

**AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING
AND ENTREPRENEURIAL DEVELOPMENT**

**AMELIORATIVE EFFECTS OF *Senna siamea* LEAF DECOCTION IN
LOPERAMIDE-INDUCED CONSTIPATED ALBINO RATS**

**ISAAC ADJEI
(8212090006)**

JUNE, 2024

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ISAAC ADJEI

(8212090006)

**A thesis submitted to the School of Graduate Studies, Akenten Appiah-Menka
University of Skills Training and Entrepreneurial Development in partial fulfillment
of the requirements for the award of a Master of Philosophy Degree in Biology**

JUNE, 2024

DECLARATION

STUDENT'S DECLARATION

I, Isaac Adjei declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE.....

DATE.....

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the Akenten-Appiah Menka University of Skills Training and Entrepreneurial Development, Mampong.

DR. HOLY KWABLA ZANU

SIGNATURE.....

DATE.....

DEDICATION

This work is dedicated to Almighty God and My family.

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ABBREVIATIONS

ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
ALP	Alkaline phosphatase
GGT	Gamma-glutamyl transferase
TP	Total protein
ALB	Albumen
GLO	Globulin
TB	Total Bilirubin
DB	Direct Bilirubin
IB	Indirect Bilirubin
FISH	Fluorescence in Situ Hybridization
EEA	Ethanol Extract of Agarwood
LDH	Lactate Dehydrogenase
H & E	Hematoxylin and Eosin

ABSTRACT

This study sought to assess the ameliorative effects of *Senna siamea* leaf decoction in loperamide-induced constipated rats. Completely Randomized Design was employed for this study, and a total of 20 Albino rats were randomly assigned into 4 treatment groups after two weeks of acclimatization. With each treatment having 5 replicates. Treatment 1 (Control) received normal saline throughout the experimental period. Treatment 2 was administered with a dosage of 0.75 mg of loperamide in 5ml of water (5 mg/kg body weight) for 4 days. Treatment 3 received normal saline for 4 days and then 5 ml of *Senna siamea* leaf decoction with a dose concentration of 33.33 g/kg body weight for a duration of 7 days. Treatment 4 was administered with a dosage 0.75 mg of loperamide in 5 ml of water for 4 days, followed by a dosage of 5 ml of *Senna siamea* leaf decoction for a duration of 7 days by oral gavage. The study evaluated feed and water intake, faecal pellets and faecal moisture, kidney and liver functions, and kidney and liver histology. There was no significant difference in feed and water intake during the period of constipation ($p>0.05$). There was variability in feed intake on the fourth day of the *Senna siamea* leaf decoction administration. Water intake increased during the period of the *Senna siamea* leaf decoction administration. Treatment 2 recorded high water intake on the seventh day of the *Senna siamea* leaf decoction administration ($p<0.01$). Treatment 2 recorded fewer faecal pellets compared to the control group throughout the experimental period ($p<0.01$). Treatments 3 and 4 recorded more faecal pellets ($p<0.01$). Faecal moisture reduced in treatment 2 ($p<0.01$). The data on kidney function showed that treatment 2, treatment 3 and treatment 4 recorded decreased urea levels ($p<0.05$) compared to the control. Cl^- level was lower ($p<0.05$) in treatment 2 compared to the control. No differences were observed in the liver function parameters among the treatment groups throughout the experimental period ($p>0.05$). Kidney and liver tissues showed normal architecture at the end of the experiment. The research findings suggest that *Senna siamea* leaf decoction has laxative effect on loperamide-induced constipation in Albino rats.

CHAPTER ONE

1.0 INTRODUCTION

1.1: Background to the study

Constipation is a common digestive disorder characterized by infrequent, challenging, or painful passing of stool (Forootan et al., 2018). It can affect individuals across all age groups, ranging from newborns to the aged, and can negatively affect their quality of life. Diagnosis of constipation is variable, although it typically involves experiencing less than three bowel motions per week, accompanied by firm, desiccated faeces that are challenging to expel (Rao, 2022). Although infrequent constipation is typical and often not a matter of worry, persistent constipation can result in severe health complications and necessitates medical intervention (Daniali et al., 2020).

Constipation is caused by a lot of factors, which include dietary, behavioural, and physiological variables. Insufficient consumption of fibre, poor fluid intake, and a sedentary lifestyle are frequently observed factors (Zhang et al., 2022). Fibre, present in fruits, vegetables, and whole grains, increases the volume of stool and facilitates regular bowel movements, while fluids aid in maintaining the softness of the stool. On the other hand, a decrease in physical activity might hinder the movement of the intestines, making the condition worse. Comprehending these elements is essential for implementing successful preventative and treatment methods.

Physiological considerations are also a major contributing element to constipation. These encompass irregularities in the configuration or operation of the digestive system, such as a sluggish movement of the colon, dysfunction of the pelvic floor, or problems affecting

the anus and rectum. Conditions such as irritable bowel syndrome, hypothyroidism, and diabetes can also contribute to the occurrence of constipation (Xu et al., 2024).

Constipation has effects that go beyond the physical discomfort. Psychologically, it can result in considerable anguish, apprehension, and diminished quality of life. Persistent constipation can disrupt daily functioning, leading to feelings of self-consciousness and social isolation (Benitez-Rexach, 2023). Furthermore, constipation can result in problems such as hemorrhoids, anal fissures, and rectal prolapse, which can worsen discomfort and increase psychological distress (Igalada-Martinez et al., 2023).

The treatment of constipation usually entails a blend of adjustments to one's lifestyle, alterations to one's food, and the use of medications. First-line advice includes increasing dietary fiber intake, consuming plenty fluids, and participating in frequent physical activity. If individuals do not show a positive response to these interventions, healthcare professionals may recommend the use of laxatives, stool softeners, or other prescribed drugs. In instances of extreme severity, the potential treatment options that may be contemplated include biofeedback therapy or surgical interventions (Rao, S. S., Ahuja, N. K., Bharucha, A. E., Brenner, D. M., Chey, W. D., Deutsch, J. K., & Baker, J. R. 2023).

Loperamide is a commonly used non-prescription medicine generally used for the treatment of diarrhoea (Hegde et al., 2023). Loperamide functions by decelerating the peristaltic action of the intestines, hence facilitating enhanced absorption of fluids and electrolytes from the gastrointestinal tract (Lin et al., 2024). Loperamide exerts its effects by attaching to the opioid receptors located in the wall of the gastrointestinal tract, which leads to a decrease in the contraction of the muscles responsible for moving food through

the intestines. As a result, the time it takes for the contents of the intestines to pass through is prolonged. Consequently, stools become more solid and occur less frequently, which can potentially cause constipation if there is a significant delay in bowel movements. The use of loperamide can cause constipation, which is characterized by symptoms such as firm, dehydrated stools, discomfort in the abdomen, and a reduced frequency of bowel movements (Li et al., 2021).

Senna siamea, also referred to as Siamese cassia or Kassod tree, is a plant that is well-known for its strong laxative properties (Gebrehiwot et al., 2024). The laxative effects of *Senna siamea* are mainly due to its anthraquinone components, which promote bowel motions by enhancing peristalsis, the muscular contractions of the intestinal walls (Ikram et al., 2020). Upon ingestion, these compounds engage with the mucosa of the colon, stimulating the production of water and electrolytes into the intestine. This process aids in the softening of the stool and facilitates its passage. *Senna siamea* is a potent natural treatment for constipation, especially when other dietary or lifestyle therapies have been unsuccessful.

1.2: Problem Statement

The use of loperamide might cause a decrease in the speed of bowel movements, leading to severe constipation that may necessitate the use of effective treatments. Despite the availability of several pharmacological therapies, there is a growing interest in exploring alternative cures because of their potential benefits and reduced side effects. *Senna siamea*, a plant known for its robust laxative properties, emerges as a strong candidate. However, there is a lack of scientific data that supports its efficacy and safety, particularly

in relation to constipation produced by dietary, physiological variables, sedentary lifestyle and the use of loperamide in dealing with Diarrhoea.

The use of *Senna siamea* decoction, derived from the leaves of the plant, as a traditional remedy for constipation, has been well documented in ethnomedicine (Oladeji et al., 2021). Anthraquinones, which are the main active compounds, are believed to enhance intestinal motility and secretion, hence facilitating bowel movements although over dose may lead to diarrhoea, it plays a significant role in alleviating constipation. Despite the historic usage of *Senna siamea*, there is a lack of rigorous scientific study that precisely explains the advantages and mechanisms of *Senna siamea* in alleviating constipation. In order to solve this deficiency in knowledge, it is imperative to carry out an investigation to assess the effectiveness and safety of *Senna siamea* leaves decoction.

1.3: Main Objective

This study aimed to determine the effects of *Senna siamea* leaves decoction on loperamide-induced constipated rats.

1.3.1: Specific objectives

The specific objectives were to:

1. evaluate the effects of *Senna siamea* leaves decoction on feed and water intake in loperamide-induced constipated rats
2. assess the effects of *Senna siamea* leaves decoction on quantity of faecal pellets and moisture content in loperamide-induced constipated rats
3. assess the effects of *Senna siamea* leaves decoction on the kidney and liver functions in loperamide-induced constipated rats

4. examine the effects of *Senna siamea* leaves decoction on the kidney and liver histology in loperamide-induced constipated rats

1.4: Significance of the study

The significance of this study on the laxative effects of *Senna siamea* decoction in treating loperamide-induced constipation in Albino rats lies in its potential to offer an effective and natural alternative to conventional pharmacological treatments. Constipation, especially when induced by medications such as loperamide, poses a significant challenge for both patients and healthcare providers due to its impact on comfort and quality of life. Natural remedies, like *Senna siamea*, are increasingly sought after for their perceived safety and holistic benefits. By evaluating the efficacy and safety of *Senna siamea* decoction, this study aims to validate its use as a reliable treatment option, thereby providing a scientifically-backed alternative to synthetic laxatives.

Furthermore, the study's findings could have broader implications for the field of gastroenterology and integrative medicine. If *Senna siamea leaves* decoction is proven effective, it could be incorporated into treatment protocols for constipation, offering a complementary or alternative option to existing therapies. This would be particularly beneficial for patients who experience adverse effects from conventional laxatives or for those seeking more natural approaches to their healthcare. Additionally, the research could stimulate further studies into other medicinal plants and natural compounds, fostering a greater understanding and acceptance of traditional medicine within modern clinical practice.

In addition to its clinical implications, the study holds significance for the scientific community by contributing to the growing body of literature on the pharmacological effects of traditional medicinal plants. Despite the long-standing use of *Senna siamea* in various cultures, scientific evidence validating its efficacy and safety remains sparse. By providing data on its effects on loperamide-induced constipation, this research helps bridge the gap between traditional knowledge and scientific validation. This can enhance the credibility of traditional remedies and promote their integration into evidence-based medicine, fostering a more comprehensive approach to healthcare.

CHAPTER TWO

2.0: LITERATURE REVIEW

2.1: Botany of *Senna siamea*

Several botanical research projects have been undertaken to gain a deeper understanding of the biology, ecology, and potential use of the plant species *Senna siamea*. These researches have provided valuable information regarding the botanical characteristics of *Senna siamea* and have proposed several potential avenues for further research to enhance our understanding of this plant species. In a study conducted by Kambale et al. (2020), aqueous leaf extracts from three plant species native to Congo, namely *Senna siamea*, *Brillantaisia patula* and *Crossopteryx febrifuga* were utilized to investigate the environmentally friendly production of antimicrobial silver nanoparticles. The study focused on the antibacterial properties of plant extracts and their use in nanoparticle production. The work provides valuable insights into the chemical composition and biological properties of leaf extracts obtained from *Senna siamea*, contributing to a deeper understanding of its botanical characteristics.

In a similar manner, Monkheang et al. (2011) conducted a study on the barcode, molecular markers, species diversity, and utilization of medicinal Senna species, specifically *Senna siamea*, in Thailand. Based on their evaluation, *Senna siamea* is a species of Senna that thrives in Thailand. The pharmacological effects of this plant, such as its ability to alleviate constipation, are due to the presence of many anthraquinone derivatives found in its young shoots and leaves.

The traditional use of *Senna siamea* mostly originate from its laxative properties, which are attributed to the plant's anthraquinone components. The medicinal properties of *Senna siamea* are ascribed to its abundance of anthraquinone derivatives, which are also associated with the plant's pharmacological activity. The study of *Senna siamea* is important for traditional medicine and conservation efforts due to its valuable insights into the plant's therapeutic properties and genetic variability. This work contributes to our understanding of the botanical characteristics of *Senna siamea*, as well as its ecological and cultural significance.

Ajmani et al. (2019) conducted a study on the adsorption of hexavalent chromium utilizing *Senna siamea* seed pods that were in their original state or activated with zinc chloride. The study focused on examining the equilibrium, kinetics, and thermodynamics of this biosorption process. This study examined the ability of *Senna siamea* to adsorb hexavalent chromium from water solutions, offering valuable information on the potential environmental applications of this plant. This work provides valuable insights into the botanical traits and ecological relevance of *Senna siamea*, particularly in relation to its ability for biosorption. Ajmani et al. (2019) conducted a study on the extrafloral nectaries of *Senna siamea*, focusing on their location, structure, and changes during the plant's development, as well as their ability to absorb substances from the environment. The study provided insights into the potential significance of extrafloral nectaries in defensive mechanisms and plant-insect interactions, as well as the ecological function of these structures in *Senna siamea*. This study enhances our comprehension of the botanical attributes and ecological relationships of *Senna siamea*.

