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PHYTOCHEMICAL SCREENING OF METHANOLIC EXTRACT OF INDIGENOUS *MOMORDICA CHARANTIA* FRUITS

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ABSTRACT

Momordica charantia L., commonly known as bitter gourd or bitter melon, is an important indigenous medicinal and edible plant belonging to the family Cucurbitaceae. The plant has a long history of traditional use in various systems of medicine, particularly in the management of metabolic disorders, gastrointestinal complaints, infections, inflammation, and other health conditions. The therapeutic importance of *M. charantia* has been associated with the presence of diverse biologically active primary and secondary metabolites. The present study was undertaken to investigate the preliminary phytochemical constituents of methanolic extracts of indigenous *Momordica charantia* fruits, with the broader intent of providing scientific evidence for the medicinal potential of this locally available plant resource. Qualitative phytochemical screening was conducted using standard chemical tests for major groups of phytoconstituents. The results demonstrated the presence of a

broad range of phytochemical classes in the investigated extracts. Alkaloids were detected by Mayer's, Wagner's, Dragendorff's, and Hager's tests. Carbohydrates showed positive reactions in Molisch's, Benedict's, and Fehling's tests. Glycosides were detected by Modified Borntrager's and Legal's tests, while saponins produced positive results in the froth and foam tests. Phytosterols were detected by Salkowski's and Liebermann–Burchard's tests. Phenolic compounds were identified using the ferric chloride test. In addition, tannins were detected by the gelatin test, whereas flavonoids gave positive reactions in the alkaline reagent and lead acetate tests. Proteins and amino acids were also detected through Xanthoproteic and Ninhydrin tests. Collectively, these findings indicate that the investigated *M. charantia* material contains several chemically diverse classes of phytoconstituents, including alkaloids, carbohydrates, glycosides, saponins, phytosterols, phenolic compounds, tannins, flavonoids, proteins, and amino acids. The observed phytochemical diversity is consistent with previous investigations reporting the occurrence of multiple bioactive constituents in different parts of *M. charantia*. Earlier studies have identified phenolic compounds, flavonoids, saponins, sterols, glycosides, terpenoids, cucurbitane-type triterpenoids, and other metabolites in *M. charantia*. The detection of these constituents provides a plausible phytochemical basis for several biological activities reported for the plant, including antioxidant, antimicrobial, antidiabetic, anti-inflammatory, anthelmintic, and cytotoxic effects. However, preliminary qualitative screening only establishes the probable presence or absence of broad phytochemical groups and does not determine the exact chemical identity, concentration, purity, or pharmacological potency of individual compounds. The present findings therefore support the ethnomedicinal importance of indigenous *M. charantia* and demonstrate its potential as a source of biologically active natural products. The study also provides a preliminary scientific foundation for subsequent quantitative phytochemical investigations, chromatographic profiling, isolation and identification of individual bioactive compounds, and evaluation of specific pharmacological activities. Further research using standardized extraction procedures and advanced analytical techniques such as HPLC, LC-MS/MS, GC-MS, and NMR is recommended to establish the detailed phytochemical profile of the indigenous plant material. Overall, the findings suggest that *M. charantia* fruits and associated plant materials represent a promising natural source of diverse phytochemicals with potential applications in pharmaceutical, nutraceutical, and traditional medicine research.

KEYWORDS: *Momordica charantia*; Bitter melon; Indigenous medicinal plant; Phytochemical screening; Methanolic extract; Alkaloids; Flavonoids; Phenolic compounds; Saponins; Glycosides.

1. INTRODUCTION AND BACKGROUND

1.1. Background

Medicinal plants have played a fundamental role in human healthcare since ancient times and continue to serve as important sources of therapeutic agents, particularly in traditional and complementary systems of medicine. The World Health Organization recognizes traditional medicine as an important component of healthcare worldwide, especially in developing countries where medicinal plants remain widely used for the prevention and management of various diseases (World Health Organization, 2019). The therapeutic potential of medicinal plants is largely associated with their diverse chemical constituents, including alkaloids, flavonoids, phenolic compounds, tannins, saponins, glycosides, terpenoids, steroids, and other secondary metabolites. These compounds may possess a wide range of biological properties, including antioxidant, antimicrobial, anti-inflammatory, antidiabetic, anticancer, hepatoprotective, and immunomodulatory activities (Cowan, 1999; Grover & Yadav, 2004).

Phytochemical screening is an important preliminary step in the scientific investigation of medicinal plants. It involves the qualitative detection of different classes of chemical constituents in plant extracts using specific chemical reactions. Such investigations provide valuable information about the chemical composition of plant materials and help establish a scientific basis for their traditional medicinal applications. The detection of phytochemical groups can also guide subsequent studies involving quantitative analysis, compound isolation, structural characterization, and pharmacological evaluation (Harborne, 1998; Sofowora, 2008). Phytochemicals such as phenols and flavonoids are widely investigated because of their potential antioxidant properties, while alkaloids, saponins, tannins, glycosides, and terpenoids have been associated with diverse pharmacological effects (Cowan, 1999; Tiwari et al., 2011).

Momordica charantia L., commonly known as bitter gourd, bitter melon, karela, or bitter cucumber, is an important medicinal and edible plant belonging to the family Cucurbitaceae. It is a climbing or trailing herbaceous vine widely cultivated and distributed throughout tropical and subtropical regions of Asia, Africa, and other parts of the world. The plant is particularly important in South and Southeast Asian traditional medicine, where different

parts, including fruits, seeds, leaves, and roots, have been used for various therapeutic purposes. The fruit is widely consumed as a vegetable and is recognized by its characteristic bitter taste. In addition to its nutritional importance, *M. charantia* has attracted considerable scientific interest because of its diverse phytochemical composition and reported pharmacological activities (Grover & Yadav, 2004; Joseph & Jini, 2013).

The fruit of *M. charantia* contains a variety of primary and secondary metabolites. Primary metabolites include carbohydrates, proteins, and amino acids, which contribute to the nutritional properties of the fruit. Secondary metabolites include alkaloids, glycosides, flavonoids, phenolic compounds, saponins, tannins, sterols, terpenoids, and cucurbitane-type triterpenoids (Haque et al., 2011; Semiz & Sen, 2007). Several biologically active compounds have been isolated from different parts of the plant, including steroidal glycosides and cucurbitane-type triterpenoids. Charantin, a mixture of steroidal glycosides, has frequently been associated with the reported antidiabetic properties of *M. charantia*. Other compounds, including momordicosides and various cucurbitane-type triterpenoids, have also been investigated for their potential biological activities (Chen et al., 2005; Tan et al., 2008).

The traditional medicinal use of *M. charantia* has been associated particularly with the management of diabetes and other metabolic disorders. Experimental studies have reported that extracts and isolated constituents of the plant may influence glucose metabolism through several mechanisms. These include enhancement of glucose uptake, modulation of insulin signalling, inhibition of carbohydrate-digesting enzymes, and possible effects on pancreatic β-cell function (Joseph & Jini, 2013; Tan et al., 2008). Tan et al. (2008) reported that triterpenoid compounds isolated from bitter melon exhibited antidiabetic effects associated with activation of the AMP-activated protein kinase pathway. Although these findings have generated considerable interest in the plant as a potential source of antidiabetic agents, the pharmacological effects may vary depending on the plant part, extraction method, dose, chemical composition, and experimental model (Joseph & Jini, 2013).

