistry and pharmacological activities associated with *T. spathacea*. By addressing this research gap, this review aims to be a valuable reference for future investigations and potential application across various fields. Furthermore, the article discusses some limitations encountered during the review process.

2. Methodology

This comprehensive review utilized well-established databases, including SciFinder, Scopus, Web of Sciences, ScienceDirect, Google Scholar and ResearchGate. The search employed the following keywords to retrieve relevant literature, which includes ‘*Tradescantia spathacea*’, ‘*Rhoeo spathacea*’, ‘*Tradescantia discolor*’ and ‘*Oyster plant*’. A total of 845 articles were initially downloaded. However, after careful screening, only 70 articles were deemed relevant to the scope of this review.

3. Traditional Uses

The extensive records on the traditional uses of *T. spathacea* plant reflect the rich therapeutic practices across diverse cultures and regions. In southern Mexico, the plant’s extracts often combined with sugar, were used for addressing multiple health concerns, including coughs, mucus loosening [20], cancer, venereal diseases, and mycoses [21−23]. The plant was also used in China as an ointment for treating swelling and wounds [24], while aqueous extracts of the plant were employed in cosmetics to improve skin appearance [25]. In India, *T. spathacea* served as a remedy for various ailments [26]. In Cuba, the cataplasms of this plant were used to facilitate wound healing [27], demonstrating its versatility. In Thailand, it is used as a Thai folk remedy for fever, cough and bronchitis [28]. In the Chalna district of Bangladesh, the plant even played a role as an insecticide [29]. In Petén, the plant has been used to treat snake bites [30].

The leaves of *T. spathacea* emerged as powerful traditional remedies. Boiled leaves were used to treat hematemesis, burns, scalds, and dysentery [31]. In Indonesia, the water leaf extract provided relief for respiratory disorders [32]. In Mexico, the leaves and latex of the plant have been utilized to treat cancer [8, 33−34], ulcers, wounds, dysentery, headache, asthma, cough, intestinal infections, and inflammation [34], and haemorrhage [35]. Mexicans used leaf infusions as dermatological remedy for conditions like allergic rhinitis, superficial mycosis, ulcers, and cancer treatment [36]. The leaves

served for nervous disorders in Tabasco, [37−38]. In Kinmen, a leaf decoction was used to treat allergic rhinitis, colds, clear away heat and detoxify [39]. It was also used in Taiwan to cure blood stasis, pneumonia, relieve cough and traumatic injuries [40]. In Puerto Rico, psoriasis was treated with decoction leaves of *T. spathacea* [27]. The Burmese prescribed the leaves to treat tuberculosis [41]. In Bangladesh, *T. spathacea* leaves were traditionally consumed with sugarcane juice to treat haematuria in women [42]. In Thailand and the Caribbean islands, the leaves were used to relieve fever and asthma [16]. In Guatemala and Central America, crushed leaves were employed as a hypoglycemic agent and wound hemostatic [43], and the infusion of leaves was also used as an expectorant to treat diarrhoea [44].

In China, the flower extracts were prescribed for conditions like dysentery [13], enterorrhagia and hemoptysis [24], while also used in cosmetic applications in Yucatan, Guatemala, and Belize [45]. In Western countries, the flower was used as traditional tea ingredient, to relieve fever, cough, and bronchitis [46]. This comprehensive exploration of *T. spathacea*'s traditional uses underscores its significance in the global landscape of traditional medicine.

4. Phytochemistry

Qualitative phytochemical screening of *T. spathacea* leaf extracts has been intensively studied by several researchers and revealed a variety of bioactive compounds. Through careful phytochemical testing, these studies confirmed the presence of alkaloids, glycosides, carbohydrates, tannins, flavonoids, anthocyanins, coumarins and saponins in chloroform and methanolic leaf extracts [47-49]. Another study also found phytosterols, phenolics, tannins and terpenoids in methanolic leaf extracts [50]. However, it is important to note that these studies did not isolate and identify these secondary metabolites.

Quantitative phytochemical screening assays, including total phenolic content (TPC) and total flavonoid content (TFC) measurements, have also reported in several studies [49, 51-52], further confirmed that *T. spathacea* leaf extracts contain a significant number of phenolic compounds and flavonoids. One of the studies conducted by Tan et al. showed that the methanolic leaf extract demonstrated with a TPC of 203.9 ± 16.3 mg gallic acid equivalent (GAE) per 100 g of extract, and a TFC of 10.8 ± 2.9 mg rutin equivalent (RE) per 100 g of extract [51]. These results support the studies on the isolation of phytochemicals from *T. spathacea* leaf extracts, in which many phenolic compounds have been isolated.

Through a combination of spectroscopic and chemical analyses, a total of 37 compounds were isolated from *T. spathacea* in six distinct studies. These compounds, encompassing glycosides, quinones, phenolic compounds and flavonoids (Table 1), predominantly belonged to polyphenols (Figure 1 and Figure 2). Notably, rhoeonin (**12**) emerged as the most frequently isolated compound from *T. spathacea* leaves [49, 53-54], playing a pivotal role in imparting the red and purple hues to the leaves of *T. spathacea* [19]. Among these reports, Alvin et al. [32] and Vo et al. [55] employed nuclear magnetic resonance (NMR) data to elucidate the structures of the isolated compounds. However, in the study by El-Hawary et al., the resulting compounds were only analyzed by HPLC-PDA-MS/MS analysis without isolating or elucidating the structures of the compounds [54].

Table 1. Reported secondary metabolites of *T. spathacea*

Class of compound	Isolated compounds	Appearance	Known biological activities	Ref.
Flavonol	Kaempferol **1**	Yellow powder	Protein Tyrosine Phosphatase 1B (PTP1B) inhibitory, IC_{50}: 45.85 ± 0.59 µM	[55]
	Myricetin **2**	Light yellow crystal solid	-	[54]
	Quercetin **3**	Yellow crystalline powder		
	Epigallocatechin **4**	White powder		
	Peltatoside **5**	-		
	Rutin **6**	Solid		
	Kaempferol-*O*-hexosyl-pentoside **7**	-		
	Quercetin dihexoside **8**	Yellow crystalline powder		
	Isorhamnetin-*O*-glucuronide **9**	Yellow powder		
	Quercetin-*O*-hexoside **10**	-		
	Isorhamnetin-*O*-hexoside **11**	-		
Anthocyanine	Rhoeonin **12**	-	-	[49, 53]
Phenols	Bracteanolide A **13**	White amorphous powder	Compounds **13** to **23** exerted Protein Tyrosine Phosphatase 1B (PTP1B) inhibitory activities, with IC_{50} values ranging 4.6-68.2 µM. The highest inhibitory activity is by compound **19** (IC_{50} = 4.6 ± 0.9 µM).	[55]
	4-(3′,4′-Dihydroxyphenyl)furan-2(5*H*)-one **14**	Amorphous powder		
	(*S*)-2-Hydroxy-3-(4′-hydroxyphenyl) propanoic acid **15**	White needle		
	(*R*)-2-Hydroxy-3-(4′-hydroxyphenyl) propanoic acid **16**	White amorphous powder		
	Latifolicinin C **17**	Light yellow powder		
	Latifolicinin B **18**	Syrup		
	Latifolicinin A **19**	Syrup		
	1-(3′,4′-Dihydroxyphenyl)-2-hydroxyethan-1-one **20**	Amorphous powder		
	Hydroxytyrosol **21**	Syrup		
	Oresbiusin A **22**	Syrup		
	(±)-Tradescantin **23**	Amorphous powder		
	Syringyl-*O*-rhamnoside **24**	-	-	[54]

Phenolic acids	Ferulic acids **25**	Amber colored solid	-	[56]
	Vanillic acid **26**	White powder		
	Glycosylated vanillic acid **27**	-		
	p-coumaric acid **28**	White solid		
	Chlorogenic acid **29**	White solid		
	Protocatechuic acid **30**	Light brown solid	-	[54]
	Protocatechuic acid hexoside **31**	-		
Napthaquinone	Javanicin **32**	Red color band	Compound **32** showed antimycobial activity against *Mycobacterium tuberculosis* and *Mycobacterium phlei* with MIC values of 25 and 50 µg/mL, respectively.	[32]
Glycosides	Caffeoyl-*O*-hexoside **33**	-	Compounds **35** to **37** exerted Protein Tyrosine Phosphatase 1B (PTP1B) inhibitory activities with IC_{50} values: **35** = 41.8 ± 0.7 µM **36** = 10.8 ± 1.0 µM **37** = 15.1 ± 0.1 µM	[54]
	Feruloyl hexoside **34**	-		
	(6*S*,9*R*)-Roseoside **35**	Colorless syrup		
	Tradescantoside **36**	Amorphous powder		
Tetrahydrofuran	(2*R*,3*R*)-2,3-Dihydroxy-2-methylbutyrolactone **37**	Colorless oil		

Note: "-" not reported.

In a separate investigation conducted by Radji and colleagues, the antimycobacterial activities of aqueous leaf extracts of *T. spathacea* were evaluated against *Mycobacterium tuberculosis* H37Rv and a multi-drug resistant (MDR) strain. The concentrations tested were 1.3, 2.5, and 5.0 mg/mL using the Lowenstein-Jensen (L-J) proportion method, with rifampicin (40 µg/mL) as the positive control [41]. Remarkably, the aqueous extract showed significant efficacy, completely inhibiting both strains at 2.5 and 5.0 mg/mL, respectively. Despite these promising results, further studies are required to validate the dosage, identify effective components, and elucidate the mode of action.