Oladeji et al. (2021) observed that the Fabaceae family encompasses the genus *Senna*, which belongs to the Caesalpinioideae subfamily within the Fabales order. The genus *Senna* include approximately 250–300 officially acknowledged species, which are extensively cultivated and distributed over the globe. These species are found in significant numbers throughout the tropical and subtropical regions of Africa, Asia, Europe, and Latin America. *Senna* species generally possess pinnate leaves consisting of leaflets arranged in opposing pairs. *Senna* plants often yield flowers consisting of five petals, five sepals, and ten stamens that are straight and of varying sizes. Typically, the arrangement of flowers is in the form of racemes. *Senna* species produce fruit or legume pods that contain many seeds. The majority of *senna* species are aromatic shrubs that have a lifespan of either one year or two years. They thrive in sunny conditions. Grasslands, coastal areas, wastelands, and waterlogged areas. *Senna* species have a rich historical background in traditional medicine, being utilized in several medical systems such as Siddha, Unani, Ayurveda, traditional Chinese medicine, Tibetan medicine, and African traditional medicine. Various components of plants, including foliage, bark, trunk, seeds, and fruits, are utilized in the formulation of herbal treatments to address a diverse array of ailments and illnesses. *Senna* species possess a diverse range of bioactive compounds that have the potential to be used for medicinal purposes. Phytochemical analyses have identified a wide range of secondary metabolites in *Senna* plants, which are responsible for their pharmacological effects.

2.1.1 Laxative effects of *Senna siamea*

Constipation is a prevalent gastrointestinal disorder that impacts a significant section of the population. There is a continuous quest for efficacious laxatives to treat this ailment. *Senna siamea*, a renowned herb with notable laxative qualities, has been extensively studied. The purpose of this literature review is to integrate and condense the research on the laxative properties of *Senna siamea*. According to various ideas, *Senna siamea* may have a laxative effect by interacting with acetylcholine receptors. In their study, Kakino et al. (2010) showed that the chemicals EEA-1 and EEA-2, isolated from *Senna siamea*, have a laxative effect via acting on cholinergic receptors in a mouse model of constipation. This discovery indicates a possible explanation for the laxative effects of *Senna siamea*.

The study conducted by Seethapathy et al. (2014) highlighted the need of utilizing widely-used plant-based laxatives, such as senna, for the management of constipation. This further underscores the advantages of using *Senna siamea* for addressing digestive ailments. *Senna siamea*, despite its intense laxative properties, has been linked to potential safety hazards. Kakino et al. (2010) have established a connection between *Senna siamea* and harm to the intestinal epithelial layer, which in turn raises the likelihood of developing colorectal cancer. This raises significant concerns regarding the enduring safety of *Senna siamea* as a treatment for constipation. To summarize, the existing study elucidates the laxative properties of *Senna siamea* and underscores the plant's potential as a natural treatment for constipation.

2.1.2 Phytochemical Properties of *Senna siamea*

The phytochemical features of *Senna siamea* have been extensively researched and recorded in the literature. The objective of this review is to offer a thorough comprehension of the phytochemical makeup of *Senna siamea* by amalgamating and analyzing previous research discoveries. *Senna siamea* contains a wide range of phytochemicals, such as sennosides, anthraquinone glycosides, terpenoids, polyketides, tannins, alkaloids, flavonoids, terpenes, anthraquinone, saponins, phenolics, chromone, chromone alkaloids, anthraquinones, bi-anthraquinones, and other secondary metabolites (Seethapathy et al., 2014; Reddy et al., 2015; Widyowati & Agil, 2018). *Senna siamea* is a plant that has attracted significant attention in the field of pharmacology due to its valuable therapeutic and medicinal properties, which are attributed to a variety of chemicals.

Furthermore, Oladeji et al. (2021) stated that *Senna* species have been identified to possess more than 120 unique phytochemicals with diverse structures. The compounds present are anthrones, glycosides, tannins, saponins, anthraquinones, polyphenols, flavonoids, anthraquinones, and terpenoids, as well as piperidine alkaloids. Alkaloids play a significant role as phytoconstituents in the genus *Senna*. The detected metabolites include iso-6-cassine, (-)-cassine, and (-)-spectaline, which are notable compounds. Anthraquinones are another important group of compounds found in *Senna* species. Various parts of *Senna* plants have been shown to contain many anthraquinones and phenyloxy-anthraquinones. The phytochemicals contained in *Senna* species exhibit a wide range of pharmacological activities, including antimalarial, antidiabetic, antioxidant, antimicrobial, anti-inflammatory, analgesic, antitumor, antinociceptive, and anticancer

properties. Recent study has found that *Senna* species possess a diverse array of bioactive metabolites, such as essential oils, alkaloids, flavonoids, terpenoids, and anthraquinones. The compounds present are tannins, polyphenols, glycosides, steroids, and saponins. These metabolites have demonstrated substantial bioactivities both in laboratory experiments (in vitro) and in living organisms (in vivo). *Senna* species have a large amount of phenolic chemicals, which have been recognised as possible indicators in herbal medicine.

Plants possess inherent compounds known as phytochemicals, which exert diverse physiological impacts. The effects encompass anti-inflammatory, anti-cancer, antibacterial, hypolipidemic, hypoglycemia, and neuroprotective properties.

The phytochemical features of *Senna siamea* have been extensively studied and documented in the literature. The aim of this review is to comprehensively analyze the phytochemical composition of *Senna siamea* by consolidating and incorporating the findings of earlier studies. *Senna siamea* contains a variety of phytochemicals, including sennosides, anthraquinone glycosides, terpenoids, polyketides, tannins, alkaloids, flavonoids, terpenes, anthraquinone, saponins, phenolics, chromone, chromone alkaloids, anthraquinones, bi-anthraquinones, and other secondary metabolites (Seethapathy et al., 2014; Reddy et al., 2015; Widyowati & Agil, 2018). *Senna siamea* has compounds that contribute to its therapeutic and medicinal properties, rendering it a plant of pharmacological significance.

Recent research has found that *Senna* species possess a diverse array of bioactive metabolites, such as anthraquinones, flavonoids, terpenoids, essential oils, alkaloids,

tannins, and polyphenols. Glycosides, steroids, and saponins. These metabolites have demonstrated substantial bioactivities both in laboratory experiments (in vitro) and in living organisms (in vivo). *Senna* species have a large amount of phenolic chemicals, which have been recognized as possible indicators in herbal medicine. Various phenolic chemicals, including bioflavonoids such as procyanidin, have been identified in various components of *Senna* plants. The phytochemical features of *Senna* species have a role in their traditional usage in herbal medicine and their potential for creating novel therapeutic therapies. In addition, Monkheang et al. (2011) did a study in Thailand and made noteworthy findings about the phytochemical features of *Senna siamea*. This includes the existence of barakol, a chemical renowned for its propensity to reduce anxiety. Barakol, derived from *Senna siamea*, has demonstrated potential as an anxiolytic drug, suggesting the existence of therapeutic chemicals in the plant. The study also emphasized the presence of anthraquinone laxatives in both fresh and cooked *Senna siamea* leaves, highlighting the plant's therapeutic qualities. Ultimately, the varied phytochemical makeup of *Senna siamea*, encompassing substances such as barakol and anthraquinones, contributes to its medicinal characteristics and prospective therapeutic applications.

2.1.3 Effects of *Senna siamea* on feed intake

The total amount of food eaten by an animal in a certain time frame; usually expressed in grams or kilograms per day. It is a crucial metric for tracking the nutritional status, growth, and overall health of animals.

Senna siamea has been studied as a feed supplement in a range of animal species, with a focus on effects on feed intake and production. The cost-benefit analysis and productivity

of feeding processed tropical sickle pod (*Senna obtusifolia*) leaf meal-based diets to albino rats were investigated in a study conducted by Augustine et al. (2020). The rats' productive performance when fed diets based on *Senna obtusifolia* was demonstrated by the findings, which revealed the potential benefits of *Senna siamea* as a feed supplement. Ansah et al. (2016) also investigated the effects of tanniferous browse plants on the growth and nutritional absorption of Djallonk rams. The study found that consuming tanniferous browse plants, such as *Senna siamea*, improved Djallonk growth and nutrient digestibility in rams.

On the other hand, studies have also suggested that eating *Senna siamea* could be dangerous. Gotardo et al. (2017) looked at the impact of *Senna occidentalis* seed toxicity on laying hen egg production. The findings suggested that *Senna siamea* might have a detrimental effect on poultry output since ingesting *Senna occidentalis* seeds decreased laying hens' capacity to lay eggs. Legba et al. (2020) also assessed the anti-Salmonella activity of *Senna siamea* aqueous and ethanolic extracts, which are used in Benin's traditional management of salmonellosis. The study illustrated the potential antibacterial properties of *Senna siamea* by referencing its traditional use in the management of salmonellosis.

Hendriks et al. (2012) looked at the potential impacts of *Senna siamea* on methane reduction and nematode management in goats in addition to its influence on feed intake and productive performance. The study found that browsing species, such as *Senna siamea*, are crucial for controlling nematode infections in goats and lowering methane

emissions. The findings of this study will be useful in developing feeding schedules and management strategies that will optimize *Senna siamea* use as a feed supplement.

2.1.4 Effects of *Senna siamea* on water intake

Water intake refers to the overall amount of water that an animal consumes within a specific period, typically measured in millilitres or litres per day. It is crucial for maintaining hydration, fluid equilibrium, and overall well-being. Multiple studies have examined the impact of *Senna siamea*, also referred to as Siamese cassia, on water use. The purpose of this literature review is to compile and integrate the findings from different investigations. Filho et al. (2012) conducted an experiment to address colonic impaction in horses by examining the use of senna (*Cassia angustifolia* Vahl), enteral hydration, and intravenous hydration. According to the study's findings, the horses that incorporated senna into their treatment regimen exhibited increased water consumption. This suggests a potential correlation between the diet of an animal test subject and its intake of water and senna. Fajariani et al. (2020), conducted a separate study to assess the amount of carbon stored above the ground in Trembesi (*Albizia saman*) and Johar (*Senna siamea*) trees. The study primarily focused on carbon sequestration but also indirectly provided insights into the water intake of different tree species. The results indicated that the nitrogen-fixing tree species *Senna siamea* could potentially influence water absorption as a result of its expansive canopy and elevated transpiration rates.

Ta et al. (2021) performed a comparative FISH investigation of *Senna toratandem* repeats, yielding valuable information about the chromosomal dynamics of *Senna* species. The study enhances our comprehension of the chromosomal and genetic

elements that could potentially impact *Senna siamea's* ability to absorb and utilize water, although not directly investigating water intake.

2.1.5 Effects of *Senna siamea* on faecal pellets

An animal's faeces can provide insights on its dietary habits, overall health, and gastrointestinal system. Multiple studies have examined the impact of *Senna siamea* on faecal pellets. Multiple research findings indicate that *Senna siamea* may influence the formation of faecal pellets. A study conducted by Paguigan et al (2014), has found that *Senna siamea* has strong anti-ulcer capabilities. The investigation's findings illustrate the beneficial impact of *Senna siamea* on faecal pellets. *Senna siamea* potentially plays a role in controlling the formation of faecal pellets and enhancing gastrointestinal well-being through its anti-ulcer properties.

Dakpogan et al. (2019) investigated the anticoccidial properties of *Senna siamea* in hens. The study primarily examined the impact of *Senna siamea* on coccidiosis, however the findings also indicate that *Senna siamea* may have an influence on faecal pellets. The findings of this study enhance our comprehension of the wider impacts of *Senna siamea* on gastrointestinal well-being and faecal attributes. Bulkiah et al. (2019) conducted an examination of the energy species cultivated in reclamation zones and analyzed their wood pellet properties. While this study did not specifically examine the impact of *Senna siamea* on faecal pellets, it does offer useful insights into the characteristics of pellets originating from several plant species. Based on this information, it is possible to deduce the potential influence of *Senna siamea* on the attributes of faecal pellets.

Overall, the available data indicates that *Senna siamea* may have positive effects on faecal pellets due to its anti-ulcer and gastrointestinal health-promoting properties.

2.1.6 Effects of *Senna siamea* on faecal moisture

Faecal water content refers to the amount of water present in an animal's waste. The water content of the faeces is quantified as a percentage. Faecal moisture serves as a valuable measure of an animal's hydration status and digestive well-being. Conversely, *Senna* species, such as *Senna siamea*, are well-known for their laxative properties, according to fundamental knowledge of these species. The active components of *Senna*, specifically anthraquinone glycosides, promote the secretion of fluids from the intestinal wall into the colon and enhance the movement of the intestines, so stimulating bowel movements (Akram, M., Thiruvengadam, M., Zainab, R., Daniyal, M., Bankole, M. M., Rebezov, M., & Okuskhanova, E. 2022).