In addition to its potential antidiabetic activity, *M. charantia* has been investigated for antioxidant properties. Phenolic compounds and flavonoids are among the phytochemicals commonly associated with antioxidant effects because of their ability to donate electrons or hydrogen atoms and neutralize reactive oxygen species. Oxidative stress is implicated in the development and progression of several chronic diseases. Therefore, the presence of phenolic and flavonoid constituents in *M. charantia* may contribute to its potential health-promoting

effects (Budrat & Shotipruk, 2008; Semiz & Sen, 2007). Studies have also demonstrated antioxidant activity in different extracts of the fruit and other plant parts, suggesting that the phytochemical composition of *M. charantia* may contribute to its protective biological properties.

The antimicrobial potential of *M. charantia* has also received scientific attention. Various extracts have demonstrated inhibitory effects against selected Gram-positive and Gram-negative bacteria and some fungi. Phytochemicals such as alkaloids, flavonoids, phenolics, tannins, saponins, and terpenoid compounds may contribute to antimicrobial activity through different mechanisms, including disruption of microbial cell membranes, inhibition of essential enzymes, interference with nucleic acid synthesis, and alteration of microbial metabolism (Cowan, 1999). The antimicrobial activity of plant extracts may, however, differ considerably according to extraction solvent, concentration, microbial species, geographical origin, and environmental conditions.

The phytochemical composition of a medicinal plant can vary significantly depending on several factors, including genetic characteristics, environmental conditions, geographical location, soil composition, climate, stage of plant maturity, harvesting season, plant part, drying conditions, storage, and extraction procedures (Tiwari et al., 2011). Solvent polarity is particularly important because different solvents preferentially extract different classes of phytochemicals. Methanol is commonly used in preliminary phytochemical investigations because of its ability to extract a broad range of polar and moderately polar compounds, including phenolic compounds, flavonoids, glycosides, alkaloids, and other secondary metabolites (Harborne, 1998; Tiwari et al., 2011). Therefore, methanolic extraction is frequently employed to obtain a relatively broad preliminary phytochemical profile of medicinal plants.

Qualitative phytochemical screening commonly employs specific chemical tests for different classes of constituents. Alkaloids can be detected using Mayer's, Wagner's, Dragendorff's, and Hager's reagents. Carbohydrates may be identified using Molisch's, Benedict's, and Fehling's tests. Glycosides can be investigated through tests such as Modified Borntrager's and Legal's tests. Saponins are commonly detected through froth or foam tests, while phytosterols may be identified by Salkowski's and Liebermann–Burchard's reactions. Phenolic compounds can produce characteristic colour reactions with ferric chloride, whereas tannins may be detected using gelatin-based tests. Flavonoids can be screened using alkaline

reagent and lead acetate tests. Proteins and amino acids may be identified through Xanthoproteic and Ninhydrin reactions, respectively (Harborne, 1998; Sofowora, 2008). The use of multiple tests for a particular phytochemical group may provide additional preliminary evidence for its presence, although qualitative screening alone cannot establish the exact chemical identity or concentration of individual compounds.

Previous studies have demonstrated the phytochemical richness of *M. charantia*. Investigations of different plant parts and extracts have reported the presence of alkaloids, carbohydrates, glycosides, saponins, phytosterols, phenolic compounds, tannins, flavonoids, proteins, and amino acids (Bakare et al., 2010; Zahan et al., 2020). The occurrence of these compounds indicates that *M. charantia* is a chemically diverse medicinal plant and may serve as a valuable source of natural bioactive compounds. However, differences in phytochemical profiles have been reported among studies, which may be attributed to variations in geographical origin, plant material, cultivar, extraction solvent, extraction conditions, and analytical procedures (Budrat & Shotipruk, 2008; Tiwari et al., 2011).

Despite the extensive use of *M. charantia* in traditional medicine and its growing importance in pharmacological research, scientific investigation of indigenous plant materials remains important. Locally available plant populations may differ in their phytochemical composition from materials obtained from other geographical regions. Establishing the phytochemical profile of indigenous *M. charantia* can therefore contribute to the scientific documentation and conservation of local medicinal plant resources and may provide baseline information for future pharmacological and pharmaceutical research.

The present study was designed to investigate the preliminary phytochemical constituents of indigenous *Momordica charantia* fruits using methanolic extraction and standard qualitative phytochemical screening methods. The study specifically aimed to determine the presence of major phytochemical groups, including alkaloids, carbohydrates, glycosides, saponins, phytosterols, phenols, tannins, flavonoids, proteins, and amino acids. The findings are expected to provide baseline information regarding the phytochemical composition of indigenous *M. charantia* and establish a foundation for future quantitative phytochemical, chromatographic, pharmacological, and toxicological investigations. Ultimately, systematic evaluation of the phytochemical constituents of this indigenous medicinal plant may contribute to the development of scientifically validated herbal preparations and support further research into its potential pharmaceutical and nutraceutical applications.

Torre, Guarniz, Silva-Correa, Razco and Siche (2020) told in their study that plants are a very rich source of new chemical entities, so much so that, date to date, new prototypes with various therapeutic potentials are still being sought. No stranger to it, bitter melon (*Momordica charantia* L.) is a plant species that has attracted researchers' interest in recent years. Chemical and pharmacological studies on the *Momordica charantia* L. plant have been in existence since 1963 and have had a growing interest, deduced by the increase in the amount of research work over the years to the present. The fruits of *M. charantia* are consumed daily as a food and as a medicinal plant for traditional use in Southeast Asia, Indochina, as well as in Brazil. *M. charantia* is a plant belonging to the Cucurbitaceae family and is widely distributed in tropical and subtropical areas around the world.

According to the World health organization (WHO): medicinal plants represent an essential source of drugs. In developed countries, it is estimated that 80% of individuals use traditional medicine (Fennera et al., 2005). Daniel, Supe, & Roymon, (2014) told their study that *Momordica charantia* L. commonly known as bitter melon/gourd, a member of Cucarbitaceae, is a slender, tendril climbing, annual vine. Bitter melon is a common food item of the tropics and is used for the treatment of cancer, diabetes, and many ailments. It is a potent hypoglycemic agent and hypoglycaemic actions for potential benefit in diabetes mellitus are possible due to at least three different groups of constituents in bitter melon. These include alkaloids, insulin like peptides, and a mixture of steroidal sapogenins known as charantin. Clinical studies with multiple controls have confirmed the benefit of bitter melon for diabetes. Alpha and beta momarcharin are two proteins found in bitter melon, which are known to inhibit the AIDS virus. *M. charantia* plant has not been much investigated for its in vitro culture response. However, formation of callus is reported. *Momordica charantia* Linn. (*Bitter melon*) belongs to the family of Cucurbitaceae. It is a climbing vine which is commonly seen growing on walls and shrubs in the tropics. The textured leaves look like a bite that is why the plant is given name Momordica which means to bite. The orange fruits are soft when ripe and have black seeds with a red covering.

1.2. AIM AND OBJECTIVE OF MY STUDY

1.2.1. General Objective

To study the phytochemical screening of *Momordica charantia* fruits.