Another study conducted by Tan et al. [49], the antimicrobial potential of aqueous extracts (prepared through decoction and infusion methods) and 80% (v/v) methanolic leaf extracts of *T. spathacea* was investigated using the well diffusion technique in 96-well plates. The antimicrobial activity was evaluated against 10 bacterial strains at concentrations ranging from 0.4 to 200 mg/mL, with vancomycin as the standard drug for comparison. The decoction and infusion methods of *T. spathacea* exhibited noteworthy activity against MRSA, evidenced by the lowest minimum inhibitory concentration (MIC) values of 2.5 mg/mL. The infusion method showed moderate inhibition effects on *B. subtilis*, *S. saprophyticus*, *A. hydrophila*, while the decoction method exhibited moderate inhibition specifically against *A. hydrophila*, with a MIC value of 5 mg/mL. Furthermore, the decoction method also demonstrated a similar moderate inhibitory effect against *A. hydrophila*. However, this experiment was conducted only in one set of triplicates. It is recommended to analyze at least three independent replicates to ensure the robustness of the results [57]. In addition, the absence of negative controls to confirm the toxicity of the solvent used in preparing the extracts for the antibacterial assay highlights a limitation in the experimental design.

Yasurin et al. [59] demonstrated that chloroform and 95% (v/v) ethanolic extracts, at a concentration of 15 mg/mL (15 µL/disc), exhibited antibacterial activity against *E. coli*, *Salmonella enterica* Typhimurium U302, *Salmonella enterica Enteritidis* (human), *Salmonella enterica* 4, 5, 12: i-human US clone, *B. cereus* and *Listeria monocytogenes*, using BSAC disc diffusion method. The ethanolic extract displayed a significant inhibitory effect against *S. enterica* Typhimurium U302 and *S. enterica* 4, 5, 12: i-human US clone, with a maximum inhibition zone of 9.5 mm, while the chloroform extract exhibited 10.5 mm zone of inhibition against *S. enterica* Typhimurium U302. However, the

reported MIC values, stated in µL/mL, which may be a typographical error in the article. Additionally, the reliance on a single concentration to determine the zone of inhibition limits the exploration of the dose-response relationship of the test extracts.

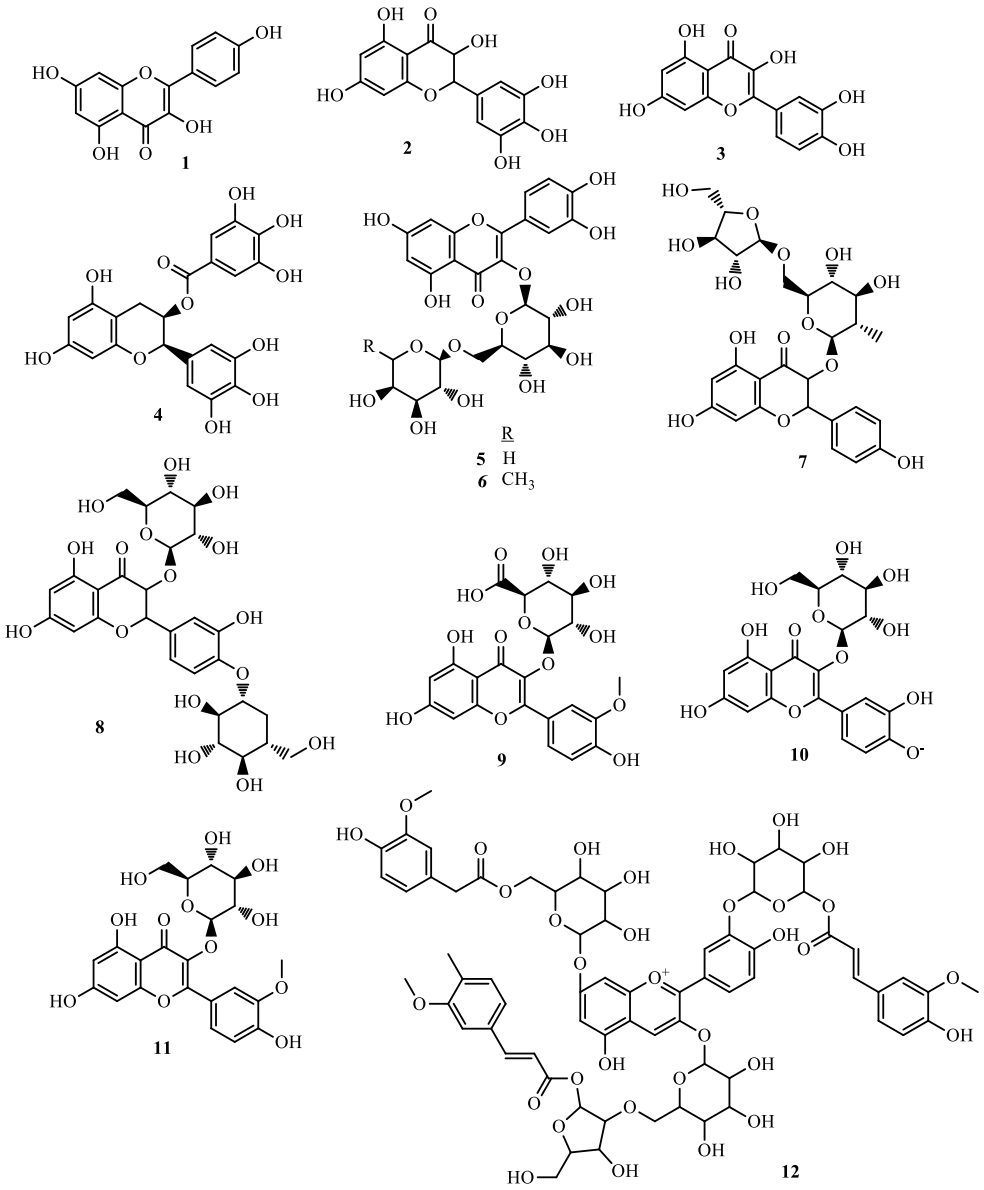

Figure 1. Flavonoids isolated from *T. spathacea*

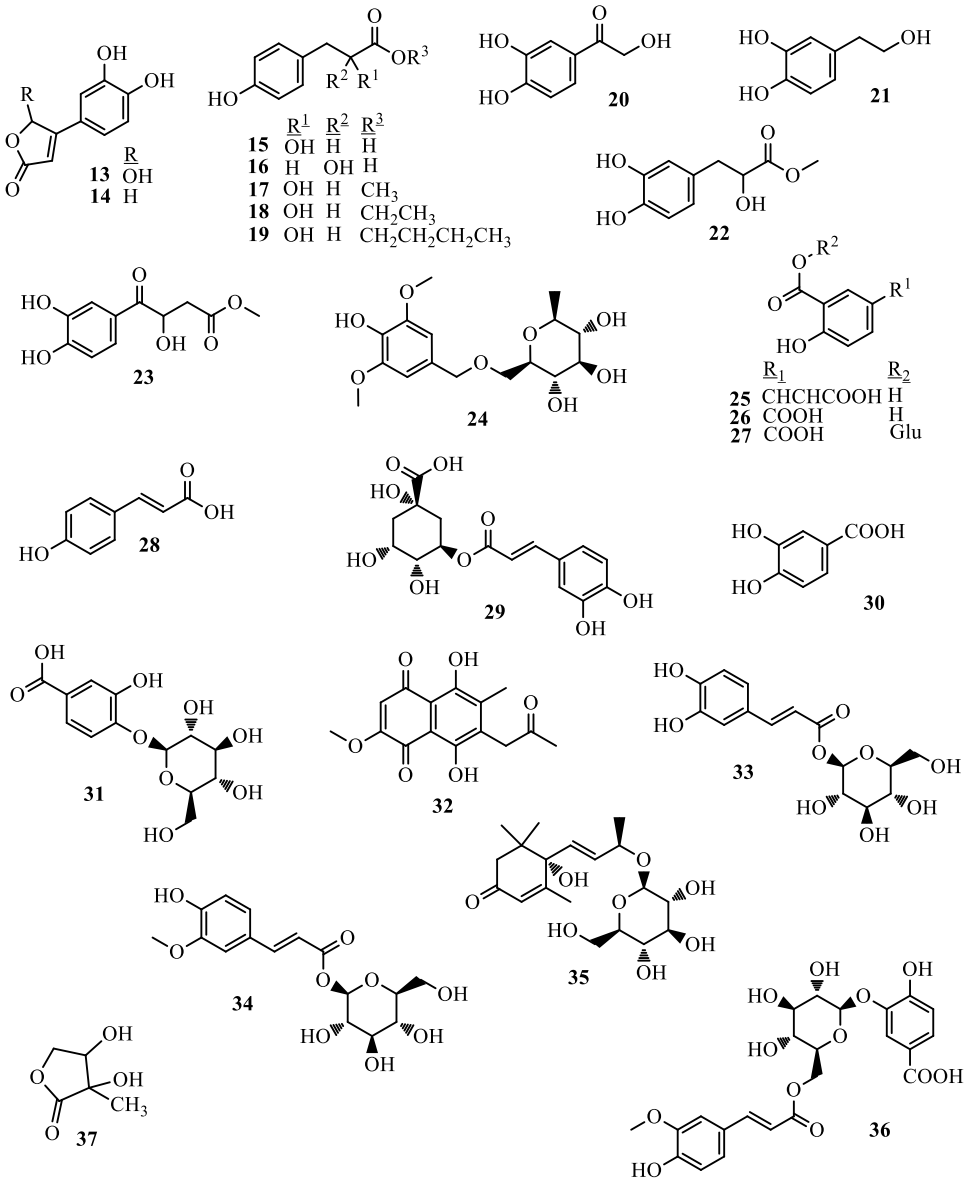

Figure 2. Phenolics and other compounds isolated from *T. spathacea*

5. Pharmacological Activities

5.1. Antimicrobial Activity

Several studies [10, 41, 49, 58−60, 69] have demonstrated the antimicrobial efficacy of *T. spathacea* against various bacteria and fungi, as detailed in Table 2. In a study conducted by Shinde et al. [10], ethanolic and aqueous extracts (10, 30, 50 mg/mL) of *T. spathacea* leaves were tested against *S. aureus*, *B. subtilis* and *Escherichia coli* with cephalexin serving as the positive control. The study reported the largest zone of inhibition as 7.3 and 6.2 mm against *S. aureus* and *E. coli*, respectively, while *B. subtilis* exhibited resistance to the extracts. Notably, the recorded zone of inhibition was significantly smaller than the positive standard tested at 1 mg/mL, with an average zone of inhibition at 12.5 mm for *S. aureus* and 14.4 mm for *E. coli* [10]. However, the source of bacterial strains and the materials for both studies were not specified, raising concerns about data reproducibility. Additionally, the study did not determine the MIC values, which are crucial for a comprehensive potency of the extracts.

