Evaluation of antidiarrheal and hypoglycemic activities of methanolic extract of *Hygrophila erecta* in mice

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A thesis submitted to the School of Pharmacy in partial fulfillment of the requirements for the degree of Bachelor of Pharmacy (Hons.)

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Declaration

I hereby declare that

1. The research work titled as "Hypoglycemice and Anti-diarrheal Activities of Methanolic Crude Extract of *H. erecta*" has been performed by me as an original study.

2. All sources of information, references, and data used in this study have been properly acknowledged and cited.

3. No part of this work has been submitted previously for any degree, diploma, or other academic qualification.

4. All laboratory work, data collection, and analysis were conducted honestly and without fabrication or falsification.

5. I take full responsibility for the authenticity and integrity of this research work.

Student's Full Name & Signature:

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Approval

The thesis titled "Evaluation of antidiarrheal and hypoglycemic activities of methanolic extract of *Hygrophila erecta* in mice" submitted by Naziba Farin **(**20146039) and Abanti Sarker Tuly (21346023) of summer 2026, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy on 23 June, 2026.

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Ethics Statement

The normal ethical criteria for the use and care of laboratory animals were adhered to in all animal experiments. The appropriate institutional ethics committee reviewed and approved the study protocol. Maximum efforts were made to reduce the sufferings of the animals and the number of the animals used.

Abstract

Hygrophila erecta is a medicinal plant with a variety numbers of pharmacological properties. In the study, an attempt was made to evaluate the hypoglycemic and anti-diarrheal activities of the methanolic crude extract of *H. erecta* using experimental animal models.The hypoglycemic activity was evaluated by monitoring blood glucose levels after oral administration of the extract at two different doses. Both doses produced a significant time-dependent reduction in blood glucose, with the maximum effect observed at the later observation period, indicating a mild hypoglycemic potential compared to previously reported standard plant extracts. The anti-diarrheal activity was assessed using a castor oil-induced diarrhea model. The extract showed a reduction in diarrheal frequency at both tested doses.These findings suggest that *H. erecta* possesses mild pharmacological activities in both hypoglycemic and anti-diarrheal models.

Keywords: *Hygrophila erecta,* hypoglycemic activity, anti-diarrheal activity, methanolic crude extract, medicinal plants.

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List of Acronyms

NCE	New Chemical Entities
NHB	National Herbarium Bangladesh
BGL	Blood Glucose Level

Chapter 1

Introduction

1.1 Background

Plants are being studied around the world for traditional uses in medicine to help treat conditions.Some examples of these ailments include cancer, diabetes, obesity, infection, arthritis and many others. Man has been using plants to heal themselves from illness for about 60 millennia (Fabricant and Farnsworth 2001). Traditional medicine fully relied on human trials and errors until the 1500s since people did not know how they became sick and how to treat it. Today we research more about what could have caused the specific illness and try to treat the patient with plants that would target the cause of the disease (Koehn and Carter 2005). Roughly 11% of the WHO's 252 approved useful and powerful drugs are plant-derived, and most of these crucial synthetic drugs are derived from natural products (Rates 2001). However, we have not yet fully explored the use of higher plants as a source of novel medicines. There are roughly 250,000 species of higher plants on Earth. According to some sources only about 6% of these have been screened for biological activity, while 15% have been studied for phytochemical tests (Fabricant and Farnsworth 2001). Therefore, many more powerful natural lead compounds are waiting to be discovered. The problem is gaining access to nature's chemical diversity.

1.2 Rationale and Objective of the Study

Phytochemical exploration is still an impressively rare suggestion for establishing new chemical entities (NCE). Although phytochemicals have produced useful pharmacological properties (Mishra & Tiwari, 2011). The kind and quantities of

chemical compounds in plants are very dependent on environmental factors, location, climate, and harvest time (Al-Jabri & Hossain, 2014). Because of heterogeneous nature of medicinal plants shown different results based on study design, we consider it is imperative to search promising medicinal plants from region specific studies like Bangladesh with the aim to scientifically verify their traditional uses and utilize them for discovering new medicines.