1.2.2. Specific Objective

- Qualitative analysis of *Momordica charantia* fruits for phytochemicals from methanolic extracts.
- Screening for alkaloids, carbohydrates, glycosides, phytosterols, phenol, saponins, tannins, flavonoids, proteins, and amino acids from *Momordica charantia* fruits.

2.0. Plant profile of *Momordica charantia*

2.1. Genus Momordica

A native of the Old World tropics, bitter gourd—also known as bitter melon, balsam pear, or bitter cucumber—belongs to Cucurbitaceae and genus Momordica, a genus of annual or perennial climbers. It is a large genus consisting of about 80 species, of which *Momordica charantia* Linn is widely cultivated (Raj and Peter 1993).

2.2. Scientific classification of *Momordica charantia*

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Cucurbitales

Family: Cucurbitaceae

Genus: Momordica

Species: *M. charantia* (Raj and Peter 1993)

Figure: 2.1 Fruits.

Figure: 2.2 Ripe Fruits.

2.3. General description of *Momordica charantia*

Momordica charantia (Bitter melon or Bitter guard) is a flowering vine in the family Cucurbitaceae. Leaves: simple, usually palmately 5-7 lobed, tendrils unbranched or 2 branched. The herbaceous, tendrilbearing vine grows to 5 m. It bears simple, alternate leaves 4–12 cm across, with 3–7 deeply separated lobes. Fruit: ovoid, ellipsoid, or spindle shaped, usually ridged, or warty, dehiscent irregularly as a 3 valved fleshy capsule or indehiscent. The fruit has a distinct warty looking exterior and an oblong shape. It is hollow in cross-section, with a relatively thin layer of flesh surrounding a central seed cavity filled with large flat seeds and pith. Seeds and pith appear white in unripe fruits, ripening to red; the flesh is crunchy and watery in texture, similar to cucumber, chayote, or green bell pepper. The skin is tender and edible. The fully ripe fruit turns orange and mushy. Bitter melon comes in a variety of shapes and sizes. The typical Chinese phenotype is 20–30 cm long, oblong with bluntly tapering ends and pale green in color, with a gently undulating, warty surface. The bitter melon more typical of India has a narrower shape with pointed ends, and a surface covered with jagged, triangular "teeth" and ridges. Coloration is green or white. Between these two extremes is any number of intermediate forms. Some bear miniature fruit of only 6–10 cm in length, which may be served individually as stuffed vegetables. These miniature fruits are popular in Southeast Asia as well as India. In Panama bitter melon is known as Balsamino. The pods are smaller and bright orange when ripe with very sweet red seeds. Flowers: Staminate flowers usually solitary on a bracteate scape, hypanthium shallow, calyx 5 lobed, petals 5, usually yellow, distinct, 1-3 with incurved scales at base, stamens usually 3, inserted toward base of hypanthium, filaments distinct, broad, anthers distinct or coherent, 2 of them dithecal, the other monothecal, cells curved or flexuous; pistillate flowers usually solitary on a bracteate scape, hypanthium ovoid to spindle shaped, perianth usually smaller than in staminate flowers, staminodes absent or 3, ovules numerous, horizontal, stigmas 3, 2 lobed. Seeds few to numerous, ovate, usually sculptured. Each plant bears separate yellow male and female flowers. Though it has been claimed that bitter melon’s bitterness comes from quinine, no evidence could be located supporting this claim (Kumar et. al., 2010).

2.4. Cultivation of *Momordica charantia*

Nadkarni (1993) told their study that Karela is an annual or perennial climber found throughout India and also cultivated up to an altitude of 1500m. It is cultivated during warm season i.e., during April to July by sowing seeds in a pit. Seeds are sown at a distance of half a meter and provided with manures. Only one plant is retained, and plant seedlings are

watered once or twice a week. Plants begin to flower 30-35 days after sowing and fruits are ready for harvesting after flowering 15-20 days.

2.5. Habitats of *Momordica charantia*

Kumar et. al., (2010) told their study that the Karela is believed to be originated in the tropics of the old world. It is widely grown in India and other parts of the Indian subcontinent, Southeast Asia, China, Africa, and the Caribbean and South America as a food and medicine.

2.6. Macroscopic Characteristics of *Momordica charantia*

Fruits: Consists of glycosides, saponins, alkaloids, reducing sugars, resins, phenolic constituents, fixed oil and free acids.

Leaves: Leaves are nutritious and have been reported as a source of calcium (1%): magnesium (4%): potassium (7%): phosphorus (5%): and iron (3%); fruits and leaves are great source of B vitamins; Thiamine (vit. B1) 4%, Riboflavin (vit. B2) 4%, Niacin (vit. B3) 2%, vit.B6 3%, Folate (vit.B9) 13% (Kumar et. al., 2010).

2.7. Phytochemistry of *Momordica charantia*

Ahmad, Hasan, Ahmad, Zishan and Zohrameena (2016) told their study that the main constituents of bitter melon *Momordica charantia* are triterpene, protein, steroid, alkaloid, inorganic, phenolic and lipid compounds. *Momordica charantia* consists the following chemical constituents those are alkaloids, momordicin and charine, momorchanins, momordicilin, charantin, momordicius, momordenol, momordin, momordolol, cryptoxanthin, cucuritacins, cucurbitns, cycloartenols, cucuritanes, erythrodiol, elaeostearic acids, galacturonic acid, gentisic acid, goyaglycosides, goyasaponins, and multiflorenol, cucurbitacins, , cucurbitanes, diosgenin erythrodiol, guanylate cyclase inhibitors, gypsogenin, lauric acid, karounidiols, hydroxytryptamines, lanosterol, ,linoleic acid, linolenic acid, momordenol, momordicinin, momordicosides.

2.8. Traditional Uses of *Momordica charantia*

Ahmad, Hasan, Ahmad, Zishan and Zohrameena (2016) told their study that *Momordica charantia* has been used in various Asian traditional medicine systems for a long time, as useful for preventing and treating various diseases. Fruits: *Momordica charantia* used in asthma, burning sensation, constipation, colic, diabetes, cough, fever (malaria): gout, helminthiases, leprosy, inflammation, skin diseases, ulcer and wound. It has also been

publicized to have hypoglycaemic (antidiabetic) properties in animal as well as human studies. Juice of *Momordica charantia* the leaves used to treat piles totally. *Momordica charantia* is used as a blood purifier due to its bitter tonic properties. It can heal boils and other blood related problems that illustrate up on the skin. Juice of *Momordica charantia* is also beneficial in treating and preventing the liver damage. Leaves: *Momordica charantia are* used in treatment of menstrual troubles,burning sensation, constipation, fever (malaria): colic,infections, worms and parasites, as an emmenogogue, measles, hepatitis and helminthiases. In Guyana traditional medicine, leaf tea is used for diabetes, to expel intestinal gas, to promote menstruation, and as an antiviral for measles, hepatitis, and feverish condition. It is used topically for sores, wound, infections and internally and externally for worms and parasites. Seeds: *Momordica charantia* are used in the treatment of ulcers, liver and spleen problems, diabetes, high cholesterol, intestinal parasites, and intestinal gas, heal wounds and stomachache etc. Roots: *Momordica charantia* are used in the treatment of syphilis, rheumatism, ulcer, boils, septic swellings, opthelmia, and in Prolapsusvagenae. *Momordica charantia* juice helps to reduce the problem of Pyorrhea (bleeding from the gums). *Momordica charantia* capsules and tinctures are widely available in the United States for the treatment of diabetes, colds flu, viruses, tumors, cancer, high cholesterol, and psoriasis. Ethnomedical Uses: In India, *Momordica charantia* used by tribal people for abortions, birth control, increasing milk flow, vaginal discharge, menstrual disorders, constipation, food, hyperglycemia, diabetes, jaundice, stones, kidney, liver, fever (malaria): eczema, gout, fat loss, hemorrhoids, hydrophobia, intestinal parasites, skin, pneumonia, leprosy, psoriasis, rheumatism, scabies, piles, snakebite, vegetables, anthelmintic, purgative.