.

The antifungal activity of various extracts of *T. spathacea*, with concentrations ranging from 0.02 to 2.5 mg/mL, was evaluated against *Candida albicans*, *C. parapsilosis*, *C. krusei*, *Cryptococcus neoformans*, *Aspergillus fumigatus* and *Trichophyton interdigitale* using the colorimetric broth microdilution method [60]. The hexane and chloroform extracts showed the lowest MIC values against *C. neoformans* (MIC values at 0.08 mg/mL, respectively). However, other extracts demonstrated MIC values ranging from 0.16 to 0.63 mg/mL. However, the antifungal activity against *A. fumigatus* could not be determined (MIC values more than 2.5 mg/mL). Despite these findings, there is no attribution of the sources of the materials used, which raises significant challenges in terms of data reproducibility. Other antibacterial studies were also documented in Table 2. The robust antimicrobial activity observed in *T. spathacea* provides a scientific basis for its traditional use in treating infections, ulcers, and wounds [34].

5.2. Antiviral Activity

The antiviral properties of *T. spathacea* are well-established, supported by historical claim in treating fever [28]. In a study conducted by Chan et al. [15], the leaves of *T. spathacea* were evaluated for their antiviral potential against Chikungunya virus, a deadly mosquito-borne virus. The study revealed that ethanolic and methanolic extracts, at a concentration of 512 µg/mL, exerted a significant cytopathic effect on the Chikungunya virus in African monkey kidney epithelial (Vero) cells, exhibiting inhibition rates of 92.6% and 91.5%, respectively. Additionally, an 80 µg/mL chloroform extract demonstrated 88.8% inhibition. Quantitative RT-PCR analysis of viral load indicated that the 80 µg/mL of chloroform extract effectively reduced virus RNA replication by 83.7%, while the ethanol and methanol extracts reduced it by 52.7% and 46.3%, respectively. However, the study did not provide results for chloroquine, preventing confirmation of the effectiveness of the extract. To establish the efficacy of the extract, further research is required, including confirmation of the mechanism of action and identification of active ingredients.

5.3. Antitumoral and Anticancer Activity

The antitumor effects of aqueous *T. spathacea* leaf extract (0.0025 to 20 mg/kg p.o.) was evaluated in Fischer rats using the resistant-hepatocyte model and the γ-glutamyl transpeptidase preneoplastic enzymatic marker. Results indicated that the leaf extract at a dose of 5 mg/kg p.o exhibited the highest protective effects against carcinogenic treatment, resulting in a 70% survival rate. Importantly, even at a high concentration of 20 mg/kg p.o., the extract demonstrated non-toxicity to the rats. However, when combined with *N*-diethylnitrosamine and the promoting carcinogen 2-acetylaminofluorene, toxicity was observed, leading to a reduced survival rate of 20% [9]. The mechanism underlying the protective action of the leaf extract remains unclear, necessitating further research to identify active components responsible for its antitumoral activity.

In another study, aqueous *T. spathacea* leaf extract ranging from 1 ng/mL to 100 µg/mL was tested on human lymphocytes mononuclear cells with phytohemagglutinin (10 µg/mL) as the positive standard [16]. Despite weak *in vitro* proliferative responses of human lymphocytes at the highest concentration (stimulation index, S. I., of 1.16), the aqueous extract was significantly less effective compared to the positive control with an S.I. of 335.80. Furthermore, the source of the materials used was not mentioned, raising concerns about data reproducibility.

Additionally, Prakash et al. [45] investigated the effects of hexane, ethyl acetate and methanol extracts of *T. spathacea* leaves on *β*-catenin protein in a human breast adenocarcinoma cell line (MCF-7). The extracts (31 to 1000 µg/mL) successfully inhibited the expression of *β*-catenin protein, achieving 76.13% inhibition at the highest concentration of 1000 µg/mL. However, the author did not specify which of the three extracts were tested against the MCF-7 cell line. Moreover, the lack of positive controls and replication raises concerns about the validity of the results. Lastly, the source of

the *β*-catenin protein and MCF-7 cell line used were not provided, further questioning the reproducibility of the data.

5.4. Anti-inflammatory Activity

T. spathacea has been identified as a promising anti-inflammatory agent, as demonstrated by research conducted by Perez et al. [61]. The anti-inflammatory activity of the 80% (v/v) ethanolic leaf extract of *T. spathacea* was evaluated by treating female Swiss mice and male Wistar rats with different doses (25, 50, 100 mg/kg p.o.) in carrageenan-induced edema. The results were then compared with a positive control, phenylbutazone (PNB) (25, 50, 100 mg/kg p.o.). The findings revealed that the ethanolic extract at 100 mg/kg exhibited 45.83% inhibition, while PNB only inhibited 37.50% at the same dose [61]. Although the therapeutic effects and mechanism of this assay are yet to be determined, its anti-inflammatory properties have proven to be highly effective. A more extensive study is needed to identify the phytochemical responsible for the inhibition effects. Early uses of *T. spathacea* were recorded in China as an anti-inflammatory agent to treat swelling [24], further supported by the significant inhibition of the anti-inflammatory activities of this plant.

5.5. Antioxidant Activity

The antioxidant activity of *T. spathacea* is extensively documented [36, 49, 52, 62−63, 70]. The antioxidant activities were primary evaluated through DPPH free radical scavenging, ferric reducing antioxidant power (FRAP), ferrous ion chelating power assay (FIC) and many more. González-Avila et al. [36] examined the DPPH free radical scavenging activity of ethanolic extract from *T. spathacea* leaves. The ethanolic extract, at concentrations of 1 and 10 μg/mL, showed inhibition of 68% and 67%, respectively. While the inhibition rates were lower than those of quercetin, they were comparable to α-tocopherol and significantly more effective than ascorbic acid.

Tan et al. [49] reported that the infusion of aqueous and methanolic extracts of *T. spathacea* leaves exhibited high total phenolic content (TPC) (465 mg and 433 mg GAE/100 g dry weight, respectively) and showed significant DPPH free radical scavenging at 378 mg and 486 mg AA/100 g dry weight, respectively. The FRAP results indicated that the TPC of the infusion extract was significantly higher than that of the decoction extract, with both having the same value of 2 mg GAE/g dry weight. However, the TPC value of the methanolic extract increased two-fold to 4 mg GAE/g. High TPC and DPPH free radical scavenging ability were corroborated by HPLC-DAD-MS analysis, revealing the presence of four well-known antioxidant phenolic compounds in the leaf extract of *T. spathacea*, namely epigallocatechin (**4**), peltatoside (**5**), rutin (**6**) and rhoeonin (**12**). However, the concentrations used for DPPH and FRAP assays were not specified, and the HPLC-DAD analysis focused solely on decoction extract. Meanwhile, the methanolic extract proved to be the most effective among the three extracts.

In another study, Russo et al. [52] evaluated the antioxidant properties of various extracts from *T. spathacea* leaves and roots. The ethanol:hexane (1:1) root extract exhibited the highest antioxidant power in the FRAP assay. However, the study had some certain shortcomings, such as a lack of information regarding the sources of the materials used and unspecified assay concentrations. Furthermore, despite the authors claiming that the ethanol: hexane (3:1) extract had the highest inhibition rate, the non-linear graph presented only with a regression value of 0.73102. In addition, while standard deviation was provided, the number of replications for the assay was not specified.

A study by Prabhune's group indicated that the methanolic leaf extract showed inhibition in both the DPPH and FRAP assay [62]. Ascorbic acid (10 mg/mL) was used as the standard, and the concentrations of extracts ranged from 0.1% to 0.5% plant powder. The results revealed that the extract with 0.5% plant powder displayed a 46.08% inhibition in the DPPH assay. However, the author did not provide justification for the use of a high concentration of the positive control (10 mg/mL), and the inhibition rate for the positive control was also not included. Crespo et al. [63] additionally documented the antioxidant activity of *T. spathacea* methanolic leaf extract (1 to 100 μg/mL), quercetin and gallic acid (0.03 to 32 μg/mL) using the DPPH free radical scavenging assay.

The methanol extract exhibited an EC_{50} potency of 42 µg/mL, while quercetin and gallic acid showed EC_{50} values of 4 µg/mL and 2 µg/mL, respectively.