Hygrophila erecta (Brum. f.) Hochr. Perennial herbs of the Acanthaceae family have proved to provide an abundant variety of bio active compounds (Lee et al., 2022) hence could contain metabolic & physiological active components altering chronic pathophysiologic changes like hyperglycemia & diarrhea. It is worthwhile to investigate other species in the Acanthaceae family, such as *Hygrophila*, for comparable activities as studies on plants from closely related species have demonstrated that they can have positive medicinal effects (Bellah et al., 2017; Nissanka et al., 2023).

The aims of this study are:

1. To evaluate the hypoglycemic effects of *H. erecta* in the mouse.

2. Evaluate the in vivo antidiarrheal activity of plant extracts using mouse diarrhea models.

3. To analyze recognized and possible phytochemical substances with biological properties for future study, by using vivo tests in mouse models.

1.3 Plant Profile

We selected the plant called *Hygrophila erecta* (Burm.f.) Hochr. for our analysis.

1.4 The Plant Family: Acanthaceae

The Acanthaceae family includes more than 4,000 species. The majority of plants are classified within the Acanthaceae family, predominantly found in subtropical regions including Asia, Africa, and Central and South America. No Acanthaceae species exist in the cooler regions of the planet. Acanthaceae plants are mostly terrestrial or may be larger climbing species. They frequently possess leaves that are arranged oppositely to each Acanthaceae flower, which features a bilabiate structure.

Andrographis paniculata is utilized in medicine for its anti-inflammatory and hepatoprotective effects (Lee et al., 2022).

1.5 The Plant Genus: Hygrophila

100 species of plants belong to the Hygrophila group, the majority of which are aquatic or semi-aquatic in their natural habitats. Hygrophila are also sometimes harvested as a medicinal treatment in Asia for diseases related to inflammation, liver damage or infection. Hygrophila plants have been used for their healing properties in Asian communities for hundreds of years.

1.6 Taxon Description

It is newly described genus with more than 100 species of flowering plants in the family Acanthaceae. Plants within this genus are endemic to tropical and subtropical regions of Asia and Africa. The genus Hygrophila is spread in marshy and swampy areas, by river banks, rice fields and floodplains Hygrophila plants are mostly erect or herbaceous prostrate plants from quadrangular stems. Species have opposite leaves and bilabiate flowers. Inflorescence tends to be axillary. Hygrophila's fruit is a linear capsule with many small seeds. These seeds become mucilaginous when they come into contact with water, which aids in seed distribution (Kirtikar & Basu, 2006; Mabberley, 2017).

1.7 Species of *Hygrophila*

Some species of *Hygrophila plants* are presented below in Table 1.

Hygrophila polysperma	*Hygrophila episcopalis*	*Hygrophila schulli*
Hygrophila auriculata	*Hygrophila difformis*	*Hygrophila erecta*

Table1: Some Species of Hygrophila

1.8 Description of *Hygrophila erecta* (Burm.f.) Hochr.

H. erecta is a herb. It is a member of the Acanthaceae family. This plant thrives in semi-aquatic environments. It originates from the subtropical regions of Asia and Africa. The plant has slender stems. It also has opposite leaves. The flowers of *H. erecta* are usually purple. They can also be violet or lavender in color. Sometimes the

flowers have whitish undertones. Many species in the Hygrophila genus have flower colors. *H. auriculata* is one example. *H. erecta* has these characteristics or features.

Hygrophila species have been utilized in traditional medicine for an extended period to address issues related to edema, hepatic disorders, urinary conditions, and dermatological ailments.