2.9. Ethno-botanical Uses of *Momordica charantia*

Gupta, Sharma, Gautam and Bhadauria (2011) told their study that ethnomedical Uses In India, *Momordica charantia* Linn. (Karela) used by tribal people for abortions, birth control, increasing milk flow, menstrual disorders, vaginal discharge, constipation, food, diabetes, hyperglycemia, jaundice, stones, kidney, liver, fever (malaria): gout, eczema, fat loss, hemorrhoids, hydrophobia, intestinal parasites, skin, leprosy, pneumonia, psoriasis, rheumatism, scabies, snakebite, vegetables, piles, tonic, anthelmintic, purgative.

2.10. Pharmacological Activity of *Momordica charantia*

2.10.1. Ant diabetic Activity of *Momordica charantia*

Khalid, Hassan, Mughal, Hassan, and Hassan (2021) included their study that there are various herbal medicines that have been used to treat diabetes in Asia and other growing nations. *M. charantia* used for the treating diabetes related condition among the native population of South America, Asia, East Africa, and India. Diabetes mellitus is the one of the five significant causes of death. It is a syndrome of disorderly metabolic rate, generally due to a permutation of heritable and environmental causes, resulting in abnormally high blood sugar levels. Etiologically, it is due to absolute or relative lack of insulin, the inattentiveness of insulin or both. *M. charantia* is one of the vital plants that have been investigated systematically for the treatment of diabetes. Current scientific indication of the biological function of *M. charantia*, it is one of the best promising plants against diabetes. Traditional uses of *M. charantia* in India discovered that it is one of the important plants for lowering blood glucose levels in patients with diabetes. It is also reported that oral management of fresh fruit juice (dose, 6 c.c. /kg. body wt.) lowered the blood sugar level. Oral management of alcoholic extracts of the plant to certain diabetic patients did not produce any hypoglycemic action. P-Insulin, a polypeptide from the seeds and fruits quickly decreased and regulated the blood sugar level. *M. charantia* can be used to lesser blood sugar levels in an animal model of diabetes. Alcohol extracted charantin from *M. charantia* comprises of mixed steroids, and it enhanced that glucose acceptance to a degree similar to the oral hypoglycemic agent, tolbutamide. Alternative compound, polypeptide found in fruits and seeds of bitter melon is comparable to insulin in composition. So, it can be of a great benefit in therapy of type 1 diabetes. Third compound is alkaloids which have been famous to have a blood sugar lowering effect. Compounds known as oleanolic acid glycosides have been found to enlarge glucose tolerance in type 2 diabetes. Hence, in the current study the aqueous extracts of *M. charantia* friuts, were estimated for the potential anti hyperlipidemic and antidiabetic effect on streptozotocin -induced diabetic rats and compared with the result with glibenclamide, a standard antidiabetic medicine. The hypoglycemic probable mechanisms in *M. charantia* have been recognized as glycosides, triterpenes, polysaccharides, saponins, alkaloids, steroids, and proteins. While numerous fresh chemicals were isolated from *M. charantia* and useful for examining their antidiabetic mechanisms. The mixture of these hypoglycemic chemicals such as charantins or saponins appeared to present a meaningfully advanced bioactivity. For example, the hypoglycemic chemicals of *M. charantia* are

confirmed as a combination of steroidal saponins known as alkaloids and charantins and mice have shown significant lowering of blood glucose levels.

2.10.2. Antimicrobial Activity of *Momordica charantia*

Khalid, Hassan, Mughal, Hassan, and Hassan (2021) showed their study that many infectious diseases have been cured with antimicrobial agents continues to present problems in modern-day medicine. As numerous studies display a significant increase in the incidence of bacterial resistance to some antibiotics. Consequently, there is a necessity to search for new infection-fighting stratagems to control microbial infections. That leaves of *M. charantia*, posses' strong antimicrobial potential against E. coli (gram-ve): *S. aureus* (gram+ve) and *C. albicans* strains. *M. charantia* has also been evolved to possess antiviral activity against Epstein Barr, Herpes and HIV viruses. In vivo study, extract of leave from plant part showed the ability to increase resistance against common viral infections of humans and animals. By increasing interferon production and ordinary killer cell activity as well as providing an immune stimulant.

2,10.3. Immunomodulatory activity of *Momordica charantia*

Cunnick et. al., (1990) told their study that immunomodulatory activity of *Momordica charantia* showed that it has a variable effect on the immune system in some conditions, like allograft rejection, someplace it was shown to have immunosuppressive effect and in some other cases immunostimulant. Immunomodulatory activity has been attributed to increase in interferon production and natural killer cell activity.

2.10.4. Hypocholesterolemic activity of *Momordica charantia*

Dhar, Ghosh and Bhattacharyya (1999) discover their study that Experiments carried out in normal as well diabetic animals have shown hypo-cholesterolemic effects by *Momordica charantia*. In a study, sunflower fed rats were fed with conjugated octadecatrienoic fatty acid isolated from *Momordica charantia* seeds for 4 weeks. After 4 weeks, these rats showed significant lowering of the plasma lipid peroxidation and erythrocyte membrane lipid peroxidation as well as nonenzymatic liver tissue lipid peroxidation.

2.10.5. Antioxidant activity of *Momordica charantia*

Khalid et. al., (2021) reported their study that *M. charantia* have medicinal value and great antioxidant properties due in part to phenols, terpenes, isoflavones, flavonoids, glucosinolates and anthroquinones. And also reported that phenolics have powerful antioxidant and free

radical-scavenging actions. All plant of *M. charantia* (flesh, aril and seeds) has been shown to a good font of phenolic compounds this one of the best studies verified that the flesh, aril and seeds totally possess very high antioxidant potential. Secondary metabolites and antioxidants play a key role in stopping disease due to oxidative anxiety, which indications to collapse of cell membranes and numerous pathological diseases. Antioxidants are naturally present in the spices and herbs and thus play a vital role in the chemoprevention of diseases and aging. Many nutritional phytochemicals, particularly phenolic compounds, have demonstrated antioxidant characteristics in various disease states such as diabetes, liver disease, cardiovascular disease, and cancer. Consequently, the profitable development of plants as roots of antioxidants for nutritional and health purposes are of great interest worldwide.