5.6. Anti-mutagenic Activity

González-Avila et al. [36] evaluated the in *vitro* antimutagenic activity of *T. spathacea* ethanolic leaf extract using plate-incorporation method on rat liver enzyme. Norfloxacin was employed as a mutagen in the study. The results indicated that *T. spathacea* leaf extract (4 – 16 mg/plate) did not cause an increase in histidine revertants in rats. In fact, in some cases, it reduced the number of revertants compared to the positive control mutagen. However, the mechanisms underlying the antigenotoxic and antimutagenic activities were not evaluated. Further investigation is necessary to identify the compounds responsible and determine the specific mechanism for the activities.

In a subsequent study, Myriam et al. [64] evaluated the effect of ethanol leaf extract of *T. spathacea* on *S. typhimurium* (TA 98, TA 100, TA 102, UTH8413, UTH8414, YG7100, YG7104, YG7108 strains) using preincubation method. The concentrations of ethanolic extract (20 and 40 µg/petri dish) were tested against the strains, with the positive control methyl-*N*'-nitro-*N*-nitrosoguanidine (MNNG) and ethyl-*N*`-nitro-*N*-nitrosoguanidine (ENNG). The results demonstrated significant antimutagenic activity against TA102 strain mutations induced by Mitomycin C. The numbers of revertants for TA100, YG7100 and UTH8414 strain mutations induced by alkylating compounds MNNG and ENNG were also reduced.

5.7. Hepatoprotective Activity

El-Hawary et al. [54] investigated the *in vivo* hepatoprotective activity of *T. spathacea* leaf ethanolic extract at two dose levels (100 mg/kg and 200 mg/kg) against liver fibrosis damage induced by carbon tetrachloride (CCl_4). The study revealed that the extract led to a decrease in the level of aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP), particularly at 100 mg/kg, with Silymarin used as a positive control (25 mg/kg). The results showed that the ethanol extract (100 mg/kg) was comparable to the positive control. However, further investigation is required to identify the effective components and determine the optimal doses for potential effects. The continuation of additional clinical studies is highly recommended.

5.8. Anti-diabetic and Anti-hyperglycemic Activity

Jesetti et al. [65] explored the *in vitro* α-glucosidase inhibition activity of methanolic leaf extracts of *T. spathacea* at concentrations ranging from 20 to 100 µg/mL, using acarbose as the positive control (20 to 100 µg/mL). The IC_{50} of the extract was found to be 85 µg/mL, slightly higher than acarbose (IC_{50} = 51 µg/mL). Subsequently, the authors investigated the anti-hyperglycemic effect of the methanolic extract of *T. spathacea* leaves in vivo. Healthy female rats were injected with alloxan monohydrate in a saline solution to induce type 2 diabetes. The rats were then administered 150, 200, and 400 mg/kg extract in 1% NaCMC, with positive control rats fed with alloxan and 2 mL/kg of NaCMC as negative control rats. Blood glucose levels were observed for 7 days. The results indicated that all doses of *T. spathacea* reduced blood glucose level from 200 mg/dl on the 1st day to less than 100 mg/dl on the 7th day [65]. However, the rationale for selecting high doses (more than 200 mg/kg) was not provided. For a meaningful pharmacological study, a dose range of not more than 200 mg/kg for an *in vivo* study of extracts should be assumed as being the upper limit [66]. Moreover, no further work was done to determine the active components in the extract [65].

Table 2. Pharmacological activities of *T. spathacea* extracts

Plant parts	Country / Region	Extract type	Model/Assay	Dose range/ Duration	Organism/ Cell line	Control	Results	Ref.
Antimicrobial/ antifungal activity								
Leaves	Eklahare, district Nashik, India	(i) 70% (v/v) ethanol (ii) Aqueous	Agar diffusion method	10, 30, 50 mg/mL of extract	Pathogenic microorganisms: (i) *S. aureus* (ii) *B. subtilis* (iii) *E. coli*	5 µg/mL of Cephalexin 250	Zone of inhibition (mm) 50 mg/mL: 70% EtOH / Aqueous / Cephalexin 250 (1 mg/mL) (i) 7.3 / 6.8 / 12.5 (ii) - / - / 13.6 (iii) 6.2 / 5.3 / 14.4	[10]
Leaves	Bogor, Indonesia	Aqueous	Lowenstein-Jensen (L-J) proportion method	1.25, 2.5, 5 mg/mL	(i) *Mycobacterium tuberculosis* H37Rv strain (ii) Isolated multi-drug resistant (MDR) strain	Rifampicin (40 µg/mL)	Inhibition rate (%) Aqueous extract: mg/mL 1.25 / 2.50 / 5.0; Rifampicin: 40 µg/mL (i) 32.1 / 100.0 / 100.0 / 100.0 (ii) 28.6 / 100.0 / 100.0 / 0	[41]
Leaves	Petaling Jaya, Malaysia	(i) Decoction (ii) Infusion (iii) 80% (v/v) Methanol extract	Well diffusion method	200 mg/mL of extract	Pathogenic microorganisms: (i) *B. cereus* (ii) *B. subtilis* (iii) *M. luteus* (iv) MRSA (v) *S. epidermidis* (vi) *S. saprophyticus* (vii) *A. hydrophila* (viii) *K. pneumonia* (ix) *N. gonorrhoeae* (x) *P. vulgaris*	Vancomycin	MIC (mg/mL) Decoction / Infusion / MeOH extract (i) 10 / 10 / 10 (ii) 10 / 5 / 10 (iii) 10 / 10 / 10 (iv) 2.5 / 2.5 / 10 (v) 10 / 10 / 10 (vi) 10 / 5 / 10 (vii) 5 / 5 / 10 (viii) 10 / 10 / - (ix) 10 / 10 / - (x) 10 / 10 / 3 Vancomycin: <0.02	[49]

Traditional uses, pharmacological properties of *Tradescantia spathacea*

Leaves	Nilgiris, Tamil Nādu, India	(i) Benzene (ii) Chloroform (iii) Methanol (iv) Petroleum ether (v) Aqueous	Disk diffusion method	2.5, 5, 10 mg/mL of extract and 20 µL/disk	Pathogenic microorganisms: (i) *S. aureus* (ii) *S. citrus* (iii) *B. subtilis* (iv) *Serratia* (v) *P. vulgaris* (vi) *K. pneumoniae* (vii) *S. Typhi* (viii) *P. aeruginosa*	Chloramphenicol and Streptomycin (10 µg/disk)	Zone of inhibition (mm) 5 mg/mL: (i) 9, 7, 7, 8, 7; (ii) 8, -, -, -, -; (iii) 7, 8, -, -, -; (iv) 9, 8, 7, 7, 7; (v) 9, 7, 9, 8, 7; (vi) 9, 7, -, -, -; (vii) 8, 7, 9, 9, 9; (viii) 7, -, 8, 8, 8 (P.ether, Benzene, Chloroform, MeOH, Water)	[58]
Leaves	Pak Thongchai, Nakhon Ratchasima Province, Thailand	(i) 95% (v/v) ethanol (ii) Chloroform	Disk diffusion method	15 mg/mL of extract and 15 µL/disk	Pathogenic microorganisms: (i) *E. coli* (ii) *S. enterica* Typhimurium U302 (iii) *S. enterica* Enteritidis (human) (iv) *S. enterica* 4,5,12: i-human US clone (v) *B. cereus* (vi) *L. monocytogenes 10403S*	Penicillin-G (100 mg/mL)	MIC (µL/mL) (i) 128, - (ii) 128, 64 (iii) 128, 32 (iv) 128, 64 (v) 128, 32 (vi) 128, 32 (95% EtOH, Chloroform)	[59]
Leaves	Batu Pahat, Johor, Malaysia	(i) Hexane (ii) Chloroform (iii) Ethyl acetate (iv) Ethanol (v) Methanol (vi) Water	colorimetric broth microdilution method	0.02 to 2.50 mg/mL	Pathogenic microorganisms: (i) *C. albicans* (ii) *C. parapsilosis* (iii) *C. krusei* (iv) *C. neoformans* (v) *A. fumigatus* (vi) *T. interdigitale*	Amphotericin (0.06-8 µg/mL)	MIC (mg/mL) (i) 0.31, 0.31, 0.63, 0.63, 0.63, 0.63 (ii) 0.31, 0.31, 0.63, 0.63, 0.63, 0.63 (iii) 0.63, 0.63, 0.63, 0.63, 0.63, 0.63 (iv) 0.08, 0.08, 0.31, 0.16, 0.16, 0.31 (v) >2.50, >2.50, >2.50, >2.50, >2.50, >2.50 (vi) 0.31, 0.63, >2.50, >2.50, >2.50, >2.50 (Hexane, Chloroform, EA, EtOH, MeOH, Water)	[60]