1.9 Taxonomic Hierarchy

Kingdom: Plantae

Division: Tracheophyta

Subdivision: Spermatophytina

Class: Anqiospermae

Order: Lamiales

Family: Acanthaceae

Genus: Hygrophila

Species: *H. Erecta*

Scientific name: *Hygrophila erecta(Burm.f.) Hochr.*

Synonym: *Hygrophila ringens* or *Hygrophila phlomoides*

Common name: Erect hygrophila and Upright water-willow

1.10 General Botanical Data

The plant is known as a herb that has lived for many years, and it is found in the water or close to water.The stems of this plant are thin. They have four sides. It has simple leaves.They come out in pairs, growing opposite one another and are spear or line-shaped.The plant produces flowers in clusters at the junction of the stem and leaves, typically exhibiting purple or violet hues, though occasionally appearing lavender. The plant yields elongated, slender fruits containing numerous little seeds. This plant flourishes in regions with consistent moisture, typically located near lakes, rivers, marshes, and wetlands.

Duration: The plants are Perennial.

Habit: They are Herb plants that can be aquatic or semi-aquatic

Leaf Retention: Green (under suitable conditions)

Bloom Color: Purple, violet or lavender and may have whitish undertones

Habitat: These implants live in Marshy and wetland environments

1.11 Distribution

H. erecta can be seen in tropical as well as subtropical regions. This includes places like India and Sri Lanka and Bangladesh. It also seems to grows in several parts of Southeast Asia and Africa. We can normally find *H. erecta* in various wetlands and rice fields as well as ditches along riverbanks. They are found in places with lot of water.

1.12 Chemistry of *Hygrophila erecta* (Burm.f.) Hochr.

The *H. erecta* itself are not transparent from the standpoint of their chemical constituents. So we examine studies of plants in the same group such as H. auriculata.The chemistry of *Hygrophila* plants includes flavonoids, phenolic compounds, alkaloids, terpenoids, steroids, tannins, and saponins. Flavonoids and phenolic compounds are the most common types to be found. They are believed to account for the majority offer of health benefits of the plant.

Studies on Hygrophila extracts revealed the presence of fatty acids, B-sitosterol and triterpenoids. Such chemicals, possessing natural antioxidant and anti-inflammatory properties which have contributed to the health benefits of the plant.

1.13 Pharmacology

H. erecta has been used for medicinal purpose since a long back. Despite this, there are no studies regarding its pharmacology.Research on similar plants in the Hygrophila family shows that they have many biological effects.

Extracts from Hygrophila plants have been found to have -inflammatory, antioxidant, liver-protecting, diuretic, and antimicrobial effects in experiments. *H. auriculata* has been shown to have significant anti-inflammatory and liver-protecting effects in animal studies.

Some studies also suggest that *H. erecta* extracts may have potential in cancer research because of their activity. However, Hygrophila extracts antibacterial activity varies depending on how they're extracted and which part of the plant is used. This means that detailed pharmacology studies are needed.

1.14 Socio-Economic Importance

Discovering safe, effective, and sustainable medicines remains a huge challenge in drug discovery. Medicinal plants are still original sources of new molecules mainly due to their high diversity in structures and huge potential for solving health problems.If modern techniques are employed in studying plants like *H. erecta*, we may find medicines through them. This will enable to make herbal medicines cost effective and address healthcare problems in underprivileged areas with little or no access to it.

Furthermore, the use and production of plants while ensuring sustainability could yield more revenue for the countryside populations as well as environmental protection and economic growth. This can all contribute to making society better socially. Medicinal plants like *H. erecta* are important for socio-progression. They can help us develop medicines and improve the lives of people in rural areas

Chapter 2

Methodology

2.1 Study Design

Hygrophila erecta (Burm. f.) Hochr., Wetland medicinal species, Acanthaceae family The experiments included preparation of natural crude methanolic extract. The goal of these experiments was to find out the potential hypoglycemic and antidiarrheal activity of pharmacological chemicals in *H. erecta*.

2.1.1 Plant Material collection and Processing

Live plant material of *H. erecta* was collected from the natural habitat from the Wetland during the active growing phase. Later it was discovered and confirmed by Senior Scientific Officer Abdur Rahim at National Herbarium Bangladesh (NHB), Mirpur, Dhaka. The collected plants were identified by a botanist and a sample of the plant was kept at the herbarium for reference. The leaves and stems were then removed, cleaned with water and air-dried in the shade.This process continued until the material had a steady weight.The dried plant material was then crushed into a powder using an electric grinder.