The laxative effects of *Senna* are often associated with an increase in the moisture content of faeces. *Senna* has the ability to facilitate bowel movements by attracting water into the colon, potentially resulting in increased moisture content in the faeces. *Senna* functions by increasing the water content of the stool, leading to the production of softer and more hydrated faeces. Individuals with constipation or difficulty in passing solid, dehydrated faeces may benefit from this. *Senna siamea*, similar to other *Senna* species, can help regulate stool consistency by promoting enough hydration of the excrement. This can facilitate the promotion of regular bowel movements and mitigate the symptoms of constipation. *Senna* has the potential to enhance the frequency of bowel movements and promote moisture in faeces. However, it is important to exercise caution and only take it

sparingly and under medical supervision. Excessive or extended use of Senna laxatives can result in dehydration, imbalances in electrolyte levels, and reliance on laxatives. Scientific research and clinical trials may examine the impact of *Senna siamea* on the moisture content of faeces in animal models or human participants to evaluate its effectiveness as a natural laxative and its influence on gastrointestinal function. Zhu et al. (2023) documented the moisture contents of senna species. Senna and its main component, sennosides, are effective laxatives for treating intestinal constipation. Diarrhoea can result from a significant rise in the moisture level of the faeces due to the administration of large amounts of senna extract and sennosides. The application of Renzhu ointment through the skin significantly reduced the occurrence and severity of diarrhoea in a mouse model with senna-induced diarrhoea. This treatment also decreased the frequency of loose stools and the moisture content of faeces. Upon administration of a senna extract solution, BALB/c mice exhibited pronounced diarrhoea and a reduction in the moisture level of their faecal matter. Interventions of utilizing *Malus pumila* leaf flavonoids have demonstrated anti-diarrhoeal advantages by increasing the moisture content of the faeces.

The anti-ulcer effect of *Senna siamea* has been studied, highlighting its therapeutic potential in gastrointestinal problems, as well as its potential impact on faecal moisture (Paguigan et al., 2014). This suggests that *Senna siamea* has a broader influence on gastrointestinal health, in addition to its impact on faecal moisture.

2.1.7 Effects of *Senna siamea* on kidney function

The kidneys are a pair of renal organs located bilaterally in the lumbar region, adjacent to the vertebral column. Kidneys play a vital role in excreting waste, regulating blood

pressure, and maintaining the body's fluid and electrolyte equilibrium. *Senna siamea* is a tropical tree that has demonstrated diverse impacts on several biological systems. Although the direct effects of *Senna siamea* on kidney function have not been thoroughly investigated, numerous studies have examined its influence on other physiological systems. These studies may offer valuable information regarding the potential effects of *Senna siamea* on kidney function. The objective of this literature review is to provide a comprehensive summary of the existing knowledge regarding the influence of *Senna siamea* on renal function. In their study, Sugumar et al. (2016) investigated the hepatoprotective and nephroprotective effects. The effects of a hydroethanolic extract of *Senna alata* on both enzymatic and nonenzymatic antioxidant systems were investigated in rats with streptozotocin-induced diabetes. Given the observed protective effects of the extract on the liver and kidneys, the findings of the study indicate a potential beneficial influence on kidney function. This study, which focuses on an extract derived from a distinct species of *Senna* known as *Senna alata*, did not specifically investigate the impact of *Senna siamea* on kidney function. Logah et al. (2020) investigated the nutritional characteristics and soil carbon storage of *Senna siamea* groves in Ghana's semi-deciduous forest region. Although not directly assessing renal function, this research provides significant observations regarding the ecological impacts of *Senna siamea*, which could potentially influence the overall well-being of the nearby community. It is necessary to comprehend the impact of *Senna siamea* on the environment in order to evaluate potential ecological pathways that may indirectly affect kidney function. In a similar vein, Gaiser et al. (2011) examined the impact of incorporating various residual materials, such as *Senna siamea*, on the alterations in soil organic carbon levels in a

tropical Acrisol. This research, similar to the work conducted by Logah et al. (2020), enhances our understanding of the environmental impacts of *Senna siamea*. This is crucial for evaluating the potential consequences it might have on kidney function. Ugbogu et al. (2016) conducted a toxicological evaluation of the aqueous dry leaf extracts of *Senna alata* on Albino rats. While the study primarily examined a different species of Senna, it provides valuable information on the potential toxicity of Senna plant extracts. This information is relevant for understanding the safety and impact on kidney function of *Senna siamea*. Osei-Tutu et al. (2018) conducted a study to examine the impact of multipurpose trees and shrubs, specifically *Senna siamea*, on degraded soils in a semi-deciduous forest zone. This work has provided a better understanding of the ecological and environmental impacts of *Senna siamea*, which can indirectly impair renal function.

2.1.8 Effects of *Senna siamea* on liver function

The phrase "liver function" refers to the numerous essential roles that the liver plays in maintaining overall health and balance in the body. *Senna siamea*, also referred to as *Cassia siamea*, is a leguminous tree indigenous to Southeast Asia and is well esteemed for its several therapeutic uses. The hepatoprotective properties of *Senna siamea* and its components have been extensively investigated in several studies. The objective of this literature review is to provide a comprehensive analysis of the study findings about the effects of *Senna siamea* on liver function, with the goal of enhancing readers' understanding. Several research investigations have investigated the hepatoprotective effects of *Senna siamea* and its individual components. The species *Senna senguiana*, which is closely related, exhibited notable hepatoprotective properties against liver

damage in rats induced by d-galactosamine (d-GalN) through its extract derived from the bark. This was evidenced by the significantly reduced levels of elevated aspartate aminotransferase (AST) and total bilirubin in the treated mice, as evaluated by Sobeh et al. (2017). Furthermore, research demonstrated that the alkaloids obtained from the leaves of *Senna alata* reduced the functioning of many liver enzymes, including alanine transaminases, gamma glutamyl transferase (GGT), AST, and alkaline phosphatase (ALP), while simultaneously increasing the amounts of these enzymes in the bloodstream. These findings indicate that certain elements of *Senna siamea* may modulate the function of hepatic enzymes.

The hepatoprotective activity of Sennoside A (SA), a constituent of *Senna siamea*, has also been demonstrated. This contributes to the existing body of research that substantiates the potential advantages of *Senna siamea* in preserving liver health (Le et al., 2021). In contrast to previous research highlighting the hepatoprotective benefits, Vitalone et al. (2011) found that the administration of *Cassia angustifolia* leaf extract did not have a significant impact on liver function markers. This emphasizes the significance of species-specific differences in the liver-protective characteristics of Senna plants and underscores the necessity for further research to identify the specific components responsible for the observed effects on the liver. Overall, this study's examination of the existing literature confirms the hepatoprotective effects of *Senna siamea* and its components. Based on the results, it appears that *Senna siamea* could serve as a beneficial adjunctive treatment for liver problems and the maintenance of liver function.

2.1.9 Effects of *Senna siamea* on kidney histology

Renal tissue is analyzed using a microscope to evaluate its structure and performance. It assists in identifying any pathological changes or abnormalities in the glomeruli, tubules, and blood vessels that form the structural components of the kidney. Nevertheless, specific research has suggested that prolonged or excessive use of Senna or its active constituents, such as anthraquinones, can result in kidney toxicity. These findings are derived from widely known information and relate to the impact of Senna on the histopathology of the kidneys. Nephrotoxicity is the term used to describe kidney damage caused by exposure to a harmful chemical. The impact of Senna on kidney histology can reveal histological changes such as glomerular destruction, tubular necrosis, interstitial inflammation, and other signs of renal damage. The objective is to assess the impact of Senna on renal function parameters, such as blood urea nitrogen (BUN), glomerular filtration rate (GFR), and serum creatinine levels, to evaluate kidney health and function. The renal tissue's inflammatory response, characterized by immune cell infiltration and the production of cytokines, may be associated with kidney injury induced by *Senna*. An examination of kidney histology can detect cellular injury, including alterations in the structure and function of the glomeruli, renal tubules, and interstitial cells caused by exposure to senna or its components. Studying the impact of Senna on kidney histology using animal models will help us comprehend the mechanisms of nephrotoxicity and potential pathways that contribute to renal damage. Evaluating the safety and potential hazards of using products containing Senna necessitates comprehending the impact of Senna on renal histology, especially in those with pre-existing kidney illness or those susceptible to kidney injury. The histopathology of *Senna siamea* kidneys was examined

in a study conducted by Ugbogu et al. (2016). The investigation entailed analyzing kidney sections from Albino rats that were administered varying doses of *Senna siamea's* aqueous dry leaf extract, as well as a control group that did not receive the extract. The micrographs were magnified 40 times using hematoxylin and eosin staining (H&E). The histological examination of the kidney sections revealed that the aqueous dried leaf extract of *Senna siamea* did not induce any harm or pathological alterations in the kidneys of the treated rats.

According to Albasher et al. (2020), the examination of the kidney tissue revealed that both the control group and the group treated with SME showed a normal kidney structure without any signs of abnormal changes in the tissue. Significant alterations were noted in the renal tubules and glomeruli of rats that were intoxicated with CdCl₂. The observed alterations consisted of hydropic degeneration and hypertrophy of the proximal tubular epithelium, tubular edema, and glomerular shrinkage. The nephroprotective efficacy of Senna extract counteracted the renal damage induced by Cd injections, indicating its potential protective impact against Cd-induced renal injury. These findings suggest that Senna extract may have a preventative effect in lowering the histological changes in the kidney caused by cadmium (Cd) poisoning.

2.1.10 Effects of *Senna siamea* on liver histology

The liver is an essential organ due to its regulation of numerous physiological functions, such as nutrient storage, metabolism, and detoxification. Preserving liver function is essential for maintaining overall health. Extensive research has been conducted on the

possible impact of various plant species on liver histology and function. A plant that has been studied for its impact on liver function is *Senna siamea*.

Wang et al. (2019) investigated the ability of *Senna alexandrina* extract supplementation to reduce the oxidative, inflammatory, and apoptotic effects caused by injecting cadmium chloride into the rat liver. The results showed that supplementation with *Senna alexandrina* extract effectively decreased oxidative stress, inflammation, and apoptosis in liver tissue, thereby confirming its hepatoprotective benefits. This research provides valuable new findings regarding the hepatoprotective effects of *Senna alexandrina* extract on liver histology, emphasizing its potential as a natural remedy for liver-related ailments.

In addition, Fajariani et al. (2020) evaluated the amount of carbon stored above ground in Trembesi (*Albizia saman*) and Johar (*Senna siamea*) trees. The primary aim of the study was to capture carbon, but it also provided insights into the potential environmental impacts and ecological significance of *Senna siamea*. Although this study does not specifically investigate the impact of *Senna siamea* on liver histology, it emphasizes the necessity for further research to fully comprehend the comprehensive impacts of *Senna siamea* on physiological and environmental aspects.

Gebrezgi et al. (2020) conducted a study on the subacute hepatotoxicity of *Senna occidentalis* seed extracts in Swiss albino mice. While this study specifically examined one species of Senna, it highlights concerns regarding the potential hepatotoxic effects of certain Senna species. This discovery highlights the importance of doing species-specific

research when assessing the impact of Senna on liver function, as various species may demonstrate distinct physiological responses.

In addition, Ugboju et al. (2016) performed a toxicological evaluation of the effects of *Senna alata* L. aqueous dry leaf extracts on Albino rats. The study emphasized the importance of conducting thorough safety investigations before using Senna species for medical reasons and highlighted the potential adverse effects of *Senna alata* L. on liver function. This work highlights the importance of conducting further research on the hepatotoxicity of various Senna species and enhances our comprehension of the possible dangers associated with Senna species. The literature review concludes by highlighting the importance of conducting safety assessments and species-specific investigations, in addition to exploring the possible hepatoprotective properties of Senna species.

2.2 Pharmacological Properties of Loperamide

The distinctive mechanisms by which drugs impact the body, particularly when employed for medical or therapeutic intentions, are known as their pharmacological characteristics. These qualities govern the interactions between pharmaceuticals and the body, the mechanisms by which they achieve their desired effects, and the presence of any adverse side effects or reactions. Loperamide's pharmacological features have been extensively studied. Malinky et al. (2021) conducted a study that provided a comprehensive analysis of the pharmacological properties of loperamide, encompassing Loperamide, a powerful agonist of the μ -opioid receptor, primarily affects the peripheral nervous system. When used within the recommended therapeutic range of 2-8 mg per day, it demonstrates remarkable effectiveness and a favourable level of safety. Loperamide has been included

in the World Health Organization's model list of essential drugs. It possesses the capacity to inhibit voltage-gated L-type calcium channels and induce cell death that relies on autophagy. Loperamide exhibits a low level of absorption into the bloodstream when taken orally by humans, with a bioavailability of only 0.3 %. Additionally, it has a large distribution throughout the body, with a volume of distribution of 4 liters per kilogram of body weight. The medication experiences fast metabolism in the liver, resulting in unfavourable pharmacokinetic characteristics. The findings emphasize the pharmacological properties of loperamide as a powerful agonist of the μ -opioid receptor, indicating its potential for therapeutic use and unique metabolic characteristics.

Regnard et al. (2011) provided a description of the pharmacological properties of loperamide, stating that it acts as a potent agonist of the μ -opioid receptor. While the liver, particularly the enzyme CYP3A4, plays a major role in metabolizing it, this substance is easily absorbed from the gastrointestinal system. Loperamide's antidiarrhoeal effect is achieved by reducing the movement of the gut muscles responsible for propulsion and increasing the activity of other muscles in the gut wall. This is accomplished by directly being absorbed into the gut wall and influencing the myenteric plexus in the longitudinal muscle layer. This leads to an increase in the time it takes for food to pass through the intestines. Furthermore, loperamide enhances nocturnal continence in individuals with an ileo-anal pouch by increasing the contractile strength of the anal sphincter. It exhibits the ability to reduce secretions by blocking calmodulin, which is a unique characteristic among opioids. Additionally, it affects the movement of water and electrolytes in the intestines by enhancing absorption. Loperamide inhibits the

sodium-dependent absorption of glucose and other nutrients from the small intestine. Animal research has demonstrated the emergence of resistance to the gastrointestinal effects of loperamide. However, in people with persistent diarrhoea, loperamide has been effectively utilized for many years without any signs of tolerance. The aforementioned discoveries emphasize the intricate pharmacological effects of loperamide in managing diarrhoea and associated ailments.