Roots	Kuala Lumpur	(i) Hexane (ii) Ethyl acetate	(i) Disc diffusion (DF) (ii) Broth microdilution (MD)	(i) 5, 10, 20, 40 mg/mL (ii) Hex: 0.019 to 10 mg/mL EA: 0.039 to 20 mg/mL	(i) *E. faecium* (ii) *S. aureus* (iii) *E. coli* (iv) *A. baumannii*	(i) Gentamycin (10 µg/disc) (ii) Tetracycline HCl (0.008 to 5 mg/mL)	(i) Only active against *S. aureus* with minimum inhibition at 10 mg/mL with 8 mm inhibition zone for Hex extract; and at 20 mg/mL with 8 mm inhibition zone for EA extract. (ii) MIC values for Hex and EA extract were 10 and 20 mg/mL, respectively.	[69]
Antiviral activity								
Leaves	Batu Pahat, Johor, Malaysia	(i) Chloroform (ii) Ethanol (iii) Methanol	(i) *In vitro* Cytopathic effect inhibition assay (ii) *In vitro* Quantitative RT-PCR assay	(i) Chloform(80 µg/mL) (ii) EtOH (512 µg/mL) (iii) MeOH:512 µg/mL	(i) African monkey kidney epithelial (Vero) cell line (CCL-81) (ii) Chikungunya virus RNA	Chloroquine (0.39 to 12.4 µM)	The highest cytopathic impact was seen from the ethanol and methanol extracts, with cell viabilities of 92.6% ± 1.0% and 91.5% ± 1.7%. Chloroform extract at 80 µg/mL successfully reduced 83.7% of virus RNA replication, while ethanol and methanol extracts were 52.7% and 46.3%, respectively.	[15]
Antitumoral/Anticancer activity								
Leaves	Mexico	Aqueous	*In vivo* rat resistant-hepatocyte model	0.0025 to 20 mg/kg of extracts	Rats	Rat with complete carcinogenic treatment	The results showed that at 5 mg/kg dose had the most protecting effect with a 70% survivability. At high doses of 20 mg/kg, it was non-toxic towards the rats.	[9]
Leaves	Nonthaburi, Thailand	Aqueous	*In vitro* lymphoproliferation assay	1 ng/mL to 100 µg/mL	Human lymphocytes mononuclear cells	Phytohemagglutinin (10 µg/mL)	Conc. / Effect of lymphocyte proliferation (S.I.) 1 ng/mL: 1.82 ± 1.55 10 ng/mL: 1.41 ± 0.27 100 ng/mL: 0.95 ± 0.19 1 µg/mL: 1.06 ± 0.19 5 µg/mL: 1.70 ± 0.40 10 µg/mL: 1.53 ± 0.29 100 µg/mL: 1.16 ± 0.29	[16]

Leaves	India	(i) Hexane (ii) Ethyl acetate (iii) Methanol	*In vitro* MTT assay	31 to 1000 µg/mL	MCF-7 cell line			[45]

Test Drug + ß-Catenin	Test Conc in µg/mL	% Cytotoxicity	CTC_{50} in µg/mL
MCF-7	1000	76.13	230
	500	61.49	
	250	52.76	
	125	40.84	
	60.5	24.95	
	31.25	00.51	

Anti-inflammatory activity

Leaves	Tabasco, Mexico	80% Ethanolic extract	*In vivo* carrageenan-induced edema	25, 50, 100 mg/kg	0.1% carrageenan solution	(i) Aqueous solution of phenylbutazone (PNB) (25, 50, 100 mg/kg) (positive control) (ii) Saline (negative control)		[61]

Dose (mg/kg)	Inhibition (%)
25	27.77
50	33.33
100	45.83

Antioxidant activity

Leaves	Veracruz, Mexico	Ethanolic extract	*In vitro* DPPH radical scavenging assay	1, 10, 100 µg/mL	(i) Quercetin (ii) α-tocopherol (iii) Ascorbic acid (1, 10, 100 µg/mL)	The ethanol extracts of 1, 10, and 100 µg/mL showed 67%, 68%, and 80% inhibitory activity, respectively.	[36]
Leaves	Petaling Jaya, Malaysia	(i) Decoction (ii) Infusion (iii) Methanolic extract	*In vitro:* (i) DPPH radical scavenging assay (DPPH) (ii) Ferric reducing antioxidant potential (FRAP) (iii) Ferrous ion chelating (FIC) assay		(i) Ascorbic acid (ii) Gallic acid	FIC assay was done but none of the extract exhibited metal chelating ability.	[49]

	DPPH (mg AA/100 g)	FRAP (mg GAE/g)
Decoction	309 ± 47	2 ± 0
Infusion	378 ± 91	2 ± 1
Methanolic extract	486 ± 116	4 ± 1

Leaves and roots	St. Thomas Uni, Indonesia	(i) 3:1 EtOH:Hex (ii) 1:1 EtOH:Hex (iii) 100% Ethanolic extract	*In vitro:* (i) DPPH radical scavenging assay (ii) Ferric reducing antioxidant potential (FRAP)		(i) Ascorbic acid (ii) Gallic acid	The author claimed that 3:1 ethanol: hexane root extracts exhibited the highest DPPH FRS inhibition activity, but no results were provided. Plant Extract — FRAP (mg AAE/g) 3:1 EtOH:Hex Leaves — 3 ± 1 1:1 EtOH:Hex Leaves — 2 ± 0 100 EtOH Leaves — 3 ± 0 3:1 EtOH:Hex Roots — 4 ± 1 1:1 EtOH:Hex Roots — 4 ± 1 100 EtOH Roots — 3 ± 1	[52]
Leaves	YC Institute of Science, Satara	Aqueous	*In vitro:* (i) DPPH radical scavenging assay (ii) Ferric reducing antioxidant potential (FRAP)	0.1% to 0.5%	Ascorbic acid (10 mg/mL)	The results showed *T. spathacea* has 46.08% inhibition for DPPH assay at 0.5% plant powder concentration. The results for FRAP assay were 1.0527 ascorbic acid equivalent.	[62]
Leaves	San Francisco de Campeche, Campeche, México	Methanolic extract	*In vitro* DPPH radical scavenging assay	1 to 100 µg/mL	Gallic acid and quercetin (1-50 µg/mL)	Antioxidant DPPH Plant Extract — Potency EC_{50} (µg/mL) Methanolic extract — 42 ± 10	[63]
Roots	Kuala Lumpur, Malaysia	Hexane and Ethyl acetate extracts	*In vitro*: (i) DPPH and (ii) FRAP assay	(i) 3 to 400 µg/mL (ii) 1 to 100 µg/mL	(i) Ascorbic acid (ii) Trolox	Plant Extract — DPPH EC_{50} (µg/mL) — FRAP (mmol Fe^{2+}/g DW) Hex — 266 ± 48 — 2.47 ± 0.49 Ethyl acetate — 88 ± 16 — 6.13±0.87 Ascorbic acid — 6 ± 0 — 11.76 ± 0.12 Trolox — 8 ± 1 — 19.86 ± 0.24	[70]

Antimutagenic activity

Leaves	Veracruz, Mexico	Ethanolic extract	Plate-incorporation method on rat liver enzyme	4 – 16 mg/ plate	*S. typhimurium* TA97, TA98 and TA100 strains	Picrolonic acid, 2-aminoantracene, benzo[a]pyrene, *N*-ethyl-*N*'-nitro-*N*-nitrosoguanidine, cyclophosphamide	See table below	[36]

ECE mg/ plate	TA97		TA98		TA100	
	-S9	+S9	-S9	+S9	-S9	+S9
0	102±26	131±24	29±4	31±2	241±11	381±35
4	177±9	150±12	35±5	49±6	294±27	387±6
8	148±33	149±30	34±8	37±6	312±31	304±85
12	155±19	132±29	35±3	38±11	290±30	273±25
16	79±18	128±7	39±2	37±13	245±23	324±29
20	57±8	153±27	0	39±9	238±22	235±16
40	Nd	Nd	0	0	256±26	228±1
60	Nd	Nd	0	0	38±33	242±12
Mutagen (Norfloxacin)	590	2065	328	1600	3900	1246

Leaves	Veracruz, Mexico	Ethanolic extract	Preincubation method	20 and 40 µg/mL	*S. typhimurium* TA97, TA98 and TA100, TA102, UTH8413, UTH8414, YG7100, YG7104, YG7108 strains	Methyl-*N*`-nitro-*N*-nitrosoguanidine (MNNG), ethyl-*N*`-nitro-*N*-nitrosoguanidine (ENNG)	The author claimed that the extracts were only effective against TA100, TA102, YG7100 and UTH8414 strains.	[64]

Traditional uses, pharmacological properties of *Tradescantia spathacea*

Hepaprotective activity								
Leaves	Giza, Egypt	80% ethanolic extract	*In vivo* hepaprotective	100, 200 mg/kg	Male albino rats	Silymarin (25 mg/kg)	Groups / AST (U/L) / ALT (U/L) / ALP (U/L) Control: 38.6 ± 1.1 / 37.9 ± 1.2 / 7.4 ± 0.1 CCl_4 Control: 155.6 ± 6.2 / 153.2 ± 6.8 / 58.2 ± 3.8 *T. spathacea* (100 mg/kg): 52.6 ± 1.8 / 56.9 ± 2.1 / 16.9 ± 0.7 *T. spathacea* (200 mg/kg): 58.3 ± 1.6 / 62.2 ± 1.4 / 17.1 ± 0.1 Silymarin: 39.2 ± 1.9 / 42.5 ± 1.2 / 7.8 ± 0.1	[54]
Antidiabetic and anti-hyperglycemic activity								
Leaves	Hue city, Viet Nam	Methanolic extract	*In vitro* Protein tyrosine phosphatase 1B (PTP1B) inhibitory assay	-	*p*-nitrophenyl phosphate (*p*NPP) (substrate)	Ursolic acid	The results indicated that Bracteanolide A **13**, Latifolicinin C **17**, Latifolicinin A **19**, and Oresbiusin A **22** possessed potent inhibitory activity toward PTP1B with IC_{50} values of 7.8 ± 0.8, 6.8 ± 0.9, 4.6 ± 0.9, and 6.4 ± 0.1 µM, respectively.	[55]
Leaves	Laknepally, Warangal, Telangana, India	Methanolic extract	*In-vitro*: (i) Inhibitory activity of α-amylase (ii) Inhibitory activity of α-glucosidase *In vivo*: (iii) Oral glucose tolerance test (iv) Hypoglycemic test	(i), (ii): 20, 40, 60, 80 and 100 µg/mL (iii), (iv): 150, 200 and 400 mg/kg	(i) α-amylase solution (ii) α-glucosidase (iii) Normal rats (iv) Alloxan diabetic rats	Acarbose	(i) IC_{50}: 66 ± 0 µg/mL (ii) IC_{50}: 85 ± 1 µg/mL (iii) 400 mg/kg significantly reduced the area under the blood glucose level curve in a typical rat test. (iv) One dose of the extract decreased blood glucose level from 211 mg/dl to 89 mg/dl at 400 mg/kg of methanolic extract.	[65]
Cytotoxicity activity								
Leaves	Batu Pahat, Johor, Malaysia	Hexane, chloroform, Ethyl acetate, ethanol, methanol and distilled water	Cell viability by neutral red uptake assay	5 – 640 µg/mL	African monkey kidney epithelial (Vero) cell line (CCL-81)		Extracts / CC_{50} (µg/mL) Chloroform: 238.5 ± 3.1 Ethanol: NA Methanol: NA "NA" expressed as no cytotoxicity at the highest concentration	[15]

tested (640 µg/mL)