2.1.2 Preparation of Botanical Materials

The plant material was crushed into a powder and then extracted with methanol using a maceration method. Methanol was chosen for extraction because it is often used to extract secondary plant compounds like phenolics, flavonoids and glycosides(Sasidharan et al., 2010). A known amount of plant material was put into

clean amber bottles and then enough analytical-grade methanol was added to cover the plant material. The bottles were sealed tight and were kept at room temperature for 21 days. During the time, shaking by hand was done to improve solvent penetration and the extraction of phytochemical constituents. After 21 days , the mixture was filtered through Whatman No. 1 filter paper to separate the liquid part from the plant bits. Then using a rotary evaporator (at not higher than 40 °C), the filtrate was collected and concentrated under reduced pressure (low temperature evaporation prevented the thermal degradation of heat sensitive phytochemicals). The concentrated extract was collected as methanolic extract, crude, in a clean labeled air tight container and stored at 4°C until required for subsequent chemical analyses.

2.1.3 Crude Extract Storage

Crude methanolic extract was then transferred into sterile and dry glass.The labelling on the extracted container included plant name, extraction solvent, extraction date and sample code. We kept the extract away from light so that the sensitive chemicals in it would not break down. Then it was put into cold storage until it could be further analyzed. Conditions were undertaken for chemical stability and phytochemical integrity of crude extract.

2.2 Evaluation of Hypoglycemic Activity

2.2.1 Principle

In vivo glucose tolerance-based methods in mice have been used to examine the hypoglycemic potential of methanolic plant extracts (Farzana et al., 2022). In this approach, we first measured the blood glucose levels of individual mice at baseline. Final blood glucose levels with initial blood glucose levels and the percent reduction of blood glucose level were compared. Hypoglycaemic effect, which means that *Humulus erectus* plant extract can lower or control the increase of blood glucose normal level as a result of sugar/glucose administration.

2.2.2 Experimental Animal

Six Swiss-albino mice of either sex, aged 4-5 weeks, were utilized for each group in the experiment.

2.2.3 Preparation of Test Materials

Two test solution were prepared in the experiment. One solution was made from

29 ml + 8 ml and another one was prepared from 57 ml + 8 ml.

The prepared solutions were then divided into four separate containers as follows:

Box 1: 29 ml solution

Box 2: 57 ml solution

Each box was administered 1 ml of the prepared solution at a time. After 1 hour, 1 ml of sugar solution was added to the remaining two boxes.

For the evaluation of the hypoglycemic activity of the methanolic crude extract of *H. erecta,* several test materials were used, as listed in Table 2.

Sl. No.	**Test material**	**Purpose**	**Amount / dose used**
1	Methanolic crude extract of *Hygrophila erecta*	Test sample	200 mg/kg and 400 mg/kg body weight
2	Vehicle / solvent	Preparation of extract solution	8 mL for each dose
3	Sugar solution	To increase blood glucose level	1 mL per animal
4	Experimental mice	In vivo test animals	6 mice per box/group
5	Glucometer	Measurement of blood glucose level	BGL recorded in mmol/L
6	Oral syringe / feeding needle	Oral administration	1 mL at a time
7	Animal box	Grouping of animals	Box 1 and Box 2

Table 2: Test materials used for the evaluation of hypoglycemic activity of methanolic crude extract of Hygrophila erecta

The preparation of test solutions for hypoglycemic activity is shown in Table 3.

Box	Mean body weight	Dose	Calculation	Extract amount	Vehicle volume	Final test solution
Box 1	24.16 g	200 mg/kg bw	(200/1000)×24.16×6	≈ 29 mg	8 mL	29 mg extract + 8 mL vehicle
Box 2	23.66 g	400 mg/kg bw	(400/1000)×23.66×6	≈ 57 mg	8 mL	57 mg extract + 8 mL vehicle

Table 3: Preparation of test solutions for hypoglycemic activity

The experimental design for the in vivo hypoglycemic activity is shown in Table 4.