Taguchi et al. (1999) conducted a study on loperamide and found that it is a synthetic opioid that mainly targets the μ -opioid receptors in the gut. This leads to a decrease in gastrointestinal motility and transit time. Due to its limited ability to cross the blood-brain barrier, it has minimal influence on the central nervous system and reduces the chances of negative effects, such as respiratory depression. Loperamide is an effective long-acting drug for treating diarrhoea because it increases the time it takes for food to pass through the colon and enhances the absorption of water and electrolytes in the intestines. When the medication is administered as instructed, it carries a low risk of being misused or causing addiction. It is also minimally absorbed into the body and is well-tolerated for the treatment of diarrhoea. Loperamide undergoes substantial first-pass metabolism in the liver, resulting in limited absorption into the bloodstream, and its byproducts are mostly eliminated through faecal excretion. The pharmacological profile of loperamide is characterized by its distinct features, making it a secure and efficient remedy for diarrhoea. This is primarily due to its activity on peripheral opioid receptors and its minimal impact on the central nervous system.

In a similar vein, Jedidi et al. (2019), examined the pharmacological properties of loperamide and found that this opioid agonist receptor reduces peristaltic movement by reducing the production of prostaglandin and acetylcholine during distension. It is administered as a remedy for diarrhoea in some situations, such as infectious gastroenteritis, functional diarrhoea, and traveler's diarrhoea. Loperamide's ability to enhance anal sphincter tone can lead to improved faecal continence in both patients with and without diarrhoea. Loperamide demonstrates both antispasmodic and antidiarrhoeal characteristics. The combination of loperamide with additional bioactive chemicals can potentially enhance the effects on the intestinal membranes, immune system, and gut microbiota of the targeted host. This text discusses the mechanisms of action and therapeutic benefits of loperamide in treating diarrhoea and related gastrointestinal illnesses.

On the other hand, Joris Vandebossche et al. (2010) identified the pharmacological properties of loperamide and discussed its role as an activator of the peripherally active μ opioid receptor. Due to its strong affinity for P-glycoprotein, loperamide is more likely to cause central adverse effects and potential interactions with other medications. CYP2C8 and CYP3A4 are the main enzymes involved in the metabolism of loperamide. Loperamide can modify the distribution, elimination, absorption, and ability to cross the blood-brain barrier of medications due to its ability to decrease P-glycoprotein. Research has shown that loperamide's ability to decrease the removal of substances by P-glycoprotein may impact its effects on the central nervous system and its interactions with other medications. However, the available evidence is limited and does not provide a clear conclusion. The existing data is inadequate to establish a clinically meaningful

correlation between loperamide and inhibitors or substrates of P-glycoproteins that result in central nervous system depression or opioid toxicity at permissible levels. The results highlight the complex pharmacological characteristics of loperamide, its interactions with P-glycoprotein, and the need for further research to fully understand its importance in clinical practice.

Additionally, S. Sahed et al. (2016) examined the pharmacological properties of loperamide. They discovered that it has the ability to decrease the movement of the colon and the secretion of water in the intestines, resulting in a delay in the movement of material through the intestines and the time it takes for faeces to be expelled. The animals experience spells of constipation as a consequence of this. Loperamide-induced constipation is a widely recognised model of spastic constipation. It is characterized by a decrease in the consumption of food and fluids, leading to a decrease in the quantity, weight, and moisture content of faecal pellets.

2.2.1 Effects of loperamide on feed intake

Multiple trials have been carried out to examine the impact of loperamide on the consumption of food. A study conducted by Lee et al (2012) presented comprehensive data and highlighted the main discoveries concerning the consumption of food in cases of constipation produced by loperamide. Surprisingly, there was a noticeable difference in food consumption across all groups that were given Ficus Pasata (FP) during the entire experiment, when compared to the control or loperamide-only groups. However, no unusual symptoms were detected. All experimental groups had whole blood and serum tests that fell within the normal levels. The faecal excretion parameter was enhanced in

all groups who received FP, despite the occurrence of lower food consumption in certain groups throughout the entire study period.

Ashafa et al. (2011), found that administering loperamide significantly decreased water intake and the number, water content, and weight of faecal pellets in rats. This suggests that constipation was induced by loperamide. Nevertheless, there was no notable disparity detected in the food consumption between the control group and the constipated animals.

Similarly, Nafiu et al. (2015) examined the feed intake of rats with loperamide-induced constipation and found that there was no notable disparity in feed intake between the control rats and the rats with loperamide-induced constipation prior to therapy. Following treatment, there was no statistically significant disparity in the feed intake between all groups of rats, including the normal control and constipated control. These findings suggest that the injection of loperamide did not have a substantial impact on the rats' food consumption.

In a similar manner, Nweje et al. (2019) investigated and documented the feed consumption of loperamide. Loperamide effectively decreased the quantity of poo pellets and the moisture content of faecal pellets in rats when compared to the normal control, suggesting the presence of constipation. Nevertheless, there were no notable disparities in the consumption of food, consumption of water, and body mass between the constipated

animals and the normal rats. The data indicate that loperamide caused constipation in the rats, but it did not have a substantial impact on their food consumption.

In a similar manner, Tosan et al. (2014) conducted an analysis and presented comprehensive data on the main discoveries on the consumption of loperamide. Loperamide markedly reduced the weight, water content, and quantity of faecal pellets in the constipated rats in comparison to the normal control group. Loperamide markedly decreased the water consumption in the constipated rats when compared to the normal control group. Nevertheless, there was no substantial disparity in the amount of food consumed by the control group without constipation and the animals with constipation. The study found that loperamide, administered to induce constipation in rats, had an effect on the faecal characteristics and water consumption of the constipated rats, but did not significantly change their food intake.

On the other hand, the study conducted by Saheed et al. (2016) found that when loperamide was given orally, it led to a notable decrease in the amount of food consumed by the rats in the trial. At the maximum tested dosage of the extract, the animals' eating habits were similar to those of the normal control group and the reference standard medication utilized in the study.

2.2.2 Effects of loperamide on water intake

The primary findings about loperamide's effect on water consumption were reported in a study conducted by Nweje et al. (2019) with the aim of investigating the drug's influence

on water intake. Prior to loperamide medication, there was no noticeable disparity in the water intake between constipated rats and normal rats. There was no significant difference in water consumption between constipated rats and normal rats after they received loperamide therapy. In a study conducted by Nafiu et al. (2015), the researchers investigated the water consumption of rats with constipation induced by loperamide. The results showed that there was no statistically significant difference in the water intake between the constipated rats and the control rats. These findings indicate that the loperamide dose did not have an impact on the rats' water consumption.

However, Tosan et al. (2014) also examined and analyzed the significant data on the water consumption of rats experiencing constipation as a result of loperamide. Loperamide significantly decreased water consumption in albino rats compared to the normal control group. This indicated that the rats were experiencing constipation. Ultimately, the rats' consumption of water was drastically diminished following the administration of loperamide, while their consumption of food remained same, thereby confirming the successful induction of constipation.

Ashafa et al. (2011) examined and recorded the amount of water consumed by loperamide, highlighting the differences. Administration of loperamide to constipated rats resulted in a significant reduction in their consumption of water. The rats that were not treated for constipation exhibited a reduction in their water intake.

2.2.3 Effects of loperamide on faecal pellets

Faecal pellets serve as indicators of an animal's dietary habits, overall well-being, and digestive efficiency. In their study, Nafiu et al. (2015) examined and documented the significant discoveries related to the faecal pellets of rats with constipation induced by loperamide. Loperamide markedly decreased the quantity of faecal pellets in the constipated rats in comparison to the normal control rats. There was no significant difference in the water content of the faecal pellets between the normal and constipated rats.

In a similar vein, vera et al. (2019) investigated the impact of loperamide on faecal pellet formation in rats. The study observed significant alterations in the faecal pellets of rats following the injection of loperamide. There was a gradual rise in the number of faecal pellets discovered in the colorectum of rats treated with loperamide at a dose of 0.1 mg/kg between 4 and 8 hours. This suggests that there was an effect on the amount of faeces produced. The modest amount of barium that entered the small intestine did not pass through this organ in the usual way, and there was very little contrast in the cecum and colorectum during the entire trial in the animals that were given a dose of 10 mg/kg of loperamide. Following a single dosage of loperamide, the mechanical properties of the colonic wall remained very stable. This is evidenced by the comparable maximum size and density of the faecal pellets across all treatments, except for the highest dose of loperamide, which prevented barium from reaching the colon. In summary, the study indicates that loperamide has notable impacts on the creation of faecal pellets, the movement of the colon, and the physical characteristics of the colon wall in rats.

In addition, Ashafa et al. (2011) documented the presence of faecal pellets in rats with constipation produced by loperamide. Loperamide effectively decreased the quantity, moisture content, and mass of the faecal pellets, suggesting the development of constipation in the rats. The decrease in water consumption by the constipated animals can be related to the drug's action, which likely caused a reduction in the water content of the faecal pellets.

In a similar vein, Nweje et al. (2019) found that loperamide effectively decreased the quantity of faecal pellets and the moisture content of faecal pellets in constipated rats as compared to normal rats. This decrease suggested the initiation of constipation in the rats. Nevertheless, loperamide did not have a substantial impact on the consumption of food, water, and the overall body weight of the constipated animals as compared to the normal rats.

In addition, Tosan et al. (2014) conducted an analysis on the impact of loperamide on faecal pellets. They reported significant data related to the faecal pellets of rats with constipation produced by loperamide. Constipation was effectively produced in the rats using loperamide, as evidenced by the increased faecal characteristics compared to the rats in the normal control group. The oral administration of the aqueous extract of *Acacia ataxacantha* leaves demonstrated a notable laxative effect and effectively alleviated constipation induced by loperamide in a way that was dependent on the dosage, as evidenced by the rise in faecal output.

2.2.4 Effects of loperamide on faecal moisture

The quantity of water present in an animal's waste material. The water content of the faeces is quantified as a percentage. Faecal moisture serves as a valuable measure of an animal's hydration status and digestive well-being. In Nweje et al.'s (2019) study on the impact of loperamide on faecal moisture, it was shown that loperamide significantly reduced the water content in faecal pellets of constipated rats compared to normal rats. This decline indicated that constipation had been caused.

In a similar manner, Nafiu et al. (2015) examined and presented the primary outcomes concerning faecal moisture in rats experiencing constipation caused by loperamide, providing a thorough account of the facts. The constipated rats' faecal pellets had a significantly reduced water content as compared to the faecal pellets of the control rats. In summary, the constipation caused by loperamide resulted in a decrease in the moisture level of the faecal pellets.

Ashafa et al. (2011) found that administering loperamide to rats significantly reduced the moisture content of their faecal pellets. This decline indicated that the rats had developed constipation. However, the amount of water in the faecal pellets of constipated rats significantly increased in a dose-dependent way when they were given the ethanolic extract of Aloe vera. This suggests that the aloe vera extract might counteract the constipation caused by loperamide, which decreases the moisture in the faeces.

Tosan et al. (2014) conducted a study on constipated rats treated with loperamide. They observed and documented significant findings related to faecal moisture. The researchers

concluded that the rats were effectively induced to develop constipation by loperamide, as evidenced by the higher faecal characteristics compared to the normal control rats. The significant decrease in loperamide's activity certainly caused the reduction in water content in the faecal pellets, which may have led to a decrease in water consumption in constipated animals.

2.2.5 Effects of loperamide on kidney function

Loperamide is a pharmacological agent predominantly employed as an antidiarrhoeal medicine for the treatment of both acute and chronic diarrhoea. Its mechanism of action involves inhibiting the peristaltic movement of the intestines, resulting in a reduction in the frequency of bowel movements and a firmer consistency of stool.

When it comes to its impact on kidney function, loperamide is generally not linked to direct kidney toxicity or impairment. Unlike certain other medications, this drug is not predominantly metabolized by the kidneys, hence decreasing the likelihood of side effects connected to the kidneys.

Nevertheless, it is crucial to acknowledge that in instances of severe diarrhoea, dehydration may arise, leading to an indirect influence on renal function. Dehydration diminishes the circulation of blood to the kidneys, which can result in the development of acute kidney injury or the deterioration of pre-existing kidney conditions. Jumbo et al. (2021) did a study to examine the impact of loperamide on kidney function. The delivery of loperamide resulted in a reduction in electrolytes, specifically potassium and sodium

ions. This indicates that the drug has the ability to disrupt the balance of electrolytes, which in turn inhibits the intestines' ability to retain fluid.