Leaves	Veracruz, Mexico	Hexane, chloroform, petroleum ether, acetone, ethyl acetate, ethanol, methanol, and distilled water	MTS cytotoxicity assay	10, 100 µg/mL	NIH/3T3 cell line Extract: Distilled water; Concentration (µg/mL): 10; Cell viability (%): 81.2 ± 5.8 Extract: Pet.ether; Concentration (µg/mL): 10; Cell viability (%): 93.4 ± 5.2 PC3 cell line Extract: Distilled water; Concentration (µg/mL): 10; Cell viability (%): 63.3 ± 3.7 Extract: Pet. ether; Concentration (µg/mL): 100; Cell viability (%): 61.2 ± 2.5 Extract: Chloroform; Concentration (µg/mL): 100; Cell viability (%): 60.3 ± 2.1 Extract: Hexane; Concentration (µg/mL): 100; Cell viability (%): 59.6 ± 2.6 HepG2 cell line Extract: Ethyl Acetate; Concentration (µg/mL): 100; Cell viability (%): 8.9 ± 1.1 Extract: Pet. ether; Concentration (µg/mL): 10; Cell viability (%): 8.8 ± 1.7 Extract: Chloroform; Concentration (µg/mL): 10; Cell viability (%): 3.5 ± 0.3 HT29 cell line Extract: Distilled water; Concentration (µg/mL): 100; Cell viability (%): 10.6 ± 1.5 Extract: Methanol; Concentration (µg/mL): 100; Cell viability (%): 32.0 ± 14.4 Extract: Pet. ether; Concentration (µg/mL): 10; Cell viability (%): 31.1 ± 13.4 Extract: Chloroform; Concentration (µg/mL): 10; Cell viability (%): 26.6 ± 6.5	[56]

Leaves	Perak, Malaysia	Herxane, chloroform, Ethyl acetate, ethanol, methanol and distilled water	Cell viability by neutral red uptake assay	5 – 640 µg/mL	African monkey kidney epithelial (Vero) cell line (CCL-81)		Extracts: Hexane – CC_{50} 457.2 ± 6.2; Chloroform – 238.5 ± 3.1; Ethyl Acetate – -; Ethanol – -; Methanol – -; Distilled water – -. "-" denotes no significant cytotoxicity at the highest concentration tested (640 µg/mL)	[60]
Vasorelaxant activity								
Leaves	San Francisco de Campeche, Campeche, México	Methanolic extract	*In vivo* vasorelaxant activity	0.03 to 560 µg/mL	Rats (*Rattus norvergicus*)	Papaverine (0.1-3 µg/mL)	Vasorelaxant activity: Methanolic extract – Potency EC_{50} >500 (µg/mL)	[63]
Anti-Coagulant activity								
Leaves	Timarpur, Karimnagar District, Telangana	Methanolic extract	*In vivo* blood clotting time measurement and prothrombin time.	5, 10, 20 mg/mL	Acid citrate dextrose (anticoagulant) and Calcium Thromboplastin reagent	Phosphate Buffered Saline (PBS)	5 mg/mL: Blood clotting time 5.24 sec, Prothrombin time 40.35 sec; 10 mg/mL: 10.87 sec, 65.74 sec; 100 mg/mL: 18.24 sec, 80.78 sec	[68]
Anti-helminthic activity								
Leaves	Timarpur, Karimnagar District, Telangana	Ethanolic extract	Paralysis and death time of earthworms *Pheretima posthuma*	10 and 20 mg/mL	Indian adult earthworms, *Pheretima posthum*	Albendazole (10 mg/mL) and Tween 80	20 mg/mL: Paralysis time 80 ± 5 mins, Death time 120 ± 10 mins; 100 mg/mL: 110 ± 10 mins, 150 ± 10 mins	[69]
Antigenotoxic activity								
Leaves	Veracruz, Mexico	Ethanolic extract	*In vitro* Genotoxicity assay	19 - 500 ng/culture dish	(i) Hepatocytes isolated from male Wistar rats (180-200 g) (ii) Diethyl nitrosamine (DEN) (1.25 µM)		Ethanolic extract was not genotoxic and reverted in 75% of the genotoxicity induced by DEN.	[56]

Sixteen compounds from aerial parts of *T. spathacea* methanolic extract were evaluated for the inhibition of the type 2 diabetes-causing protein tyrosine phosphatase 1B (PTP1B) using *p*-nitrophenyl phosphate (*p*NPP) as a substrate, with ursolic acid as the positive control [55]. Compound **13**, 17, **19** and **22** exhibited IC_{50} (7.82, 6.80, 4.55 and 6.38 µM, respectively) of less than 10 µM, while compounds **23** and **36** were chosen for further kinetic analysis using Lineweaver-Burk plots. Compound **22** emerged as the most potent, with an inhibition constant (K_i) of 4.06 µM in a noncompetitive mode of inhibition, followed by compound **17** with a K_i of 4.45 µM in a mixed mode of inhibition. Other compounds have K_i values ranging from 7.15 to 18.36 µM in competitive and mixed inhibition modes. Future *in vivo* studies should be conducted to comprehensively understand their cellular effects and metabolism for the development of diabetic drugs.

5.9. Cytotoxicity Activity

The cytotoxicity effects of *T. spathacea* leaf extracts were investiagted by Chan et al. [15], García-Varela et al. [56] and Oon et al. [60]. García-Varela et al. [56] evaluated the cytotoxic properties of various extracts from *T. spathacea* leaves using a cell proliferation assay against colon cancer cell line (HT-29), liver cancer cell line (Hep-G2) and prostate cancer cell line (PC3) and fibroblast cell line (NIH/3T3). The results revealed that the chloroform extract at 10 µg/mL gave only 3.5% viability against the Hep-G2 cells. The aqueous extract (10 µg/mL) demonstrated significant inhibition effects on HT-29 and PC-3 cells, with cell viabilities of 10.9% and 63.6%, respectively. In contrast, the normal NIH/3T3 cells showed 81.2% viable cells.

Oon and co-workers reported that the ethyl acetate, ethanol, methanol, and water extracts of *T. spathacea* leaves, at concentrations ranging from 5 to 640 µg/mL, exhibited no significant cytotoxicity, even at the highest concentration (640 µg/mL), against African monkey kidney epithelial (Vero) cells. Cell viability remained above 90%, as determined by 96-well microtiter plates method [60]. Meanwhile, Chan and team reported that the CC_{50} values for chloroform, ethanol and methanol extract were non-toxic, as no cytotoxicity effect were observed at the highest concentration (640 µg/mL) [15].

5.10. Other Activities

Various activities, including anti-genotoxic activity [56], vasorelaxant activity [63], blood anti-coagulant [68] and in vitro anti-helminthic [69], have been reported (Table 2). García-Varela et al. conducted a study on the antigenotoxic activities of T. spathacea ethanolic leaf extract (1.9 to 500 ng) against hepatocyte cells induced with genotoxic effect by incorporating 1.25 µM of diethylnitrosamine (DEN) [56]. The ethanolic extract of *T. spathacea* demonstrated non-genotoxicity and successfully reverted 75% of the genotoxicity induced by DEN, suggesting its potential as a chemoprotection agent.

In the study on *in vitro* anti-helminthic activity conducted by Chamakuri et al. [69], the ethanolic extract of *T. spathacea* leaves, at concentrations of 10 and 20 mg/mL, was evaluated against an Indian adult earthworm, *Pheretima posthuma*, with Albendazole (10 mg/mL) and 1% (m/v) Tween 80 as the positive and negative controls, respectively. *Pheretima posthuma* exhibited a death time of 120 minutes and 150 minutes for 20 mg/mL and 10 mg/mL ethanolic leaf extract, respectively, compared to Albendazole, which had a death time of 70 minutes. However, the lack of replication of the analysis raised concerns about the reliability of experimental results. The validity of the observation should be ensured through the analysis of at least three independent replicates [57]. In addition, the source of the materials used was not specified, raising questions about the data reproducibility.

5.11. Toxicity

While the sap of the fresh leaves from *T. spathacea* is commonly considered an irritant [1], the study revealed that the ethanol extract from the leaves of *T. spathacea* were found neither mutagenic in *S. typhimurium* nor genotoxic in liver cell culture, even at concentrations as high as four- and 166-

fold of those needed for maximal antimutagenic or chemoprotective activities, respectively [64]. These findings suggest that *T. spathacea* may potentially serve as a medically adjunctive or chemoprotective agent. Jesetti et al. [65] also conducted acute oral toxicity studies at doses up to 5 g/kg, observing no toxic reactions or lethality in Wistar rats. However, these findings alone are insufficient to draw conclusions regarding the overall toxicity and safety of the plants. Further comprehensive exploration of the toxicity profile of *T. spathacea* is imperative for a more thorough understanding.