Group	Box	Treatment	Dose	No. of animals	Observation time	Administration
MCE 1	Box 1	Methanolic crude extract of *H. erecta*	200 mg/kg bw	6	0, 1, 2, and 3 h	1 mL test solution orally
MCE 2	Box 2	Methanolic crude extract of *H. erecta*	400 mg/kg bw	6	0, 1, 2, and 3 h	1 mL test solution orally

Table 4: Experimental design for in vivo hypoglycemic activity

The individual blood glucose readings of mice treated with methanolic crude extract of *H. erecta* at 200 mg/kg are presented in Table 5.

Time	M1	M2	M3	M4	M5	M6
0 h	6.7	7.1	7.5	7.1	6.1	7.2
1h	7.2	6.2	6.3	5.7	5.4	5.9
2h	5.5	6	6.1	5.3	4.9	5.7
3h	5.4	5.8	5.9	5.1	4.6	5.6

Table 5: Individual blood glucose readings of mice treated with methanolic crude extract of H. erecta at 200 mg/kg

M=Mouse

The individual blood glucose readings of mice treated with methanolic crude extract of *H. erecta* at 400 mg/kg are presented in Table 6.

Time	M1	M2	M3	M4	M5	M6
0h	5.4	6.7	7.5	7	6.5	6.3
1h	3.6	4.4	4.6	6.7	4.5	6
2h	3.3	3.9	4.2	6.3	4	5.6
3h	3.2	3.5	3.9	5.8	3.8	5.2

Table 6: Individual blood glucose readings of mice treated with methanolic crude extract of H. erecta at 400 mg/kg

2.3 Evaluation of Antidiarrheal Activity

2.3.1 Principle

Castor oil-induced diarrhea in mice was used to screen the antidiarrheal efficacy of the methanolic extract of *C. trifoliata* leaves (Shoba and Thomas, 2001). Each mouse was fed 1ml of castor oil and the number of fecal stools excreted by each mouse was documented. By comparing the results of the experimental groups to those of the control group, the anti-diarrheal activity of the samples were estimated.

2.3.2 Experimental Animal

Six Swiss-albino mice of either sex, aged 4-5 weeks, were utilized for each group in the experiment.

2.3.3 Preparation of Test Materials

Two test solutions were prepared from using the *H. erecta* methanolic crude extract. The first solution was prepared for 200 mg/kg body weight and the second were at a dose of 400 mg/kg body weight.

To achieve the 200 mg/kg dose, small amount of methanolic crude extract (~29 mg) was dissolved in approximately 8 mL of vehicle. Approximately 57 mg methanolic crude extract was suspended 8 mL vehicle for the 400 mg/kg dose. One milliliter (1 mL) of the test solution was administered to each mouse orally. After 2 hours, each mouse received 1 mL of castor oil by mouth to induce diarrhea.

For the screening antidiarrheal effect of the methanolic crude extract of *H. erecta,* several test materials were used, as listed in Table 7.

Sl. No.	Test material	Purpose	Amount / dose used
1	Methanolic crude extract of *H. erecta*	Test sample for antidiarrheal activity	200 mg/kg and 400 mg/kg body weight
2	Vehicle / solvent	Preparation of extract solution	8 mL for each dose
3	Castor oil	To induce diarrhea in mice	1 mL per mouse
4	Experimental mice	In vivo test animals	6 mice per box/group
5	Oral syringe / feeding needle	Oral administration	1 mL at a time
6	Animal box/cage	Grouping of animals	Box 1 and Box 2

Table 7: The test materials for screening antidiarrheal effect of methanolic crude extract of H. erecta

The preparation of test solutions for antidiarrheal activity is shown in Table 8.