2.10.6. Anticancerous and Antitumorous Activity of *Momordica charantia*

Gupta, Sharma, Gautam and Bhadauria (2011) included their study that Bitter melon and its extract inhibit cancer and tumor formation. A novel phytochemical in karela has clinically demonstrated the ability to inhibit an enzyme named guanylate cyclase. This enzyme is thought to be linked to the pathogenesis and replication of not only psoriasis, but leukemia and cancer as well. Other phytochemicals that have been documented with cytotoxic activity are a group of ribosome-inactivating proteins named alpha and beta momorcharin, momordin and cucurbitacin B. And also developed and patented one more chemical compound "MAP-30", which was able to inhibit prostate tumor growth. Momordin, another phytochemical has clinically demonstrated anti cancerous activity against Hodgkin's lymphoma in vivo31 and several other in vivo studies have shown the cytostatic and antitumor activity of the entire plant of bitter melon. Further studies reported that a water extract blocked the growth of rat prostate carcinoma, and a hot water extract of the entire plant inhibited the development of the mammary tumors in mice. Numerous in vitro studies have also demonstrated the anti-cancerous and anti- leukemic activity of bitter melon against numerous cell lines including liver cancer, human leukemia, melanoma, and solid sarcomas.

2.10.7 Antiviral Activity of *Momordica charantia*

Gupta, Sharma, Gautam and Bhadauria (2011) included their study that Karela and its isolated phytochemicals, also has been documented with in vitro antiviral activity against numerous viruses including Epstein-Barr, herpes, and HIV viruses. In an in vivo study, a leaf extract demonstrated the ability to increase resistance to viral infections as well as to provide

an immunostimulant effect in humans and animals (increasing interferon production and natural killer cell activity). Two proteins known as alpha-and beta- momorcharin (which are present in the seeds, fruit, and leaves) have been reported to inhibit the HIV virus in vitro39, 40). In one study, HIV infected cells treated with alpha- and beta-momocharin showed a nearly complete loss of viral antigen while healthy cells were largely unaffected. In 1996 the inventors of the chemical protein along MAP-30 filed a U.S. patent, stating it was "useful for treating tumors and HIV infections. In treating HIV infection, the protein is administered alone or in conjunction with conventional AIDS therapies. Another clinical study showed that MAP-30's antiviral activity was also relative to the herpes virus *in vitro*.

2.10.8. Anti-Malarial Activity of *Momordica charantia*

Karela is traditionally regarded by Asians, as well as Panamanians and Colombians, as useful plant for preventing and treating malaria. Laboratory studies have confirmed that various species of Karela have antimalarial activity. Leaves brewed in hot water to create a tea to treat malaria.

2.10.9. Antifertility Activity of *Momordica charantia*

Stepka et al., (1974) have demonstrated in vivo antifertility effect of fruit and leaf of bitter melon in female animals.

2.10.10. Anti-Genotoxic Activity of *Momordica charantia*

Balboa and Lim-Sylianco, (1992) have reported that *Momordica charantia* (Karela) decreases the genotoxic activity of methylnitrosamine, methanesulfonate and tetracycline, as shown by the decrease in chromosome breakage.

2.10.11. Antineoplastic Activity of *Momordica charantia*

Ganguly and Das (2000) included their study that a skin carcinogenesis in mice, aqueous extract of the fruit of *M. charantia* provide protection against the development of skin tumors and increases life expectancy. The extract also reduced carcinogen-induced lipid peroxidation in the liver, DNA damage in lymphocytes, and significantly activated hepatic glutathione-S-transferase, glutathioneperoxidase, and catalase, all of which had become functionally depressed by exposure to the carcinogen used in the study. Many studies suggest a potentially prophylactic role against carcinogenesis of water-soluble constituents of bitter melon fruit, possibly mediated by their modulatory effect on enzymes involved in the biotransformation and detoxification of xenobiotic substances.

2.10.12. Anti-ulcerative and Immunomodulatory Activity of *Momordica charantia*

Gupta, Sharma, Gautam and Bhadauria (2011) included their study that the traditional use of bitter melon for treating gastrointestinal ulcers is recommended. Dried fruits powder administered in filtered honey have significant and dose-dependent activity against ethanol-induced ulcerogenesis in rats. Various studies have found both immunostimulating and immunosuppressive effects, due to extracts and isolated constituents of bitter melon.

2.10.13. Anti-obesity activity of *Momordica charantia*

Kumar et al. (2010) reported that the *Momordica charantia* increase the activity of adenosine 5 monophosphate kinase (AMPK): an enzyme that facilitates cellular glucose uptake and fatty acid oxidation. Compounds in bitter melon improve lipid profiles. They reduce liver secretion of apolipoprotein B (Apo B) - the primary lipoprotein of low-density "bad" cholesterol reduces apolipoprotein C- III expression, the protein found in very-low density cholesterol which turns into LDL/Bad Cholesterol and increases the expression of apolipoprotein A-1 (ApoA1) the major protein component of high density "good" cholesterol.

2.10.14. Wound healing activity of *Momordica charantia*

Sharma et al. (2009) reported that *Momordica charantia* Linn. fruit powder, in the form of an ointment (10% w/w dried powder in simple ointment base) showed a statically significant response ($P < 0.01$) in terms of wound contracting ability, wound closure time, period of epithelisation, tensile strength of the wound and regeneration of tissues at wound site when compared with the control group, and these results were comparable to those of reference drug povidone iodine ointment in an excision, incision and dead space wound model in rats.

2.10.15. Antifeedant activity of *Momordica charantia*

Upadhyay, Agrahari and Singh (2015) reported their study that ethanolic extracts of *M. charantia* leaves show antifeedant activity against the diamondback moth, Plutella xylostella larvae. And showed that momordicin I and momordicin II had significant antifeedant activity on the larvae of Plutella xylostella and momordicin II was more active than momordicin I. In addition, momordicin I and momordicin II had significant inhibitive effect on the rate of weight gain and survival of Pluella xylostella larvae. And also, that methanolic extract of *M. charantia* leaves inhibited feeding of two armyworm larvae, Spodoptera litura and Pseudaletia seperata. Momordicin II, a triterpene monoglucoside was identified as an antifeedant compound.

2.10.16. Trypanocidal activity of *Momordica charantia*

Upadhyay, Agrahari and Singh (2015) told their study the effective concentration of ethanolic extract of *M. charantia* leaves, capable of killing 50% of Trypanosoma cruzi parasites (IC50) was 46.06 µg mLG1. The Minimum Inhibitory Concentration (MIC) was 1024 µg mLG1. Metronidazole showed a potentiation of its antifungal effect when combined with an extract of *M. charantia*.

2.10.17. Antipyretic effect of *Momordica charantia*

Upadhyay, Agrahari and Singh (2015) discover their study the ethanolic extracts (500 mg kgG1) of *M. charantia* fruit showed antipyretic effect in a study which was carried out using yeast-induced pyrexia in rats. The antipyretic activity of *M. charantia* may be due to the individual or combined action of bioactive constituents present in it.

2.10.18. Neuroprotective effect of *Momordica charantia*

Upadhyay, Agrahari and Singh (2015) told their study that *M. charantia* possess neuroprotective effects on High-Fat Diet (HFD)-associated blood brain barrier disruption, stress and neuroinflammatory cytokines. And showed that cerebral oxidative stress and damage and neurological deficits were dose dependently attenuated by pre-treatment with the lyophilized *M. charantia* juice (200-800 mg kgG).