6. Conclusions and Future Perspective

T. spathacea, a widely recognized species in traditional herbal medicine, has garnered significant attention from researchers due to its applications in treating various ailments. This review comprehensively explores the traditional uses, phytochemical composition, and pharmacological activities of *T. spathacea*, aiming to serve as a reference for its further development. While numerous pharmacological studies have highlighted the plant's diverse activities, aligning with its traditional medicinal role. For instance, studies have demonstrated that *T. spathacea* leaves possess potent antimicrobial and antioxidant activity, further supporting the traditional use of the leaves for wounds, skin infections, fever, cancer, rhinitis, and respiratory ailments. However, certain limitations within the existing literature necessitate attention.

Primarily, most of the pharmacological investigations are either conducted in animal models or *in vitro*, lacking elucidation of the pharmacokinetics and pharmacodynamics profiles of extracts exhibiting promising activities. Consequently, there is a pressing need for *in vivo* human extrapolation and clinical studies to establish safe and effective starting doses for human applications. Furthermore, limited research on the biological activity of isolated compounds underscores the importance of extensive bioassay-guided fractionation to identify bioactive compounds and elucidate their mechanisms of action.

The lack of toxicity studies in current works calls for comprehensive evaluations to assess the adverse effects of the extracts and bioactive components, along with establishing the overall toxicity profile of the plant. Moreover, while most studies focus solely on the leaves, it is essential to explore the pharmacological activities of other plant parts, such as the whole plant, root and flowers of *T. spathacea*, which have been traditionally used in conventional medicine. Finally, ensuring the repeatability of experiments, incorporating controls and standards, specifying the source of materials, and rationalizing the selection of doses or concentrations of extracts and controls are crucial aspects for verifying and validating the experimental findings. Addressing these considerations will enhance the robustness and applicability of future research on *T. spathacea*.

Acknowledgments

This work was financially supported by TAR UMT Publication incentive with a vote head number 86000-4923.

ORCID

Siow-Ping Tan: 0000-0002-5861-6962
Xin-Yi Keng: 0009-0006-9740-3966
Bryan Chi-Wah Lim: 0000-0002-7697-144X
Hui-Yin Tan: 0000-0002-6018-7730

References

[1] M. Butnariu, C. Quispe, J. Herrera-Bravo, A. Fernández-Ochoa, Emamzadeh-Yazdi, Simin, C. O. Adetunji, A. E. Memudu, A. Otlewska, P. Bogdan, H. Antolak, K. Tamimi, N. Baghalpour, J. M. Bakhtiyari, S. Sen, K. Acharya, A. Segura-Carretero, M. Cádiz-Gurrea, S. H. E. Lim and J. Sharifi-Rad

(2022). A Review on *Tradescantia*: Phytochemical constituents, biological activities and health-promoting effects, *Front. Biosci.* **27**, 197-211.

[2] H. Golczyk (2013). Cytogenetics of *Tradescantia spathacea* (syn. *Rhoeo spathacea*). A review Cytogenetyka *Tradescantia spathacea* (syn. *Rhoeo spathacea*), *Ann. UMCS. Biol*. **68**, 39-53.

[3] D. R. Hunt (1986). Campelia, Rhoeo and Zebrina United with *Tradescantia*: American Commelinaceae: XIII, *Kew Bull*. **41**, 401-405.

[4] C. R. Hardy and D. W. Stevenson (2000). Floral organogenesis in some species of *Tradescantia* and *Callisia* (Commelinaceae), *Int. J. Plant Sci*. **161**, 551-562.

[5] R. G. Hawke (2010). A comparative study of *Tradescantia Cultivars*, Plant Eval. Notes **34**, 1-9.

[6] M. O. O. Pellegrini (2017). Morphological phylogeny of *Tradescantia* L. (Commelinaceae) sheds light on a new infrageneric classification for the genus and novelties on the systematics of subtribe *Tradescantiinae*, *PhytoKeys* **89**, 11-72.

[7] S. Pulipaka, A. Suttee, M. R. Kumar and P. Sriram (2020). A review on phytopharmacological activities of *Alpinia mutica* and *Tradescantia spathacea*, *Plant Arch*. **2**, 9011-9018.

[8] V. A. Argueta and A. L. Cano (1994). Atlas de las Plantas de la medicina tradicional Mexicana, *Inst. Nat́ l. Indigenista Mex*. 1424-1425.

[9] T. Rosales-Reyes, M. de la Garza, C. Arias-Castro, M. Rodríguez-Mendiola, S. Fattel-Fazenda, E. Arce-Popoca, S. Hernandez-Garcia and S. Villa-Treviño (2008). Aqueous crude extract of *Rhoeo discolor*, a Mexican medicinal plant, decreases the formation of liver preneoplastic foci in rats, *J. Ethnopharmacol*. **115**, 381-386.

[10] P. R. Shinde, P. V. Gujrani, A. R. Gupta, P. G. Dhondge and S. J. Sangle (2021). Exploration of pharmacognostic, phytochemical and antibacterial potential of *Rhoeo discolor* Hance, *J. Pharm. Phytochem*. **10**, 1625-1630.

[11] I. M. Madaleno (2009). Medicinal Knowledge in Cuba - domestic prescriptions using front and backyard biodiversity, Conf. Int. Res. Food Security, Nat. Resource Mgmt., Rural Devt., University of Hamburg.

[12] R. Nair, T. Kalariya and S. Chanda (2005). Antibacterial activity of some selected Indian medicinal flora, *Turkish J. Biol*. **29**, 41-47.

[13] I. Marian, (2007). 1000 de plante medicinale (1000 Kräuter), Aquila. Oradea'93 Oradea.

[14] R. A. DeFilipps and G. A. Krupnick (2018). The medicinal plants of Myanmar, *PhytoKeys* **28**, 1-341.

[15] Y. S. Chan, K. S. Khoo and N. W. Sit (2016). Investigation of twenty selected medicinal plants from Malaysia for anti-Chikungunya virus activity, *Int. Microbiol*. **19**, 175-182.

[16] B. Sriwanthana, W. Treesangsri, B. Boriboontrakul, S. Niumsakul and P. Chavalittumrong (2007). *In vitro* effects of Thai medicinal plants on human lymphocyte activity Songklanakarin, *J. Sci. Tech*. **29**, 17-28.

[17] T. Prajapati, A. Shukla and N. Modi (2020). *Tradescantia spathacea* Sw: A review of its pharmacological and ethnopharmacological properties, *Int. J. Res. Cult. Soc*. **4**, 52-56.

[18] K. A. Langeland and R. K. Stocker (2001). Control of non-native plants in natural areas of Florida, *Dept. Agron. Inst. Food Agric. Sci. Uni. Florida*, 242-252.

[19] J. B. L. Tan and Y. M. Kwan (2020). The biological activities of the spiderworts (*Tradescantia*), *Food Chem*. **317**, 126411-126420.

[20] R. A. DeFilipps and G. A. Krupnick (2018). The medicinal plants of Myanmar, *PhytoKeys* **102**, 1-134.

[21] M. Martı´nez (1969). Las plantas medicinales de Me´xico, *ed:* Botas. Méx, pp.368-372.

[22] R. M. Mendieta (1981). Plantas medicinales del estado de Yucata´n, *ed*: Cecsa. Méx, pp.225-229.

[23] A. Aguilar, R. Camacho and S. Chino (1994). Herbario medicinal del Instituto Mexicano del Seguro Social, (IMSS), Me´xico, pp. 35-36.

[24] J. A. Duke and E. S. Ayensu (1985). Medicinal plants of China, References Publications, Algonac.

[25] A. Meybeck, P. Potier, F. Bonte, F. Picot and J. P. Cosson (1999). Use of the Rhoeo discolor plant extracts in cosmetics and pharmaceutics in particular in dermatology, *Pat. Abs. France*, FR2767690.

[26] V. Tandon, B. Kapoor and B. M. Gupta (2004). Herbal drug research in India: A trend analysis using IJP as a marker (1995-2003), *Indian J. Pharmacol*. **36**, 99-100.

[27] C. Luciano-Montalvo, I. Boulogne and J. Gavillan-Suarez (2013). A screening for antimicrobial activities of Caribbean herbal remedies, *BMC Complement. Alt. Med*. **13**, 126-133.

[28] N. Bunyapraphatsara and A. Chokechaijareonporn (2000). Sa-moon-prai: Mai-peun-ban. Prachachon Printing, Bangkok.

[29] M. Rahmatullah, D. Ferdausi, A. Mollik, R. Jahan, M. H. Chowdhury and W. M. Haque (2010). A survey of medicinal plants used by Kavirajes of Chalna area, Khulna district, Bangladesh, *Afr. J. Tradit. Complement. Altern. Med*. **7**, 91-97.

[30] R. Roys (1931). The Ethhno-Botany of the Maya. The Tulane University of Louisiana, New Orleans. U.S.A.

[31] Forest Department (1999). Medicinal plants of Popa Mountain Park. Ministry of Forestry, Yangon, Myanmar.

[32] A. Alvin, K. I. Miller and B. A. Neilan (2014). Exploring the potential of endophytes from medicinal plants as sources of antimycobacterial compounds, *Microbiol. Res*. **169**, 483-495.

[33] R. S. Del-Amo (1979). Plantas medicinales del estado de Veracruz, Instituto Nacional de Investigaciones Sobre Recursos Bioticos, M exico.

[34] M. A. Magaña-Alejandro, L. M. Gama-Campillo and R. Mariaca-Méndez (2010). The use of medicinal plants in Maya-chontal communities from Nacajuca, Tabasco, Mexico, *Polibotánica* **29**, 213-262.