Box	Mean body weight	Dose	Calculation	Extract amount	Vehicle volume	Final test solution
Box 1	24.16 g	200 mg/kg bw	(200/1000)×24.16 ×6	≈ 29 mg	8 mL	29 mg extract + 8 mL vehicle
Box 2	23.66 g	400 mg/kg bw	(400/1000)×23.66 ×6	≈ 57 mg	8 mL	57 mg extract + 8 mL vehicle

Table 8: Preparation of test solutions for antidiarrheal activity

Chapter 3

Result

3.1 Result of Hypoglycemic activity

The hypoglycemic activity of *H. erecta* is shown in Table 9.

Dose	0 h BGL(mol/ml)	1 h BGL(mol/ml)	Reduction at 1 h	2 h BGL(mol/ml)	Reduction at 2 h	3 h BGL(mol/ml)	Reduction at 3 h
200 mg/kg	6.95 ± 0.20	6.12 ± 0.25	11.99%	5.58 ± 0.18	19.66%	5.40 ± 0.20	22.30%
400 mg/kg	6.57 ± 0.29	4.97 ± 0.47	24.37%	4.55 ± 0.47	30.71%	4.23 ± 0.42	35.53%

Table 9: Hypoglycemic activity of the methanolic crude extract of Hygrophila erecta

Equation used:

$$Reduction(\%) = \frac{Initial\ BGL - BGL\ at\ specific\ time}{Initial\ BGL} \times 100$$

Where, Initial BGL=BGL at 0 hour

The hypoglycemic in vivo study indicates that the methanolic crude drug extract of *H. erecta* lowers blood glucose level in mice. At a dosage of 200 mg/kg, the blood glucose level(mol/ml) decreased from 6.95 ± 0.20 at 0 hours to 6.12 ± 0.25, 5.58 ± 0.18, and 5.40 ± 0.20 at 1, 2, and 3 hours, respectively. The subsequent reductions were 11.99%, 19.66%, and 22.30%. At a dosage of 400 mg/kg, the blood glucose level(mol/ml) appeared to decline from 6.57 ± 0.29 at 0 hours to 4.97 ± 0.47, 4.55 ± 0.47, and 4.23 ± 0.42 at 1, 2, and 3 hours, respectively. The respective decreases were 24.37%, 30.71%, and 35.53%.

3.2 Result of Antidiarrheal activity

The antidiarrheal activity of *H. erecta* is shown in Table 10.

Dose	Initial count after castor oil(N0. of Feces)	After 1 hr(N0. of Feces)	Reduction at 1 hr	After 2 hr(N0. of Feces)	Reduction at 2 hr	After 3 hr(N0. of Feces)	Reduction at 3 hr
200 mg/kg	9	7	22.22%	7	22.22%	6	33.33%
400 mg/kg	11	9	18.18%	8	27.27%	8	27.27%

Table 10: Antidiarrheal activity of methanolic extract after castor oil administration

Equation used:

$$Reduction\ of\ Diarrhea(\%) = \frac{Initial\ diarrheal\ count - Count\ after\ treatment}{Initial\ diarrheal\ count} \times 100$$

The crude methanolic extract exhibited moderate anti-diarrheal effectiveness in the castor oil-induced diarrhea model. The diarrheal count in the 200 mg/kg dose group was 9 initially, 7 after 1 hour, 7 after 2 hours, and 6 after 3 hours. There is a 22.22% drop after 1 and 2 hours, and a 33.33% reduction after 3 hours. In the 400 mg/kg dosage group, the number of feces decreased from 11 to 9 after 1 hour, and to 8 after 2 and 3 hours, reflecting reductions of 18.18%, 27.27%, and 27.27%, respectively.

Chapter 4

Discussion

4.1 Discussion of Hypoglycemic activity of the methanolic crude extract of *H. erecta*

The present findings of hypoglycemia activity of *H. erecta* are partially comparable with the study of Farzana et al. (2022) who found considerable hypoglycemic activity of methanolic crude extract of *Wendlandia tinctoria var. grandis* stem in dose and time dependent way. The previous results revealed that both 200 mg/kg and 400 mg/kg considerably lowered blood glucose in a time-dependent way at the end of 3 h which suggests some hypoglycemic action. The maximum hypoglycemic activity in this investigation was 35.53% (at 3 h) at 400 mg/kg and the same dose of *W. tinctoria* showed a 52.36% decrease. This indicates that the current extract exhibits minor hypoglycemic action, albeit inferior to that of the reference plant extract. The increased activity in the article may be attributed to the presence of phenolic compounds, including liquiritigenin, naringenin, apigenin, kaempferol, glabridin, and ferulic acid, which have been reported to have antioxidant and hypoglycemic properties.