2.2.6 Effects of loperamide on liver function

Liver function encompasses the diverse and vital responsibilities that the liver fulfills in maintaining overall physiological well-being and balance. The liver is an essential organ that plays a crucial role in various physiological processes, such as metabolism, detoxification, bile production, protein synthesis, storage, blood filtration, and hormone metabolism. In their work, Bachawa et al. (2024) examined and documented the significant discoveries about the impact of loperamide on liver function. The liver histology of mice treated with loperamide exhibited no notable alterations in terms of sinusoids, hepatic cords, or Kupffer cells. In contrast to the positive control group, the groups that were administered methanolic pomegranate peel extract and metformin hydrochloride demonstrated a dose-dependent enhancement in liver histology. This improvement was characterized by a clearly defined central vein, the absence of perivascular fibrosis, and well-developed hepatic cords and nuclei. The results indicate that the injection of loperamide did not cause any noticeable changes in liver function, as seen by the absence of any aberrant tissue structures in the livers of the mice that received the treatment.

In a similar vein, Lee and Kang (2019) found that loperamide-induced constipation in rats adversely affected liver function. There were no notable changes in the levels of γ -

glutamyltransferase (γ -GT) and lactate dehydrogenase (LDH) in any of the groups, suggesting that loperamide-induced constipation did not cause major abnormalities in these liver enzymes. The loperamide-treated group exhibited a modest elevation in AST concentration compared to the normal control group, indicating the possibility of loperamide-induced liver damage in the rats.

In a study conducted by S. Saheed et al. (2016), the impact of loperamide on liver function in rats was investigated and analyzed. The study revealed that constipation produced by loperamide caused modifications in liver function indices, including variations in serum levels of albumen, total protein, bilirubin, and specific enzyme activities such as ALP, ALT, AST, and GGT. This indicates a possible hepatoprotective impact of the extract on liver harm caused by constipation.

2.2.7 Effects of loperamide on kidney histology

The process of analyzing kidney tissue at a microscopic level in order to assess its structure and functionality. It aids in the detection of any pathological alterations or irregularities in the structural elements of the kidney, such as glomeruli, tubules, and blood vessels. Jumbo et al. (2021) conducted a study where they examined the kidney tissues of Wistar rats that were exposed to loperamide-induced toxicity. The histological evaluation of these tissues revealed some important discoveries. The renal tissues of Wistar rats drunk with loperamide and treated with different doses of senokot (150 mg/kg), aqueous extract (250 mg/kg and 500 mg/kg), and saponin fraction (125 mg/kg and 250 mg/kg) exhibited enhanced cellularity in the majority of glomeruli, characterized

by the presence of proliferating mesangial cells and many tubules filled with fluid. The kidney tissues of the groups administered with 15 mg/kg of senokot, 250 mg/kg and 500 mg/kg aqueous extract, and 250 mg/kg saponin fraction displayed a medical disease called global mesangial proliferative glomerulonephritis, possibly caused by intestinal irritation as a side effect. The kidney tissue of Wistar rats that were made poisonous by loperamide and treated with a 125 mg/kg saponin fraction had a normal structure. However, the kidney tissue of rats treated with a 250 mg/kg saponin fraction showed a condition called global mesangial proliferative glomerulonephritis. The results suggest that loperamide has a significant effect on the kidney histology of Wistar rats, but this effect can be reduced by treating them with an aqueous extract and saponin fraction of *Centella asiatica* leaves.

2.2.8 Effects of loperamide on liver histology

Liver tissue is examined under a microscope to evaluate its structure and detect any irregularities. The process includes examining the cellular constituents, structure, and general arrangement of the liver tissue. Multiple experiments have been carried out to investigate the impact of loperamide on liver histology. Bachawa et al. (2024) did a study on the liver histology of loperamide treatment and presented their findings. The group treated with 3-mg/kg loperamide hydrochloride showed no alterations in cellular structure, and the villi had a distinct and well-defined shape and structure. No substantial abnormalities were observed in the sinusoids, hepatic cords, or Kupffer cells of the liver tissues in the loperamide-treated group, as determined by histological analysis. The

results indicate that the injection of loperamide did not have a notable effect on the liver's histology in the trial.

In a similar vein, Jumbo et al. (2021) conducted a study examining the histological analysis of liver tissues from Wistar rats that were induced with loperamide toxicity. The researchers observed that the liver tissues of the Wistar rats drunk with loperamide and not treated, exhibited hepatocyte congestion with dilated sinusoids. Additionally, there was an elevated quantity of erythrocytes present in the liver cell parenchyma. The results suggest that the use of loperamide had a negative impact on the liver tissues of the untreated rats.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area and Duration of Study

The study was conducted at the Department of Education of the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (Ashanti Mampong Campus). Mampong Municipality is one of the Municipal Assemblies in the Ashanti Region following the splitting and upgrading of the former Sekyere West District into Mampong Municipal and Sekyere Central District. It is also one of the administrative municipals in the Ashanti Region of Ghana. It is bounded to the south by the Sekyere South district, to the east by Sekyere Central, and to the North by Ejura Sekyedumase districts. The capital of the Municipality is Mampong. It is also located within longitudes $0^{\circ}05''W$ and $1^{\circ}30''W$ and latitudes $6^{\circ}55''N$ and $7^{\circ}30''N$. The Municipality covers an area of about 23.9 km². The major towns within the Municipality are Mampong, Krobo, Dadease, Asaam, Kofiase and Adidwan. The Municipality has an average annual rainfall of 1,270mm and two rainy seasons. The major rainy season starts in March and ends in August while the minor is between September and November. The remaining months span of the Harmattan dry season. The average annual temperature is 27⁰C with variations in mean monthly temperature ranging between 22⁰C - 30⁰C (Frimpong, B. F. (2015).

3.2 Experimental Rats and Design

In this study, 20 sexually mature female Albino rats aged 10 – 12 weeks with an average bodyweight of 150 g were obtained from a local breeder in Asante Mampong, Ashanti

Region of Ghana. The animals were transferred to the Animal experimental farm of the Department of Education, Animal Science at the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (Ashante Mampong Campus) for the purpose of conducting the experiment. The animals underwent a 14-day acclimatization period. Subsequently, the rats were divided into four groups using a complete randomized design, with each group consisting of five rats. Treatment 1 (Control) was administered normal saline continuously for the entire trial. Treatment 2 received a dosage of 0.75 mg/5 ml of loperamide for a duration of 4 days. Treatment 3 received normal saline for 4 days and then 5 ml of *Senna siamea* leaf decoction for a duration of 7 days. Treatment 4 was administered a dosage of 0.75 mg/5 ml of loperamide for a duration of 4 days, followed by a dosage of 5 ml of *Senna siamea* leaf decoction for a duration of 7 days. The dosages for both loperamide and *Senna siamea* leaves decoction were obtained from various studies on senna siamea. All treatments were administered by oral gavage.

3.3 Housing and Feeding

The Albino rats utilized in this investigation were individually housed in an Aluminium cage that was covered with a wire mesh. The cage was partitioned into four (4) compartments, each measuring 70 cm × 60 cm × 40 cm. The enclosure ensured adequate airflow and effectively prevented any attempts to break free. The wire netting effectively confined the rats while still facilitating air movement. Adequate space was allocated to allow the rats to move about with ease. The experimental animals were provided a conducive environment with a temperature of 29°C and a normal PH. An electric bulb was provided in the cage as a source of light for the rats. It was crucial to facilitate their innate behaviors and reduce stress. The cage possessed a self-cleaning mechanism, which

effectively upheld hygiene standards and minimized the need for hand cleaning. Each compartment was equipped with gates at the top, allowing entry to the interior without causing significant disturbance to the rats or their surroundings. This improved the level of care provided while simultaneously reducing the amount of stress experienced when feeding the animals or removing water and feeding troughs for cleaning purposes.

The experimental rats were provided with unrestricted access to a rodent food. They were fed with grain-based diets and drinking water throughout the whole study period.

3.4 Preparation of Decoction

The fresh *Senna siamea* leaves were harvested from the plants around Akenten-Appiah Minka University of Skilled Training and Entrepreneurial Development. The leaves were brought to the department of agriculture for identification. The leaves were washed with distilled water. The leaves were dried under shade to preserve the phytochemical elements. 1000g of the dry leaves was boiled in 1000ml of distilled water at 100 °C to obtain the decoction. The decoction was filtered aseptically severally using a muslin cloth to obtain the extract. The filtered leaf extract was stored in a functional refrigerator (4 °C) until the time of use.

3.5 Preparation of Loperamide

Colodium produced by Indoco Remedies Limited was purchased from Costa Pharmacy in Kumasi, Ghana. 15 mg of the colodium was dissolved in 100 ml of sterile distilled water. The solution was stored in a functional refrigerator (4 °C) until the time of use. It was then administered by oral gavage. The dosage was obtained from previous studies on loperamide by other research groups.

3.6 Parameters Measured

3.6.1 Faecal moisture

1.8 g of faecal pellets were collected from each treatment and weighed using electronic balance and the initial weight of the samples were recorded. The faecal samples were kept in separate crucibles and dried using furnace at 100 °C to obtain the dry weight of the samples. The dry weight of each faecal sample was recorded. The difference in weight between the initial weight of faecal samples (wet faecal samples) and the dry faecal sample in each treatment determined the moisture content in the faecal samples.

3.6.2 Faecal pellets

Faecal pellets of each treatment were collected every morning at 10 am throughout the experiment. The faecal pellets were counted and the total number for each treatment was recorded.

3.6.3 Feed Intake

All the experimental animals were given the same kind of feed in a separate feeding trough. The feed for each treatment was weighed and recorded before it was given to the experimental animal to obtain the initial weight of the feed. In the following morning the feed was reweighed to obtain the final weight of the feed for each experimental rat. The final weight of the feed is recorded. The difference in weight determined the quantities of feed consumed by each experimental animal. This activity was performed throughout the period for the experiment. The feed was given to all the experimental animals at the same time of the day.

3.6.4 Water Intake

The experimental animals were given clean water throughout the experiment. Each animal was provided a water trough. The initial volume of water for each experimental animal was recorded. In each morning of the experiment, the volume of water left in each water trough was measured and recorded. The difference in volume determined the quantities of water that was taken by each experimental animal. This activity was performed throughout the experiment.

3.6.5 Biochemical parameters

A cardiac puncture technique was employed to obtain a 5 ml sample of blood. A sterile syringe equipped with a needle produced by Jiangsu Shenli Medical Production Company Limited, China was utilized for this purpose. The collected blood was then transferred into tubes that contained gel, specifically serum separator tubes. The tubes were appropriately identified in order to distinguish the individual rats within each treatment group. The centrifugation process was conducted using the Faithful FLC-041 apparatus for a duration of 20 minutes. Subsequently, the biochemical parameters, including lipid profile, liver function test, and kidney function test, were determined at the Ashanti Mampong Municipal hospital using the BS-3000B Sinnova Chemistry Analyzer.

3.6.6 Tissue Histomorphometry

At the end of the experiment, the animals were macroscopically examined, weighed, and sacrificed under slight chloroform anesthesia. After anesthetizing the rat for about 2

minutes, the rat was supinely positioned on a dissection board, pinned down to prevent movement during the dissection, and an abdominal incision was made through the middle line on the ventral surface of the rat with sterilized surgical blade, scissors, pins, and forceps to expose the internal organs of the rat. Dissection of rats was done at the University's Biology laboratory (Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development-Mampong Campus).

The liver and kidney were rinsed in buffer saline before being fixed in freshly prepared 10 % formalin. The specimens underwent dehydration using various concentrations of ethyl alcohol, followed by clearing in xylene, and then embedding in paraffin wax. The tissue sections were subsequently sliced to a thickness of 5 μm and affixed onto glass slides. These slides were then subjected to staining with hematoxylin and eosin. The resulting samples were viewed under a light microscope to observe the hepatocytes (H), central vein (CV), sinusoid (S); containing capillaries and Kupffer cells of the liver, glomeruli (G), bowman space (BS), renal tubules (RT), tubular cells (TC), and normal cuboidal epithelia cells (CEC) within the medullar of the kidney were studied (Rahman, M. A., Sultana, N., Ayman, U., Bhakta, S., Afrose, M., Afrin, M., & Haque, Z. 2022).

3.7 Data Analysis

Data analysis was conducted by using Minitab statistical software (Version 20.0). One-way analysis of variance (ANOVA) and post hoc Tukey's test were performed to determine the significant difference between groups. All data collected were presented as graphs, tables, and as mean \pm SEM. Values were considered statistically significant if $p < 0.05$

CHAPTER FOUR

4.0 RESULTS

4.1 : Constipation and *Senna siamea* Leaves Decoction on Feed Intake

Table 4.1.1: Effects of constipation on the Feed intake (g) of Albino rats

Feed intake	T 1 (Normal saline)	T 2 (0.75 mg/5 ml of loperamide)	T 3 (normal saline)	T 4 (0.75 mg/5 ml of loperamide)	SEM	P-value
Day 1	14.60	13.00	15.60	12.80	0.653	0.395
Day 2	14.40	12.60	15.20	13.20	0.604	0.449
Day 3	18.40	16.60	16.00	16.40	0.514	0.385
Day 4	16.20	17.60	16.20	17.60	0.533	0.666

^{abc} Means in the same row with different superscripts are significantly different ($p < 0.05$)

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In comparison with the control group, no differences ($p > 0.05$) were observed in the feed intake among the treatment groups during the period the rats were constipated (Table 4.1).