3.0. MATERIALS AND METHODS

3.1. Plant materials

Momordica charantia fruits was selected as the experimental material.

3.2. Place and Period of study

The study was carried out in the Biochemistry Laboratory of Faculty of Unani & Ayurvedic Medicine, Hamdard University Bangladesh during the period of August to November 2022.

3.3. Preparation of fine powder of *Momordica charantia*

Momordica charantia was collected from the local market of Baluakandi, Gazaria. All of the materials washed with clean water and sun-dry under shade then the dried fruits made into powder by means of mechanical blender and preserved in an air-tight container at room temperature until extraction.

3.4. Extracting Materials

Extraction of *Momordica charantia* done by polar (methanol) solvents. The following materials are required while extracting them. Dried *Momordica charantia* fruits, Methanol, Distilled water, Beaker, Hot water bath, Drier, Weight machine, Glass rods, Tissue paper, Spatula, Titrating pipette, Foil papers, Vial, Blender machine and Scissor.

3.5. Preparation of Extraction of *Momordica charantia*

The grinded 200 gm powder taken into clean glass containers and was soaked in 500 ml 100% Methanol. Then the container was sealed and kept for 3 days with occasional shaking and stirring. The whole mixture was filtered by a piece of clean, white cotton material and then the filtrate was further filtered with Whitman filter paper No.1 filter paper and then make the filtrates into one third of their obtaining volume and perform phytochemicals experiments for qualitative analysis. Remaining filtrates placed on water-bath at 40°C to obtain crude extracts.

3.6. Reagents and chemicals

Reagents and chemicals such as Wagner's reagent (lodine in Potassium Iodide): Hagger's reagent (saturated picric acid solution): Mayer's reagent (Potassium Mercurie lodide): Draggendrof's reagent (Solution of Potassium Bismuth Iodide): Molisch's reagent (Alcoholic alpha-naphthol solution): Benedict's Reagent, Fehling's reagent, Salkowski reagent, concentrated sulphuric acid, 10% lead acetate, 0.1% ferric chloride, Fehling's solution, Dilute NaOH. Ammonia, Dilute HCI, Distilled water & Methanol were used in this study**.**

3.7. Phytochemical Analysis of *Momordica charantia*

The crude extract was subjected to different chemical tests to find out the qualitative presence of phytochemical which was identified by characterized color changes using standard procedure as described for alkaloids (Harborne, 1973): steroids (Trease & Evans, 1989). phenolics and flavonoids (Awe & Sodipo, 2001): saponins and cardiac glycosides (Sofowora, 1993): tannins (odebiyi & Sofowora, 1978): terpenoids and saponins (Obadonia & Ochuko, 2001).

3.7.1. Detection of alkaloids: Extract was dissolved in dilute Hydrochloric acid and filtered.

3.7.1.1. Mayer's Test: Filtrate was treated with Mayer's reagent (Potassium Mercuric Iodide). Formation of a yellow-colored precipitate indicates the presence of alkaloids.

3.7.1.2. Wagner's Test: Filtrate was treated with Wagner's reagent (Iodine in Potassium Iodide). Formation of brown/reddish precipitate indicates the presence of alkaloids.

3.7.1.3. Dragendroff's Test: Filtrate was treated with Dragendroff's reagent (Solution of Potassium Bismuth Iodide). Formation of red precipitate indicates the presence of alkaloids.

3.7.1.4. Hager's Test: Filtrate was treated with Hager's reagent (Saturated picric acid solution). Presence of alkaloids confirmed by the formation of yellow colored precipitate.

3.7.2. Detection of carbohydrates: Extract was dissolved in 5 ml distilled water and filtered. The filtrate was used to test for the presence of carbohydrates.

3.7.2.1. Molisch's Test: Filtrate was treated with 2 drops of alcoholic α-naphthol solution in a test tube. Formation of the violet ring at the junction indicates the presence of carbohydrates.

3.7.2.2. Benedict's Test: Filtrate was treated with Benedict's reagent and heated gently. Orange red precipitate indicates the presence of reducing sugars.

3.7.2.3. Fehling's Test: Filtrate was hydrolyzed with dil. HCl, neutralized with alkali and heated with Fehling's A & B solutions. Formation of red precipitate indicates the presence of reducing sugars.

3.7.3. Detection of glycosides: Extract was hydrolyzed with dil. HCl, and then subjected to test for glycosides.

3.7.3.1. Modified Borntrager's Test: Extract was treated with Ferric Chloride solution and immersed in boiling water for about 5 minutes. The mixture was cooled and extracted with equal volumes of benzene. The benzene layer was separated and treat with ammonia solution. Formation of rose-pink color in the ammonical layer indicates the presence of anthranol glycosides.

3.7.4. Legal's Test: Extract was treated with sodium nitropruside in pyridine and sodium hydroxide. Formation of pink to blood red color indicates the presence of cardiac glycosides.

3.7.5. Detection of saponins

3.7.5.1. Froth Test: Extract was diluted with distilled water to 20 ml, and this was shaken in a graduated cylinder for 15 minutes. Formation of 1 cm layer of foam indicates the presence of saponins.

3.7.5.2. Foam Test: 0.5 gm of extract was shaken with 2 ml of water. If foam produced and persists for ten minutes, it indicates the presence of saponins.

3.7.6. Detection of phytosterols

3.7.6.1. Salkowski's Test: Extract was treated with chloroform and filtered. The filtrate was treated with few drops of Concentrated Sulphuric acid, shaken and allowed to stand. Appearance of golden yellow color indicates the presence of triterpenes.

3.7.6.2. Libermann Burchard's test: Extract was treated with chloroform and filtered. The filtrate was treated with few drops of acetic anhydride, boiled, and cooled. concentrated Sulphuric acid was added. Formation of brown ring at the junction indicates the presence of phytosterols.

3.7.7. Detection of phenols

3.7.7.1. Ferric Chloride Test: Extract was treated with 3-4 drops of ferric chloride solution. Formation of bluish black color indicates the presence of phenols.

3.7.8. Detection of tannins

3.7.8.1. Gelatin Test: To the extract, 1% gelatin solution containing sodium chloride was added. Formation of white precipitate indicates the presence of tannins.

3.7.9. Detection of flavonoids

3.7.9.1. Alkaline Reagent Test: Extract was treated with few drops of sodium hydroxide solution. Formation of intense yellow color, which became colorless on addition of dilute acid, indicates the presence of flavonoids.

3.7.9.2. Lead acetate Test: Extract was treated with few drops of lead acetate solution. Formation of yellow color precipitate indicates the presence of flavonoids.

3.7.10. Detection of proteins and amino acids

3.7.10.1. Xanthoproteic Test: The extract was treated with few drops of concentrated Nitric acid. Formation of yellow color indicates the presence of proteins.

3.7.10.2. Ninhydrin Test: To the extract, 0.25% ninhydrin reagent ($C_9H_6O_4$) was added and boiled for few minutes. Formation of blue color indicates the presence of amino acid.