Antioxidant properties of phenolic constituents has role in the result of antidiabetic text. Oxidative stress plays a crucial role in the development of diabetes by damaging pancreatic β-cells and impairing insulin secretion. Antioxidants present in the extract may neutralize reactive oxygen species, protect pancreatic tissues from oxidative damage, and help maintain normal insulin function. Furthermore, some phytochemicals may suppress hepatic gluconeogenesis and glycogenolysis, resulting in decreased glucose production by the liver(Nie & Cooper, 2021).

The gradual reduction in blood glucose levels observed over the 3-hour experimental period suggests that the hypoglycemic activity demonstrated by the methanolic crude extract of *H. erecta* may result from a combination of enhanced insulin action, increased peripheral glucose utilization, and antioxidant-mediated protection of pancreatic cells. Further phytochemical and mechanistic studies are necessary to identify the specific compounds responsible for these effects and to clarify their exact mode of action.

4.2 Discussion of antidiarrheal activity of the methanolic crude extract of *H. erecta*

In this study, both doses of 200 mg/kg and 400 mg/kg decreased the production of diarrhea with time but the response was not dose-dependant. The dose of 200 mg/kg exhibited a somewhat larger reduction after 3 hours than 400 mg/kg. This difference could be attributed to biological variance across animals, small sample size or lack of appropriate control and standard medication groups in the present data set. The study of Farzana et al. (2022) showed the dose-dependent antidiarrheal efficacy of methanolic crude extract of *W. tinctoria var. grandis* stem in castor oil-induced diarrhea model. The activity of present extract was comparatively weak than the activity of the study where doses of 200 mg/kg and 400 mg/kg showed 60.53% and 73.68% reduction respectively and standard drug loperamide showed 84.21% inhibition, maximum reduction was only 33.33% at 200 mg/kg and 27.27% at 400 mg/kg after 3 hours. This implies that the antidiarrheal activity of *H. erecta* is weak and less potent than the methanolic crude extract of *W. tinctoria var. grandis* stem.

Chapter 5

Conclusion

This work investigated the hypoglycemic activity and antidiarrheal effects of the methanolic crude extract of *H. erecta* in experimental animal models. A statistically significant reduction in blood glucose was observed at both dosages of the extract, with an approximate decrease of 35.53% three hours post-dosing at the higher dosage compared to controls. The findings indicate that *H. erecta* may be a viable source of bioactive chemicals with glucose-lowering effects and could work as an antidiabetic agent. The extract demonstrated a moderate antidiarrheal activity in the castor oil-induced diarrhea model at both dosages. At a dosage of 200 mg/kg, there was a 33.33% reduction in diarrheal frequency, whereas at 400 mg/kg, the inhibition was 27.27%. Nonetheless, the reaction was not dose-dependent and was quite feeble.

While both doses demonstrated a reduction in diarrhea, the effect was not significantly dose-dependent.

The findings of this investigation indicated that *H. erecta* has preliminary pharmacological capabilities, including hypoglycemia and antidiarrheal activities. However, the conclusions are further compromised by the absence of negative controls and standard pharmacological comparison groups.

Additionally, proper controls, use of standard reference drugs, increased sample size, conduct of phytochemical isolation and mechanistic studies are conventionally recommended to confirm these activities and establish the active compounds responsible for the actions demonstrated.

References

Al-Jabri, N.N. and Hossain, M.A. (2014) 'Comparative chemical composition and antimicrobial activity study of essential oils from two imported lemon fruits samples against pathogenic bacteria', Beni-Suef University Journal of Basic and Applied Sciences, 3(4), pp. 247–253.