Table 4.1.2: Effects of *Senna siamea* leaves decoction (5 ml/day) on the Feed intake (g) of Albino rats

Feed intake	T 1 (Normal saline)	T 2 (constipated + normal saline)	T 3 (normal saline + 5 ml of <i>Senna siamea</i> leaf decoction)	T 4 (constipated + 5 ml of <i>Senna siamea</i> leaf decoction)	SEM	P-value
Day 1	14.80	16.00	16.40	15.20	0.472	0.652
Day 2	14.60	12.00	14.80	15.40	0.702	0.347
Day 3	16.00	17.00	16.00	16.80	0.600	0.917
Day 4	17.40 ^b	13.80 ^c	18.20 ^a	14.00 ^{bc}	0.604	0.004
Day 5	15.60	16.00	17.60	16.80	0.387	0.281
Day 6	18.20	15.00	16.00	16.00	0.448	0.062
Day 7	15.40	14.60	15.60	16.20	0.596	0.845

^{abc} Means in the same row with different superscripts are significantly different ($p < 0.05$)

The data on feed intake during the administration of the decoction showed variability in feed intake on the fourth day of the experiment. Rats treated with normal saline followed by 5 ml of *Senna siamea* leaves decoction only (treatment 3) recorded high feed intake ($p < 0.05$) compared to the control group.

No significant difference ($p > 0.05$) was observed during the rest of the days.

4.2: Constipation and *Senna siamea* Leaves Decoction on Water Intake

Table 4.2.1: Effects of constipation on the water intake (ml) of Albino rats

Water intake	T 1 (Normal saline)	T 2 (0.75 mg/5 ml of loperamide)	T 3 (normal saline)	T 4 (0.75 mg/5 ml of loperamide)	SEM	p-value
Day 1	26.80	27.80	26.60	26.40	0.362	0.564
Day 2	26.40	28.20	27.40	26.80	0.479	0.607
Day 3	27.00	27.20	27.40	29.60	0.408	0.070
Day 4	27.20	27.00	27.80	27.60	0.365	0.433

^{abc} Means in the same row with different superscripts are significantly different ($p < 0.05$)

In comparison with the control group, no differences ($p > 0.05$) were observed in the water intake among the treatment groups (Table 4.3).

Table 4.2.2: Effects of *Senna siamea* leaves decoction (5 ml/day) on the water intake (g) of Albino rats

Water intake	T 1 (Normal saline)	T 2 (constipated + normal saline)	T 3 (normal saline + 5 ml of <i>Senna siamea</i> leaves decoction)	T 4 (constipated + 5 ml of <i>Senna siamea</i> leaves decoction)	SEM	p-value
Day 1	26.20	28.20	27.80	27.60	0.387	0.300
Day 2	27.40	27.20	28.00	26.00	0.357	0.257
Day 3	27.20	28.20	26.20	27.20	0.398	0.363
Day 4	26.00	28.40	27.80	27.00	0.385	0.133
Day 5	25.60	26.20	26.80	26.00	0.327	0.660
Day 6	27.40	27.60	27.00	26.20	0.303	0.397
Day 7	26.60 ^b	28.80 ^a	25.80 ^b	26.20 ^{ab}	0.406	0.026

^{abc} Means in the same row with different superscripts are significantly different ($p < 0.05$)

Water intake on the seventh day during the administration of the decoction increased ($p < 0.05$) in the rats treated with 0.75 mg of loperamide only compared to the control group.

No significant difference ($p > 0.05$) was observed during the rest of the days.

4.3: Constipation and *Senna siamea* Leaves Decoction on Faecal Pellets

Table 4.3.1: Effects of constipation on the quantity of faecal pellets (g) of Albino rats

Faecal pellets	T 1 (Normal saline)	T 2 (0.75 mg of loperamide)	T 3 (normal saline)	T 4 (0.75 mg/5 ml of loperamide)	SEM	p-value
Day 1	30.20 ^a	9.60 ^b	31.20 ^a	10.80 ^b	3.19	0.005
Day 2	32.80 ^a	12.20 ^b	34.60 ^a	9.20 ^b	3.20	0.000
Day 3	33.80 ^a	9.20 ^b	26.80 ^a	8.60 ^b	3.79	0.000
Day 4	26.20 ^a	7.60 ^b	27.60 ^a	8.00 ^b	2.34	0.000

^{abc} Means in the same row with different superscripts are significantly different (p<0.05)

Experimental rats treated with 0.75 mg of loperamide recorded fewer (p<0.05) faecal pellets compared to the control group throughout the period.

Table 4.3.2: Effects of *Senna siamea* leaves decoction (5 ml/day) on the quantity of faecal pellets of Albino rats

Faecal pellets	T 1 (Normal saline)	T 2 (constipated + normal saline)	T 3 (normal saline + 5 ml of <i>Senna siamea</i> leaves decoction)	T 4 (constipated + 5 ml of <i>Senna siamea</i> leaf decoction)	SEM	p-value
Day 1	34.40 ^a	9.80 ^b	32.40 ^a	27.80 ^a	2.88	0.002
Day 2	30.80 ^a	11.80 ^b	35.20 ^a	32.20 ^a	2.95	0.008
Day 3	33.00 ^a	10.80 ^b	31.00 ^a	30.80 ^a	2.48	0.001
Day 4	29.40 ^a	9.20 ^b	32.40 ^a	30.40 ^a	2.56	0.001
Day 5	26.80 ^b	8.20 ^c	29.40 ^{ab}	33.20 ^a	2.29	0.001
Day 6	30.80 ^a	9.80 ^b	29.40 ^a	32.80 ^a	2.35	0.001
Day 7	26.40 ^a	10.00 ^b	28.40 ^a	32.40 ^a	2.23	0.001

^{abc} Means in the same row with different superscripts are significantly different ($p < 0.05$)

During the decoction administration, rats treated with only 0.75 mg of loperamide only (treatment 2) recorded fewer faecal pellets compared to the control. Rats treated with 5 ml of *Senna siamea* leaves decoction only (Treatment 3) and those treated with 0.75 mg of loperamide + 5 ml of *Senna siamea* decoction (treatment 4) and the control group recorded more faecal pellets.

4.4: Constipation and *Senna siamea* Leaves Decoction on Faecal Moisture

Table 4.4.1: Effects of constipation on the Faecal moisture (ml) of Albino rats

Faecal moisture	T 1 (Normal saline)	T 2 (0.75 mg of loperamide)	T 3 (Normal saline)	T 4 (0.75 mg of loperamide)	SEM	p-value
Day 1	0.8332 ^a	0.303 ^b	0.743 ^a	0.2397 ^b	0.0747	0.001
Day 2	0.9348 ^a	0.5488 ^{bc}	0.8337 ^{ab}	0.408 ^c	0.0616	0.001
Day 3	0.9659 ^a	0.6383 ^{bc}	0.8626 ^{ab}	0.6101 ^c	0.0440	0.001
Day 4	0.9273 ^a	0.4707 ^c	0.8567 ^{ab}	0.5627 ^{bc}	0.0564	0.001

^{abc} Means in the same row with different superscripts are significantly different ($p < 0.05$)

Faecal moisture reduced ($p < 0.01$) in rats treated with 0.75 mg of loperamide compared to the control throughout the experimental period.

Table 4.4.2: Effects of *Senna siamea* leaves decoction (5 ml/day) on the faecal moisture (ml) of Albino rat

Faecal moisture	T 1 (Normal saline)	T 2 (constipated + normal saline)	T 3 (Normal saline + 5 ml of <i>Senna siamea</i> leaves decoction)	T 4 (constipated + 5 ml of <i>Senna siamea</i> leaves decoction)	SEM	p-value
Day 1	0.8461 ^a	0.4100 ^c	1.0404 ^a	0.5607 ^{bc}	0.0672	0.001
Day 2	0.9372 ^a	0.4440 ^b	0.9651 ^a	0.7563 ^a	0.0558	0.001
Day 3	0.9088 ^a	0.5155 ^b	0.8702 ^a	0.8285 ^a	0.0408	0.001
Day 4	0.8228 ^{ab}	0.5410 ^b	0.9983 ^a	0.7010 ^a	0.0545	0.001
Day 5	0.8794 ^a	0.4504 ^b	0.8974 ^a	0.7246 ^a	0.0488	0.001
Day 6	0.9027 ^a	0.4035 ^b	0.8549 ^a	0.7012 ^a	0.0519	0.001
Day 7	0.8402 ^a	0.4281 ^b	0.8463 ^a	0.6515 ^a	0.0494	0.001

^{abc} Means in the same row with different superscripts are significantly different (p<0.05)

On the first day of the *Senna siamea* leaves decoction administration, Treatment 2 (0.75 mg of loperamide only) and treatment 4 (0.75 mg of loperamide + 5 ml of *Senna siamea* decoction) recorded lower (p<0.01) faecal moisture compared to the control. On the subsequent days, the decrease in faecal moisture was recorded in only treatment 2 compared to the control.

4.5: Constipation and *Senna siamea* Leaves Decoction on the Kidney Function

Table 4.5.1: Effects of constipation and *Senna siamea* leaves decoction (5 ml/day) on the kidney function of Albino rats

Kidney function	T 1 (Normal saline)	T 2 (Constipated + normal saline)	T 3 (Normal saline + 5 ml of <i>Senna siamea</i> leaves decoction)	T 4 (Constipated + 5 ml of <i>Senna siamea</i> leaves decoction)	SEM	p-value
Urea mmol/L	7.63 ^a	5.77 ^b	6.26 ^b	5.74 ^b	0.27	0.006
Creatinine μ mol/L	82.33	54.33	68.67	71.33	5.22	0.333
U-C Ratio	43.87	52.10	44.67	40.10	3.17	0.662
Na ⁺ mmol/L	140.67	138.67	139.33	140.00	0.31	0.097
K ⁺ mmol/L	4.47	4.20	4.30	4.63	0.12	0.676
Cl ⁻ mmol/L	105.67 ^a	101.00 ^b	101.67 ^{ab}	105.67 ^a	0.78	0.017

^{abc} Means in the same row with different superscripts are significantly different (p<0.05).

The data on kidney function indicate that 0.75 mg of loperamide only (Treatment 2), 5 ml of *Senna siamea* decoction only (Treatment 3) and 0.75 mg of loperamide + 5 ml of *Senna siamea* (Treatment 4) recorded decreased urea level (p<0.05) compared to the control group.

Cl⁻ level was higher (p<0.05) in the control, 5 ml of *Senna siamea* decoction only (treatment 3) and 0.75 mg of loperamide + 5 ml of *Senna siamea* decoction (Treatment 4). The lowest Cl⁻ level was recorded in treatment 2 (0.75 mg of loperamide only).

Creatinine, U-C ratio, NA⁺ and K⁺ levels were not affected by the treatment.

4.6: Constipation and *Senna siamea* Leaves Decoction on Liver Function

Table 4.6.1: Effects of constipation and *Senna siamea* leaves decoction (5 ml/day) on the liver function of Albino rats

Liver function	T 1 (Normal saline)	T 2 (Constipated + normal saline)	T 3 (Normal saline + 5 ml of <i>Senna siamea</i> leaves decoction)	T 4 (Constipated + 5 ml of <i>Senna siamea</i> leaves decoction)	SEM	p-value
AST U/L	291.0	304.3	286.2	257.3	26.2	0.949
ALT U/L	58.40	51.10	48.27	49.73	2.82	0.655
ALP U/L	164.9	139.3	218.6	229.1	34.2	0.811
GGT U/L	5.40	6.47	7.43	5.53	0.52	0.548
TP g/L	82.77	78.80	84.33	75.80	2.86	0.770
ALBUMIN g/L	39.07	42.57	41.40	33.03	2.18	0.468
GLOBULIN g/L	43.70	36.27	42.93	42.80	1.56	0.329
TB μ mol/L	26.33	24.83	30.27	19.00	3.45	0.769
DB μ mol/L	5.77	6.07	8.20	3.50	1.14	0.611
IB μ mol/L	22.07	20.57	18.77	15.50	2.83	0.875

^{abc} Means in the same row with different superscripts are significantly different ($p < 0.05$)

ALT (Alanine aminotransferase), *AST* (Aspartate aminotransferase), *ALP* (Alkaline phosphate), *GGT* (Gamma-glutamyl transferase), *TP* (Total protein), *ALB* (Albumen), *GLO* (Globulin), *TB* (Total bilirubin), *DB* (Direct bilirubin), and *IB* (Indirect bilirubin).