4.0. RESULTS AND DISCUSSION

4.1. Results: Phytochemical Screening of *Momordica charantia*:

The present study deals with the screening of phytochemicals of *Momordica charantia* in the Methanolic extracts in a laboratory. In methanol extract of *Momordica charantia* have present phytocompound, such as alkaloids, carbohydrates, glycosidase, saponins, phytosterol, tennis, flavonoids, proteins, and amino acids. In this study phenol, protein and amino acids are also present. screening of indigenous *Momordica charantia* fruits to identify the major classes of phytoconstituents present in the methanolic extract. The study was designed to provide a scientific basis for the traditional medicinal importance of *M. charantia* and to establish baseline information regarding the chemical constituents of locally available plant material. Particular emphasis was placed on identifying alkaloids, carbohydrates, glycosides, saponins, phytosterols, phenols, tannins, flavonoids, proteins, and amino acids through established qualitative chemical tests. The findings were also intended to contribute to future pharmacological, phytochemical, and formulation research by identifying the broad groups of natural compounds that may be responsible for the biological activities attributed to the plant. The qualitative phytochemical screening demonstrated that the investigated *M. charantia* extracts contained a wide spectrum of phytochemical classes. Such chemical diversity is important because the medicinal effects of a plant extract are often not attributable to a single compound but may result from the combined or synergistic actions of multiple constituents. Previous studies have reported that *M. charantia* contains several chemically important groups, including cucurbitane-type triterpenoids, steroidal glycosides, flavonoids, phenolic compounds, saponins, sterols, and other secondary metabolites. Therefore, the present study was intended not only to document the presence of phytochemicals but also to support further investigation into the possible relationship between the phytochemical composition of indigenous *M. charantia* and its reported biological activities.

Table 4.1. Results of alkaloids in methanolic extract of *Momordica charantia* fruits.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Alkaloids	Mayer's Test	Positive
2		Wagner's Test	Positive
3		Dragendroff's Test	Positive
4		Hager's Test	Positive

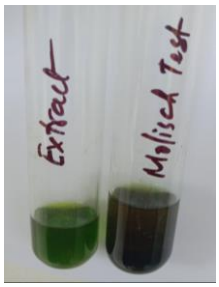

Figure 4.1: Mayer's Test

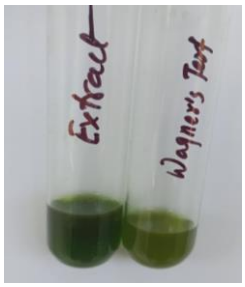

Figure 4.2: Wagner's Test

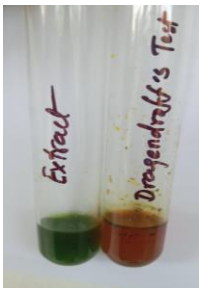

Figure 4.3: Dragendroff's Test

Figure 4.4: Hager's Test

Table 4.2: Results of carbohydrates in methanolic extract of *Momordica charantia*.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Carbohydrates	Molisch Test	Positive
2		Benedict's Test	Positive
3		Fehling Test	Positive

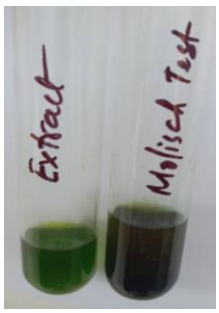

Figure 4.5: Molisch Test

Figure 4.6: Benedict's Test

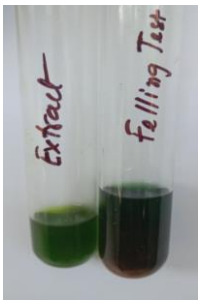

Figure 4.7: Fehling Test

Table 4.3: Results of glycoside in methanolic extract of *Momordica charantia* fruits.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Glycoside	Modified Borntrager's Test	Positive
2		Legal's Test	Positive

Table 4.4: Results of saponins in methanolic extract of *Momordica charantia* fruits:

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Saponins	Forth Test	Positive
2		Foam Test	Positive

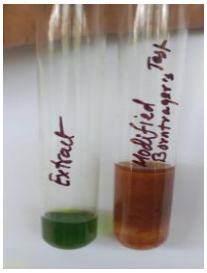

Figure 4.8: Modified Borntrager's Test

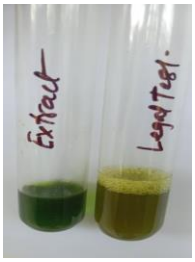

Figure 4.9: Legal's Test

Figure 4.10: Forth Test

Figure 4.11: Foam Test

Table 4.5: Results of phytosterol in methanolic extract of *Momordica charantia* fruits.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Phytosterol	Salkowski's Test	Positive
2		Libermann Burchard's Test	Positive

Table 4.6: Results of phenols in methanolic extract of *Momordica charantia* fruits.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Phenol	Ferric Chloride Test	Positive

Table 4.7: Results of tannins in methanolic extract of *Momordica charantia* seeds.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Tannins	Gelatin test	Positive

Figure 4.12: Salkowski's Test

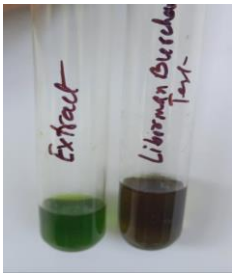

Figure 4.13: Libermann Burchard's Test

Figure 4.14: Ferric Chloride Test

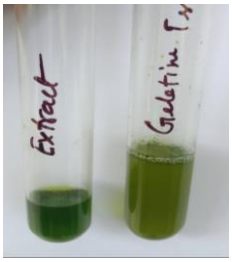

Figure 4.15: Gelatin Test

Table 4.8. Results of flavonoids in methanolic extract of *Momordica charantia* seeds.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Flavonoids	Alkaline Reagent Test	Positive
2		Lead acetate Test	Positive

Table 4.9: Results of proteins and amino acids in methanolic extract of *Momordica charantia* fruits.

Sl.	Detection of Phytochemicals	Name of the test	Result
1	Proteins & Amino acids	Xanthoproteic Test	Positive
2		Ninhydrin Test	Positive

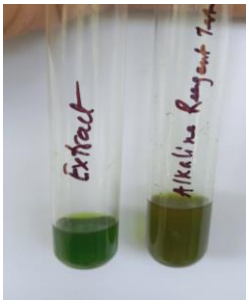

Figure 4.16: Alkaline Reagent Test

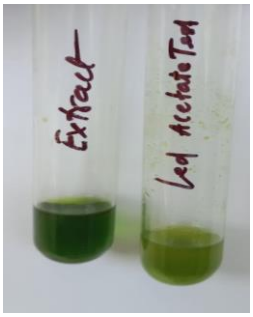

Figure 4.17: Lead acetate Test

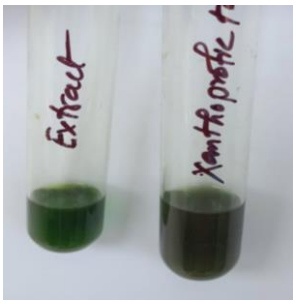

Figure 4.18: Xanthoproteic Test

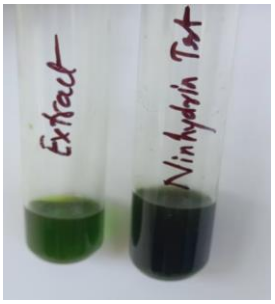

Figure 4.19: Ninhydrin Test

4.2. DISCUSSION

The present phytochemical investigation demonstrated that the methanolic extract of indigenous *Momordica charantia* showed positive reactions for a broad spectrum of phytochemical groups. The most prominent finding was the simultaneous detection of alkaloids, carbohydrates, glycosides, saponins, phytosterols, phenols, tannins, flavonoids, proteins, and amino acids. This broad phytochemical profile indicates that the investigated plant material possesses considerable chemical diversity. The findings are particularly relevant because the biological properties traditionally attributed to *M. charantia* are generally considered to arise from a complex mixture of phytochemicals rather than from one isolated constituent.