Asmat, U., Abad, K., & Ismail, K. (2016). Diabetes mellitus and oxidative stress—A concise review. *Saudi Pharmaceutical Journal, 24*(5), 547–553. https://doi.org/10.1016/j.jsps.2015.03.013

Bailey, C. J., & Day, C. (1989). Traditional plant medicines for diabetes. *Diabetes Care, 12*(8), 553–564. https://doi.org/10.2337/diacare.12.8.553

Bellah, S.M.F., Islam, M.N., Karim, M.R., Rahaman, M.M., Nasrin, M.S., Rahman, M.A. and Reza, A.S.M. (2017) 'Evaluation of cytotoxic, analgesic, antidiarrheal and phytochemical properties of Hygrophila spinosa (T. Anders) whole plant', Journal of Basic and Clinical Physiology and Pharmacology.

Fabricant, D.S. and Farnsworth, N.R. (2001) 'The value of plants used in traditional medicine for drug discovery', Environmental Health Perspectives, 109(Suppl. 1), pp. 69–75.

Farzana, M., Hossain, M.J., El-Shehawi, A.M., Sikder, M.A.A., Rahman, M.S., Al-Mansur, M.A., Albogami, S., Elseehy, M.M., Roy, A., Uddin, M.A. and Rashid, M.A. (2022) 'Phenolic constituents from Wendlandia tinctoria var. grandis (Roxb.) DC. stem deciphering pharmacological potentials against oxidation, hyperglycemia, and

diarrhea: Phyto-pharmacological and computational approaches', Molecules, 27(18), p. 5957. Available at: https://doi.org/10.3390/molecules27185957.

Kirtikar, K.R. and Basu, B.D. (2006) Indian Medicinal Plants. Vol. 3. New Delhi: International Book Distributors.

Koehn, F.E. and Carter, G.T. (2005) 'The evolving role of natural products in drug discovery', Nature Reviews Drug Discovery, 4(3), pp. 206–220.

Kottaimuthu, A. (2010). Ethnobotany of the genus Hygrophila. *Ethnobotanical Leaflets, 14*, 18–22.

Kupchan, S. M., Tsou, G., & Sigel, C. W. (1973). Datiscacin, a novel cytotoxic cucurbitacin 20-acetate from Datisca glomerata. The Journal of Organic Chemistry, 38(7), 1420–1421. https://doi.org/10.1021/jo00947a041

Newman, D. J., & Cragg, G. M. (2020). Natural products as sources of new drugs over nearly four decades from 01/1981 to 09/2019. *Journal of Natural Products, 83*(3), 770–803. https://doi.org/10.1021/acs.jnatprod.9b01285

Nie, T., & Cooper, G. J. S. (2021). Mechanisms underlying the antidiabetic activities of polyphenolic compounds: A review. *Frontiers in Pharmacology, 12*, 798329. https://doi.org/10.3389/fphar.2021.798329

Rates, S.M.K. (2001) 'Plants as source of drugs', Toxicon, 39(5), pp. 603–613.

Lee, S.J., Kim, J.E., Choi, Y.J., Jin, Y.J., Roh, Y.J., Seol, A.Y. and Lee, S.W. (2022) 'Antioxidative role of Hygrophila erecta (Brum. f.) Hochr. on UV-induced

photoaging of dermal fibroblasts and melanoma cells', Antioxidants, 11(7), p. 1317. Available at: https://doi.org/10.3390/antiox11071317.

Sasidharan, S., Chen, Y., Saravanan, D., Sundram, K., & Latha, L. (2010). Extraction, Isolation And Characterization Of Bioactive Compounds From Plants' Extracts. African Journal of Traditional, Complementary and Alternative Medicines, 8(1). https://doi.org/10.4314/ajtcam.v8i1.60483

Shoba, F.G. and Thomas, M. (2001) 'Study of antidiarrhoeal activity of four medicinal plants in castor-oil induced diarrhoea', Journal of Ethnopharmacology, 76(1), pp. 73–76. Available at: https://doi.org/10.1016/S0378-8741(00)00379-2.