In comparison with the control group, no differences ($p > 0.05$) were observed in the liver function among the treatment groups throughout the experimental period (Table 4.10)

4.7: Constipation and *Senna siamea* Leaves Decoction on Kidney Histology

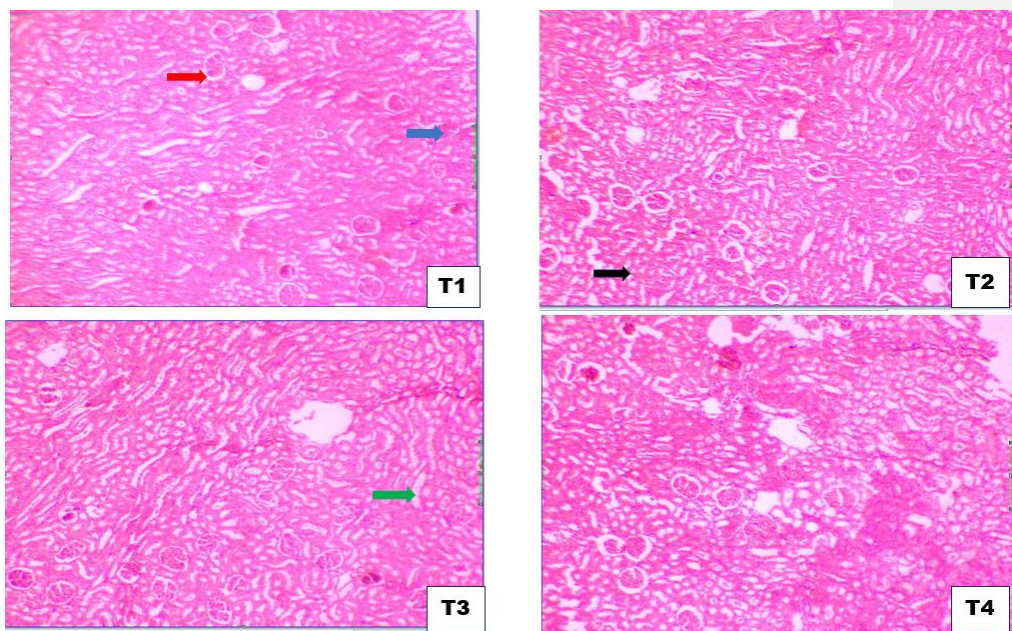


Figure 4.7. 1: Photomicrographs showing the cross sections of kidney tissues of control and treatment Albino rats stained with H&E showed at 100x magnification

Photomicrographs of histological sections of kidney tissue showing normal renal architecture of all groups with glomeruli (blue arrow), Bowman space (red arrow), renal tubules (green arrow), and normal cuboidal epithelial cells (black arrow) within the medullar.

4.8: Constipation and *Senna siamea* Leaves Decoction on Liver Histology

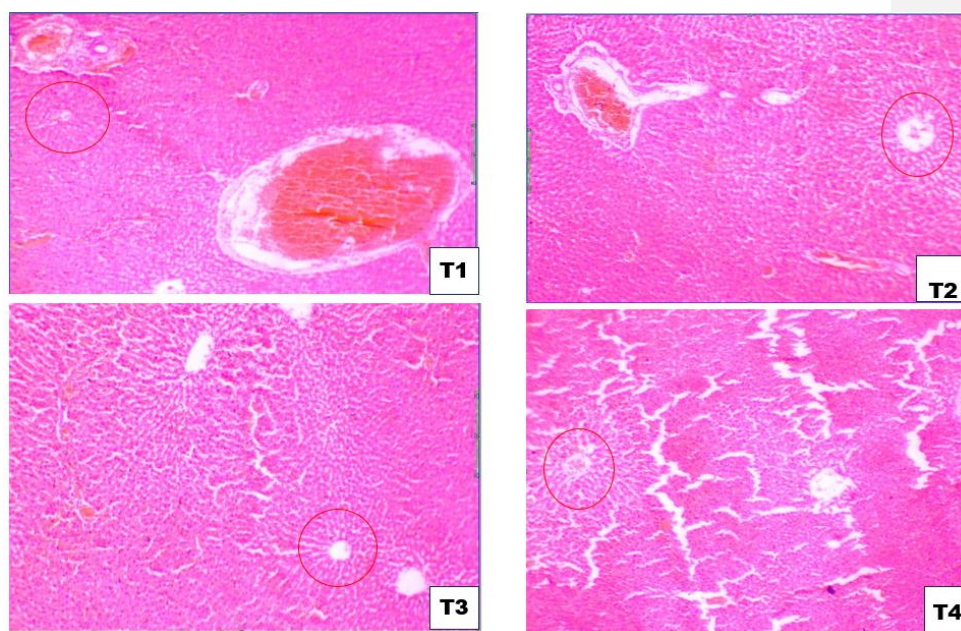


Figure 4.8.1: Photomicrographs showing the cross sections of liver tissues of control and treatment Albino rats stained with H&E showed at 100x magnification

The liver tissues of the control group and the treatment groups demonstrated normal central veins (red circles) surrounded by normal appearing hepatocytes with preserved lobular architecture.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effects of Constipation and *Senna siamea* Leaves Decoction on Feed Intake

The study findings suggest that there were no statistically significant variations ($p>0.05$) in the amount of food consumed between the treatment groups and the control group during the constipation period. This indicates that the administration of various therapies had no impact on the rats' eating behavior when constipation was induced. However, there was a noticeable increase in the amount of food consumed by rats treated with 5 ml of *Senna siamea* leaves decoction solely (treatment 3) on the fourth day. This increase in feed intake was compared to the control group. There were no notable variations in the amount of food consumed on the remaining days of the administration of the decoction, suggesting that the *Senna siamea* leaves decoction had a temporary impact on feeding behavior.

Feed intake is a vital parameter in assessing the nutritional status, development, and overall health of animals, as indicated by available literature. Prior research on *Senna siamea* and its allied species has shown both advantageous and detrimental impacts. Augustine et al. (2020) discovered that meals containing *Senna obtusifolia* leaf meal enhanced the productive performance of albino rats. This indicates that these diets may have similar advantages to those shown with *Senna siamea*. In addition, Ansah et al. (2016) found that tanniferous browse plants, such as *Senna siamea*, enhanced the growth and nutrient digestibility in Djallonk rams. These results are consistent with the observed rise in food consumption in the current research, suggesting that *Senna siamea* can improve feeding behavior in specific circumstances.

On the other hand, certain investigations have emphasized possible hazards linked to *Senna siamea*. In their study, Gotardo et al. (2017) found that the toxicity of *Senna occidentalis* seeds had harmful impacts on egg production in laying hens. This suggests that using *Senna* species excessively or inappropriately can have a negative influence on animal health and productivity. Legba et al. (2020) investigated the antibacterial effects of *Senna siamea* and its traditional application in treating salmonellosis, highlighting the plant's therapeutic potential while also suggesting its intricate bioactive composition. The inconsistent results highlight the importance of carefully evaluating the dosage and circumstances when including *Senna siamea* as a dietary supplement.

In addition to the findings of this study, several experiments have examined the impact of loperamide on the amount of food consumed by rats with induced constipation. The studies conducted by Ashafa et al. (2011), Lee et al. (2012), Tosan et al. (2014), Nafiu et al. (2015), and Nweje et al. (2019), generally concluded that there were no notable disparities in food intake between those with constipation and those in the control groups. These findings align with the initial phase of the current investigation. The consistent findings indicate that loperamide-induced constipation has minimal impact on food consumption, which is consistent with the absence of significant variations found during the constipation phase in this study. Nevertheless, Saheed et al. (2016) observed a significant reduction in food consumption when administering high dosages of loperamide. This suggests that the effect of constipation-inducing substances on feed intake may differ depending on the dosage and experimental settings.

In general, the temporary rise in food consumption found with *Senna siamea* leaves decoction is consistent with certain research findings on its prospective advantages, while the absence of notable distinctions throughout the constipation period corresponds to typical observations made with loperamide-induced constipation models. The results emphasize the subtle impacts of *Senna siamea* and emphasize the significance of dosage and context when using it as a feed supplement.

5.2 Effects of Constipation and *Senna siamea* Leaves Decoction on Water Intake

The study revealed that there were no statistically significant variations in water consumption between the rats treated with loperamide and the control group. These findings suggest that the various therapies had no impact on the rats' water intake. However, water consumption notably increased on the seventh day in constipated rats that did not receive the *Senna siamea* leaves decoction, as compared to the control group. This indicates that constipation had a distinct impact on enhancing water consumption. However, no notable variations were found on the subsequent days during the administration of the decoction.

Water consumption is a crucial measure for sustaining proper hydration, fluid equilibrium, and general welfare in animals. The findings of this study are supported by previous research conducted on *Senna siamea* and other closely related species. Filho et al. (2012) observed that horses administered with senna to treat intestinal impaction had elevated water consumption, indicating a potential association between senna ingestion and water intake. Furthermore, Fajariani et al. (2020) suggested that *Senna siamea* might potentially impact water absorption by influencing environmental factors including

canopy area and transpiration rates. While the main focus of these studies is on different factors, they do provide evidence that *Senna siamea* can have an impact on water use. Studies that particularly investigate the effect of loperamide on water consumption have produced inconsistent findings. Nweje et al. (2019) observed that there were no statistically significant disparities in water consumption between constipated rats and healthy rats, both prior to and during loperamide treatment. In a study conducted by Nafiu et al. (2015), it was found that there was no significant difference in water intake between constipated rats and control rats. This indicates that the use of loperamide did not have an impact on water consumption in their research. These findings are consistent with the early phase of the current investigation, in which no notable disparities in water consumption were detected during the period the rats were constipated.

Nevertheless, certain investigations have shown divergent results. In their study, Tosan et al. (2014), discovered that loperamide had a substantial impact on reducing water consumption in constipated rats when compared to the normal control group. This suggests that loperamide has a strong influence on decreasing water intake. In addition, Ashafa et al. (2011), noted a substantial decrease in water intake in constipated rats that were treated with loperamide. These divergent results indicate that the effect of loperamide on water consumption may differ based on the amount administered and the specific circumstances of the trial. The notable rise in water consumption reported on the seventh day where the decoction was administered in this study may indicate a distinct interaction between loperamide and the rats' physiological condition, emphasizing the intricate nature of loperamide's impacts.

5.3 Effects of Constipation and *Senna siamea* Leaves Decoction on Faecal Pellets

The study revealed that administering 0.75 mg of loperamide to the experimental rats resulted in a notable decrease in the number of faecal pellets compared to the control group over the entire period where the rats were constipated. This indicates that loperamide efficiently caused constipation. Throughout the entire period, rats that received a dosage of only 0.75 mg of loperamide consistently exhibited a lower production of faecal pellets ($p < 0.01$) in comparison to the control group. Nevertheless, rats administered with 5 ml of *Senna siamea* leaves decoction either alone or in conjunction with loperamide, along with the control group, exhibited a higher number of faecal pellets. These findings indicate that the *Senna siamea* leaves decoction alleviated the constipating effects of loperamide, facilitating regular bowel movements.

Quantifying the number of faecal pellets produced is an important measure of the overall condition of the gastrointestinal system, the quality of one's diet, and the effectiveness of digestion. The literature on *Senna siamea* provides evidence of its positive impact on gastrointestinal well-being and faecal production. Paguigan et al. (2014) showed that *Senna siamea* has potent anti-ulcer effects, which probably help in promoting regular bowel motions and enhancing the creation of faecal pellets. In a similar manner, Dakpogan et al. (2019) discovered that *Senna siamea* has the ability to prevent coccidiosis in hens. This indicates that it may have wider benefits for the gastrointestinal system, including potential enhancements in faecal characteristics.

Research examining the impact of loperamide on faecal pellets consistently demonstrates its efficacy in causing constipation. Nafiu et al. (2015) reported that loperamide effectively decreased the number of faecal pellets in constipated rats when compared to the control group, while having no impact on the moisture level of the faecal pellets. Vera et al. (2019) documented substantial modifications in the development of faecal pellets following loperamide medication, specifically observing a decrease in the amount of faecal output and changes in the patterns of bowel movements. This is consistent with the results of the present investigation, which showed that rats treated with loperamide had a reduced number of faecal pellets.

Ashafa et al. (2011) and Nweje et al. (2019) provided more evidence to corroborate these results by reporting that loperamide reduced the number, moisture content, and weight of faecal pellets, thereby proving its ability to cause constipation. Tosan et al. (2014) further emphasized that loperamide reliably caused constipation, as demonstrated by a decrease in the amount of faeces produced. These studies corroborate the results of the present research, demonstrating that loperamide consistently reduces the generation of faecal pellets, hence proving its constipating action.

5.4 Effects of Constipation and *Senna siamea* Leaves Decoction on Faecal Moisture

The study findings demonstrated a noteworthy decrease in faecal moisture in rats administered with 0.75 mg of loperamide, as compared to the control group, for the entire duration of constipation. This suggests that the induction of constipation was effectively achieved. During the period of administering the decoction, both Treatment 2 (0.75 mg of loperamide only) and Treatment 4 (0.75 mg of loperamide + 5 ml of *Senna siamea* leaves

decoction) showed significantly decreased faecal moisture compared to the control group on the first day. Following that, only Treatment 2 consistently showed a decrease in faecal moisture, indicating that the *Senna siamea* leaves decoction had a mitigating impact on faecal moisture in Treatment 4.

The moisture content of faeces is an important indicator of an animal's level of hydration and the health of its digestive system. *Senna siamea*, recognised for its cathartic effects attributed to anthraquinone glycosides, stimulates the release of fluid into the colon, hence facilitating bowel motions and potentially augmenting faecal moisture. The results of this study are consistent with the established effects of Senna, which aids in maintaining proper hydration and regulating stool consistency. As a result, it promotes regular bowel movements and relieves symptoms of constipation.

The decrease in faecal moisture observed with loperamide treatment aligns with the results reported in previous investigations. Nweje et al. (2019) and Nafiu et al. (2015) observed notable decreases in the amount of water in the faeces of rats that were given loperamide, thus validating its ability to cause constipation. In a similar vein, Ashafa et al. (2011) discovered that loperamide reduced the amount of moisture in faeces. However, the use of Aloe vera extract as an intervention counteracted this effect, demonstrating the potential of natural therapies to alleviate constipation caused by loperamide.