[35] L. Marco, V. Heike, S. Otto and H. Michael (2001). Ethnopharmacology of the Popoluca, Mexico: an evaluation, *J. Pharm. Pharmacol*. **53**, 1653-1669.

[36] M. Gonzalez-Avila, M. Arriaga-Alba, M. de la Garza, H. M. del Carmen, M. A. Dominguez-Ortiz, S. Fattel-Fazenda, S. Villa-Trevino (2003). Antigenotoxic, antimutagenic and ros scavenging activities of a Rhoeo discolor ethanolic crude extract, *Toxicol. Vitro*, **17**, 77-83.

[37] M. A. Magaña (2009). Conocimiento tradicional de las plantas medicinales en cinco comunidades Maya-Chontales del municipio de Nacajuca, Tabasco, Tesis Doctoral, Universidad Juárez Autónoma de Tabasco.

[38] G. G. S. Laura, R. C. Ricardo and B. J. Herlinda (2014). Medicinal plants for the treatment of "nervios", anxiety and depression in Mexican traditional medicine, *Rev. Bras. Farmacogn*. **24**, 591-608.

[39] R. C. Cambie and L. R. Ferguson (2003). Potential functional foods in the traditional Maori diet, *Mutat. Res*. **109**, 523-524.

[40] Executive Yuan Committee on Chinese Medicine and Pharmacy (2003). List of Medicinal Plant Resources in Taiwan, Department of Health, Executive Yuan, Taiwan.

[41] M. Radji, M. Kurniati, M and A. Kiranasari (2015). Comparative antimycobacterial activity of some Indonesian medicinal plants against multi-drug resistant Mycobacterium tuberculosis, *J. Appl. Pharm. Sci*. **5**, 19-22.

[42] M. Rahmatullah, D. Ferdausi, Md. A. H. M. Mollik, Md. N. K. Azam, M. Taufiq-Ur-Rahman and R. Jahan (2009). Ethnomedicinal survey of Bheramara area in Kushtia District, Bangladesh, *Amer. Eurasian J. Sustain. Agric*. **3**, 534-541.

[43] M. E. Nunez (1975). Plantas medicinales de Costa Rica y su Folclore, Editorial Universidad de Costa Rica. pp. 280.

[44] E. Pöll (1997). Medicinal plants of Guatemala with hypoglycemic effects, *Acta Hortic*. **500**, 197-202.

[45] R. Prakash and R. Rajesh (2014). Aberrant expression of WNT/Beta-catenin signalling pathway and *in-vitro* cytotoxic activity of *Tradescantia Spathacea* medicinal plant used to treat human breast adenocarcinoma (MCF7 Cell Lines), *Int. J. Pharm. Sci. Res*. 5, 5230-5234.

[46] F. M. Oloyede, H. C. Illoh and F. A. Oloyede (2007). Taxonomical studies of selected ornamental plants, *Ife. J. Sci*. **9**, 167-171.

[47] M. B. Nikam, P. S. Mundada, D. A. Kadam, S. N. Jadhav and V. T. Aparadh (2013). Comparative screening of various solvents for phytochemical testing using some Commelinaceae members, *Int. Res. J. Pharm. Appl. Sci*. **3**, 18-20.

[48] P. M. Kadam and N. P. Kakde (2017). Phytochemical study of *Tradescantia spathacea*, *Int. Res. J. Bio. Sci*. **6**, 48-51.

[49] J. B. L. Tan, Y. Y. Lim and S. M. Lee (2010). Antioxidant and antibacterial activity of *Rhoeo spathacea* (Swartz) stearn leaves, *J. Food Sci. Tech*. **52**, 2394-2400.

[50] J. R. Chunduri and H. R. Shah (2016). FTIR phytochemical fingerprinting and antioxidant analyses of selected indoor non-flowering indoor plants and their industrial importance, *Int. J. Curr. Pharm. Res*. **8**, 37-43.

[51] J. B. L. Tan, W. J. Yap, S. Y. Tan, Y. Y. Lim and S. M. Lee (2014). Antioxidant content, antioxidant activity, and antibacterial activity of five plants from the Commelinaceae family, *Antioxidants* **3**, 758-769.

[52] D. Russo, C. Balistreri, A. Tapanes-Castillo and M. Pina (2017). Antioxidant properties of Oyster Plant (*Tradescantia spathacea*) extracts using different methods, *Int. Conf. Ser. Multidisciplinary Sci*. **3**, 1-3.

[53] E. Idaka, T. Ogawa, T. Kondo and T. Goto (1987). Isolation of highly acylated anthocyanins from Commelinaceae plants, *Zebrina pendula*, *Rhoeo spathacea* and *Setcreasea purpurea*, *Agric. Bio. Chem*. **51**, 2215-2220.

[54] S. S. El-Hawary, I. I. Mahmoud, A. M. Faisal and S. M. Osman, A. A. Sleem, F. A. Morsy and M. M. Sabry (2020). Comparative HPLC-PDA-MS/MS tentative identification of polyphenolics from the leaf extracts of three selected *tradescantia* species and their *In-vivo* hepatoprotective activity, *Trop. J. Nat. Product Res*. **4**, 926-935.

[55] Q. H. Vo, P. H. Nguyen, B. T. Zhao, M. Y. Ali, J. S. Choi, B. S. Min, T. H. Nguyen and M. H. Woo (2015). Protein tyrosine phosphatase 1B (PTP1B) inhibitory constituents from the aerial parts of *Tradescantia spathacea* Sw, *Fitoterapia* **103**, 113-121.

[56] R. García-Varela, O. R. F. Ramírez, O. Sergio, Serna-Saldivar, J. Altamirano and G. A. Cardineau (2016). Cancer cell specific cytotoxic effect of *Rhoeo discolor* extracts and solvent fractions, *J. Ethnopharmacol*. **190**, 46-58.

[57] K. Mullane and M. Williams (2015). Unknown in biomedical research: Does an inability to deal with ambiguity contribute to issues irreproducibility, *Biochem. Pharmacol*. **97**, 133-136.

[58] V. Parivuguna, R. Gnanaprabhal, R. Dhanabalan and A. Doss (2008). Antimicrobial properties and phytochemical constituents of *Rheo discolor* Hance, *Ethnobot. Leafl*. **12**, 841-845.

[59] P. Yasurin and S. Piya-Isarakul (2015). *In-vitro* antibacterial activity screening of herb extracts against foodborne pathogenic bacteria from Thailand, *J. Pure Appl. Microbiol*. **9**, 2175-2184.

[60] Y. N. Oon, R. J. Chen, J. M. Kuan and N. W. Sit (2021). Bioactivity of medicinal plants extracts against human fungal pathogens and evaluation of toxicity using Vero cells, *Trop. Biomed*. **38**, 469-475.

[61] G. R. M. Pérez (1996). Anti-inflammatory activity of *Ambrosia artemisiaefolia* and *Rhoeo spathacea*, *Phytomedicine* **3**, 163-167.

[62] A. M. Prabhune, S. J. Jadhav, D. A. Kadam, M. D. Nandikar and V. T. Aparadh (2013). Free radical scavenging (DPPH) and ferric reducing ability (FRAP) of some commelinaceae members, *Int. J. Biol. Pharm. Allied Sci*. **2**, 1128-1134.

[63] F. J. A. Crespo, E. C. Pérez, J. D. G. V. Estrella, M. G. M. Velazquez, B. O. O. Morales, P. Z. Crecencio, E. H. Nuñez and S. E. E. Soto (2021). Vasorelaxant and antioxidant activity of some medicinal plants from Campeche, Mexico, *Pharm. Mag*. **17**, 23-30.

[64] A. A. Myriam, B. José-Lui, J. R. P. Nancy, S. N. Jaime, R. S. Roberto and G. A. Marisela (2011). Antimutagenicity mechanisms of the *Rhoeo discolor* ethanolic extract, *Exp. Toxicol. Pathol*. **63**, 243-248.

[65] N. Jesetti, R. R. Alavala, S. R. Rapaka and U. Kulandaivelu (2020). Antidiabetic activity, alpha-amylase, and alpha-glucosidase inhibitory effect of *Tradescantia spathacea* Swartz extract, *Int. Res. Pharm. Sci*. **11**, 1594-1599.

[66] M. Heinrich, G. Appendino, T. Efferth, R. Fürst, A. A. Izzo, O. Kayser, J. M. Pezzuto and A. Viljoen (2020). Best practice in research–overcoming common challenges in phytopharmacological research, *J. Enthopharmacol*. **246**, 112230-112237.

[67] R. García-Varela, O. R. F. Ramírez, O. Sergio, Serna-Saldivar, J. Altamirano and G. A. Cardineau (2016). Cancer cell specific cytotoxic effect of *Rhoeo discolor* extracts and solvent fractions, *J. Ethnopharmacol*. **190**, 46-58.

[68] S. R. Chamakuri, A. H. Syed and H. Masood (2020). *In vitro* anti-coagulant activity of methanolic extract of *Tradescantia spathacea*, *J. Chem. Pharm. Res*. **12**, 1-6.

[69] S. R. Chamakuri, S. B. Mohammed, M. Kanthala, M. Avadhootha, O. A. Mohammed, M. Ghanapuram M. Thabassum, P. Dasari, A.K. Siddaboina and M.S. Pasha et al. (2020). *In vitro* anti-helminthic activity of *Tradescantia spathacea* by using soxhlation process, *J. Chem. Pharm. Res*. **12**, 1-5.

[70] B. C. W. Lim, X. Y. Keng, K. E. Loh and S. P. Tan (2023). Determination of antioxidant and antibacterial properties of *Tradescantia spathacea* root extracts, *Vegetos* **36**, 1475-1482.