In addition, Tosan et al. (2014) found that loperamide reliably caused constipation, as indicated by a decrease in the moisture content of faeces and an increase in the features of faecal pellets compared to the control group. The findings support the observations made

in the present study that loperamide effectively reduces the moisture in faeces, therefore confirming its ability to cause constipation. Additionally, the results emphasize the potential of *Senna siamea* leaves decoction to restore faecal moisture and enhance gastrointestinal function.

Ultimately, the study affirms that loperamide substantially decreases the level of moisture in faeces, successfully causing constipation in rats. Administering *Senna siamea* decoction, especially in conjunction with loperamide, demonstrated promise in alleviating these symptoms by sustaining elevated amounts of moisture in the faces. The findings are consistent with previous research, highlighting the efficacy of *Senna siamea* as a natural laxative that enhances gastrointestinal well-being and relieves constipation.

5.5 Effects of Constipation and *Senna siamea* Leaves Decoction on Kidney Function

The investigation on renal function revealed notable data regarding the effects of various therapies using loperamide and *Senna siamea* leaves decoction on urea and chloride (Cl⁻) levels, whereas creatinine, U-C ratio, sodium (Na⁺), and potassium (K⁺) levels remained unchanged. The data indicated that administering 0.75 mg of loperamide alone (Treatment 2), 5 ml of *Senna siamea* decoction alone (Treatment 3), and a combination of both (Treatment 4) resulted in a noteworthy reduction in urea levels compared to the control group. This indicates a possible enhancement in the ability of the kidneys to eliminate waste products or a reduction in the by-products of protein metabolism. In contrast, the control group, Treatment 3, and Treatment 4 exhibited increased levels of Cl⁻, with the lowest amount of Cl⁻ observed in Treatment 2 (p<0.05).

Examining the existing literature allows for a better understanding of the significance of these discoveries. The kidneys play a vital role in eliminating waste, controlling blood pressure, and managing the balance of fluids and electrolytes. The decrease in urea levels seen in the treatment groups suggests that the combination of loperamide and *Senna siamea* may improve kidney function or decrease urea production. While there is limited direct study on the specific influence of *Senna siamea* on kidney function, studies conducted on related species such as *Senna alata* indicate potential protective effects on the kidneys. This corresponds to the decrease in urea levels reported with the administration of *Senna siamea* decoction, suggesting potential advantages for the kidneys.

Loperamide, predominantly employed as an antidiarrhoeal agent, is typically not linked to direct renal damage. The method of action involves decreasing gastrointestinal motility and increasing stool firmness, which helps relieve renal stress caused by dehydration. Nevertheless, a study conducted by Jumbo et al. (2021) has indicated that loperamide can disrupt the balance of electrolytes, leading to a decrease in potassium and sodium ions. This disruption has the potential to influence fluid retention and the overall equilibrium of electrolytes in the body. The study discovered that loperamide medication leads to a decrease in urea levels, which can be linked to its capacity to alleviate dehydration and the resulting pressure on the kidneys.

The concurrent use of loperamide and *Senna siamea* seems to have a positive impact on renal function by decreasing urea levels. The observed fluctuations in Cl⁻ concentrations suggest various effects on electrolyte equilibrium, which necessitates additional

exploration. The absence of alterations in creatinine, U-C ratio, Na⁺, and K⁺ levels indicates that these medications do not have a negative impact on these particular kidney parameters.

5.6 Effects of Constipation and *Senna siamea* Leaves Decoction on Liver Function

These findings indicate that the administration of loperamide and *Senna siamea*, either individually or together, did not have any negative impact on liver function for the length and under the conditions of the trial. Liver function encompasses the vital tasks performed by the liver to sustain general well-being, such as metabolism, detoxification, bile generation, protein synthesis, storage, blood filtration, and hormone metabolism. *Senna siamea*, alternatively referred to as *Cassia siamea*, has been the subject of research due to its hepatoprotective qualities. Studies conducted on similar species, such as *Senna senegaleana*, have shown notable hepatoprotective properties in preventing liver injury in rats. In their study, Sobeh et al. (2017) discovered that an extract derived from the bark of *Senna senegaleana* effectively decreased high levels of aspartate aminotransferase (AST) and total bilirubin in rats with liver injury produced by d-galactosamine (d-GalN). Moreover, the alkaloids derived from *Senna alata* have demonstrated the ability to regulate the functioning of various liver enzymes, such as alanine transaminase (ALT), gamma-glutamyl transferase (GGT), AST, and alkaline phosphatase (ALP). This provides additional evidence to support the potential advantages of *Senna* species for liver health.

In contrast, some studies have not observed hepatoprotective advantages from *Senna* plants. In their study, Vitalone et al. (2011) found that the leaf extract of *Cassia angustifolia* did not have a significant effect on liver function markers. This emphasizes the importance of considering differences between species and the necessity for

additional research to determine the specific components responsible for any potential effects on liver function. However, studies on Sennoside A (SA), a compound found in *Senna siamea*, have shown that it possesses hepatoprotective properties. This contributes to the existing evidence that suggests *Senna siamea* may have beneficial effects on liver health.

Loperamide, primarily employed as an antidiarrhoeal drug, has additionally been investigated for its impact on hepatic function. Bachawa et al. (2024) observed that loperamide did not induce any major histological changes in the liver tissue of mice. This suggests that loperamide does not provide a substantial risk of liver damage when used within normal parameters. In the same vein, Lee and Kang (2019) found that rats with loperamide-induced constipation did not experience significant alterations in γ -glutamyltransferase (γ -GT) and lactate dehydrogenase (LDH) levels. However, a minor elevation in AST levels suggested the possibility of mild liver strain. In their study, Saheed et al. (2016) observed alterations in liver function markers, including serum albumin, total protein, bilirubin, and enzyme activities, in rats with constipation induced by loperamide. This indicates that loperamide can have an impact on liver function in cases of severe constipation.

The study's results are consistent with existing research, suggesting that both *Senna siamea* and loperamide do not have a substantial effect on liver function when used within acceptable ranges. Although *Senna siamea* has shown hepatoprotective characteristics in multiple investigations, the absence of substantial alterations in liver function indicators in this particular study implies that its effects may be more noticeable

in situations of liver stress or damage, rather than in the context of normal, healthy liver function. In the absence of severe constipation or other stressors, loperamide does not seem to have a negative impact on liver function.

5.7 Effects of Constipation and *Senna siamea* Leaves Decoction on Kidney Histology

The photomicrographs of histological sections of kidney tissue demonstrate that all groups displayed typical renal structure, including clearly defined glomeruli, Bowman's space, renal tubules, and normal cuboidal epithelial cells in the medulla. These findings indicate that both the administration of 0.75 mg of loperamide and the *Senna siamea* decoction did not result in any observable histological alterations in the renal tissues of the rats utilized in the experiment.

The existing body of literature on the impact of Senna on kidney histology offers a diverse range of viewpoints. Although certain studies emphasize the potential adverse effects on the kidneys, especially when taken excessively or for a long period of time because of the presence of anthraquinones, other study indicates that there are no detrimental consequences when used appropriately. Ugbogu et al. (2016) discovered that there were no abnormal alterations in the kidneys of Albino rats when they were given different amounts of *Senna siamea* aqueous dry leaf extract. This finding is consistent with the results of the present investigation. Furthermore, Albasher et al. (2020) shown that Senna extract possesses the potential to provide protection against cadmium-induced renal injury. This finding reinforces the notion that the regulated utilization of Senna extract does not pose inherent harm to renal tissues.

In contrast, the possible harmful effects on the kidneys caused by loperamide have been recorded. Jumbo et al. (2021) documented notable histological alterations in the kidneys of Albino rats subjected to loperamide-induced poisoning. The modifications encompassed worldwide mesangial proliferative glomerulonephritis, which were alleviated with the administration of *Centella asiatica* extracts and saponin fractions. This indicates that these chemicals have the potential to serve as a therapy for safeguarding against renal damage generated by loperamide.

The lack of histological alterations observed in the present investigation, despite the administration of loperamide and *Senna siamea*, suggests that the doses and period employed were within safe thresholds. This discovery emphasizes the significance of the amount and length of time while utilizing these drugs. Although many studies have shown that excessive doses or continuous use of the substance may cause damage to the kidneys (nephrotoxicity), the current experiment did not produce any such harmful effects. This indicates the presence of a therapeutic window in which Senna can be administered without causing any harm to the kidneys. Additional research is required to investigate this equilibrium and enhance the secure utilization of Senna in therapeutic settings. This highlights the importance of precise dosage control in order to utilize the advantages of Senna while avoiding any harm to the kidneys.

5.8 Effects of Constipation and *Senna siamea* Leaves Decoction on Liver Histology

The liver tissues of both the control group and the treatment groups in this investigation had intact central veins, which were encircled by hepatocytes that maintained their preserved lobular structure. This discovery indicates that neither the injection of 0.75 mg

of loperamide nor the *Senna siamea* decoction caused any noticeable changes in the liver tissues of the experimental rats. This demonstrates that these treatments were not hazardous to the liver under the settings in which they were evaluated.

The literature offers a wider perspective on these findings, demonstrating varied impacts of Senna species on liver histology and function. Wang et al. (2019) examined the hepatoprotective properties of *Senna alexandrina* extract in preventing liver damage caused by cadmium chloride. Their research discovered that the extract effectively decreased oxidative stress, inflammation, and apoptosis in liver tissue, highlighting its potential advantages for liver health. This is consistent with the results of the current study, which indicate that *Senna siamea* may have hepatoprotective qualities if administered correctly.

However, certain research express concerns over the potential liver toxicity of specific Senna species. Gebrezgi et al. (2020) documented the occurrence of subacute liver damage in mice that were subjected to extracts from *Senna occidentalis* seeds. This study highlights the importance of conducting research that are tailored to the individual species involved. Ugbogu et al. (2016) emphasized the possible negative impact on liver function in Albino rats that were given extracts of *Senna alata* L. They recommended doing comprehensive safety evaluations before using Senna species for medicinal purposes. These data suggest that certain Senna species may have advantageous impacts on liver well-being, while others may provide potential hazards. Therefore, it is crucial to carefully evaluate the particular species and dosages when considering their use.

The literature offers information on the diverse impacts of loperamide on liver histology. In their study, Bachawa et al. (2024) found that rats treated with 3 mg/kg of loperamide hydrochloride did not show any notable changes in the liver's histology. The cellular structure remained intact, and the villi were well-defined. This corroborates the present study's results indicating that loperamide, when given at the prescribed dosage, did not have any negative impact on liver tissues. In contrast, Jumbo et al. (2021) discovered hepatocyte congestion and dilated sinusoids in the liver tissues of Albino rats that were treated with loperamide without any extra therapeutic intervention. This suggests that loperamide may have hepatotoxic effects under specific circumstances.

The study's findings indicate that all groups had normal liver histology, which is consistent with previous research revealing that both *Senna siamea* and loperamide can be safely administered without causing harm to liver tissues, as long as they are utilized in controlled conditions and adequate dosages. Nevertheless, the divergent results in the existing body of study emphasize the importance of vigilant observation and species-specific investigation in order to comprehensively comprehend the hepatotoxic and hepatoprotective capabilities of various *Senna* species and guarantee their secure therapeutic utilization.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

- Administering 0.75 mg of loperamide, *Senna siamea* leaves decoction, or their combination resulted in a significant reduction in urea levels, indicating potential improvements in kidney function or waste product elimination. Chloride levels varied among treatments, suggesting effects on electrolyte balance. However, creatinine, U-C ratio, sodium, and potassium levels remained unchanged, suggesting these parameters were not adversely affected by the treatments.
- The study found no significant differences in liver function markers between the treatment and control groups, suggesting that neither loperamide nor *Senna siamea* leaves decoction had a detrimental impact on liver function under the conditions of this experiment.
- There were no significant differences in food intake among the treatment groups during the period the experimental rats were constipated, except for a noticeable increase in food consumption in rats treated with *Senna siamea* decoction on the fourth day. This suggests that *Senna siamea* may have a transient effect on feeding behavior.
- Water intake increased significantly on the seventh day in rats treated with 0.75 mg of loperamide alone, indicating that loperamide at this dose might affect water consumption. No significant changes were observed in water intake on other days, suggesting that the effect of loperamide on water intake may be limited to specific conditions or doses.

- Loperamide administration significantly reduced the number of faecal pellets, indicating its effectiveness in inducing constipation. *Senna siamea* leaves decoction appeared to alleviate this effect, suggesting potential benefits for gastrointestinal motility.
- Faecal moisture was significantly lower in rats treated with 0.75 mg of loperamide, indicating induced constipation. *Senna siamea* decoction appeared to mitigate these effects, suggesting a potential benefit in restoring normal faecal moisture.
- Histological examination of kidney tissues showed no observable damage, indicating that the treatments did not adversely affect renal structure.
- Liver tissues from all groups exhibited normal histological features, suggesting that neither loperamide nor *Senna siamea* decoction caused noticeable liver damage under the experimental conditions.

6.2 Recommendations

The following are worth recommending:

- Further research on combined effects is recommended to explore the combined effects of loperamide and *Senna siamea* decoction on renal function, particularly focusing on long-term impacts and varying dosages to establish optimal conditions for therapeutic use.
- It is crucial to standardize dosages for both loperamide and *Senna siamea* decoction in experimental and clinical settings to better understand their

individual and combined effects on kidney and liver functions, as well as gastrointestinal health.

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