The detection of alkaloids in the present study was confirmed by four qualitative tests: Mayer's, Wagner's, Dragendorff's, and Hager's tests. The positive results obtained with multiple reagents strengthen the preliminary evidence for the presence of alkaloid-type compounds. This observation is comparable with the findings of Zahan et al. (2020): who reported alkaloids in methanolic extracts of *M. charantia* seeds. Similarly, Razak (2019) reported alkaloids in *M. charantia* fruit and seed extracts. Bakare et al. (2010) also reported alkaloids among the phytochemicals detected in *M. charantia*. These similarities suggest that alkaloid constituents may occur in different organs of the plant, although their concentration can vary according to plant part, geographical origin, maturity, extraction solvent, and analytical method. Alkaloids are pharmacologically important because many compounds in this class possess antimicrobial, antioxidant, anti-inflammatory, and other biological properties. Nevertheless, qualitative detection alone cannot establish which specific alkaloids are present or whether they contribute directly to the pharmacological effects of the extract.

The positive findings for carbohydrates in Molisch's, Benedict's, and Fehling's tests indicate the presence of carbohydrate constituents and reducing sugars. This result is biologically plausible because *M. charantia* fruits are edible plant tissues containing substantial primary metabolites. Bakare et al. (2010) documented carbohydrate components in *M. charantia* during nutritional and chemical evaluation. Zahan et al. (2020) similarly reported carbohydrates in methanolic seed extracts. However, carbohydrates are primary metabolites and should be interpreted differently from specialized secondary metabolites. Their presence contributes to the nutritional and biochemical profile of the fruit but does not, by itself, establish medicinal activity.

The present study also showed positive reactions for glycosides, as demonstrated by Modified Borntrager's and Legal's tests. This finding is consistent with previous reports. Islam and Sattar (2013) observed several phytochemical constituents in aqueous and ethanolic extracts of *M. charantia* fruits, while Haque et al. (2011) reviewed the occurrence of glycosides and cucurbitane-type compounds in the plant. Zahan et al. (2020) also reported glycosides in methanolic seed extract. The occurrence of glycosidic compounds is of particular interest because *M. charantia* contains several biologically active glycosides, including steroidal and triterpenoid glycosides. Charantin, for example, has historically been described as a mixture of steroidal glucosides, while numerous cucurbitane-type glycosides have also been reported from the plant. Therefore, the positive glycoside reactions in the present study may indicate the presence of chemically important constituents; however, specific compound identification would require chromatographic and spectroscopic analysis.
Saponins were detected through positive froth and foam tests. The finding agrees with Zahan et al. (2020): who reported saponins in methanolic *M. charantia* seed extract, and with Bakare et al. (2010): who identified saponins among the phytochemicals of *M. charantia*. Razak (2019) also reported saponins in *M. charantia* fruit extracts. Saponins are amphiphilic compounds characterized by their ability to produce persistent foam in aqueous systems. Their reported biological activities include antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory effects. Consequently, the presence of saponins may contribute to some of the biological properties associated with *M. charantia*. However, the froth test is only a preliminary screening method and cannot differentiate among individual saponins or quantify their abundance.

The detection of phytosterols by Salkowski's and Liebermann–Burchard's tests is another significant finding. This result corresponds with reports describing sterol constituents in *M. charantia*. Semiz and Sen (2007) discussed the presence of sterol-related constituents and cucurbitane-type compounds in the plant, while Grover and Yadav (2004) reviewed the phytochemical and pharmacological characteristics of *M. charantia*. The plant is known to contain sterols such as β-sitosterol and stigmasterol derivatives, and charantin has been described as a mixture involving steroidal glucosides. The detection of phytosterols in the present investigation may therefore have important implications for understanding the biological activity of the extract. Nevertheless, the specific sterol composition cannot be established using only Salkowski's and Liebermann–Burchard's reactions.

The positive phenolic reaction with ferric chloride and the detection of tannins through the gelatin test indicate the presence of phenolic constituents. These findings are consistent with previous studies. Islam and Sattar (2013) reported phenolic compounds in *M. charantia* fruit extracts and also investigated their antioxidant properties. Malik et al. (2019) demonstrated that extraction conditions and solvent polarity influence the phytochemical profile and antioxidant activity of *M. charantia* fruit extracts. Similarly, the review by Olaniyi et al. (2018) emphasized the occurrence of phenolic compounds and flavonoids in *M. charantia*. Phenolic compounds are particularly important because they can act as hydrogen or electron donors and may contribute to antioxidant activity. Tannins may also exhibit antimicrobial and antioxidant properties. Thus, the positive phenol and tannin findings provide a possible phytochemical explanation for some of the antioxidant and antimicrobial activities previously reported for *M. charantia*.

The present study further demonstrated the presence of flavonoids, confirmed by alkaline reagent and lead acetate tests. This observation is strongly supported by previous research. Zahan et al. (2020) detected flavonoids in methanolic seed extracts, while Razak (2019) reported flavonoids in extracts of *M. charantia* fruit and seed. The presence of flavonoids is also consistent with broader phytochemical reviews of the species, which have identified compounds such as quercetin and luteolin derivatives. Flavonoids are widely recognized for their antioxidant, anti-inflammatory, antimicrobial, and potentially antidiabetic activities. Therefore, the flavonoid content of indigenous *M. charantia* may contribute to the biological effects attributed to the plant. However, the intensity of a qualitative test cannot be directly interpreted as a measure of flavonoid concentration.

The detection of proteins and amino acids through Xanthoproteic and Ninhydrin tests also agrees with the findings of previous investigations. Zahan et al. (2020) reported proteins and amino acids in methanolic extracts of *M. charantia* seeds, while Islam and Sattar (2013) found proteins and amino acids particularly in ethanolic fruit extracts. This difference between extraction systems is important because solvent polarity can substantially influence the compounds extracted from plant tissues. Protein and amino acid constituents are particularly relevant to the nutritional value of *M. charantia*, although they should not necessarily be classified as the principal secondary metabolites responsible for its medicinal effects.

The overall findings of the present study are broadly comparable with the comprehensive screening reported by Zahan et al. (2020): who detected alkaloids, carbohydrates, glycosides, saponins, phytosterols, phenols, tannins, flavonoids, proteins, and amino acids in methanolic *M. charantia* seed extract. The remarkable similarity between the two phytochemical profiles strengthens the reliability of the present findings. However, the comparison must be made cautiously because the present thesis primarily focuses on fruits, whereas Zahan et al. investigated seeds. Plant organs may differ considerably in their phytochemical composition.

The findings are also comparable with the study of Razak (2019): in which fruit and seed extracts prepared using solvents of different polarity showed the presence of alkaloids, flavonoids, saponins, phenols, tannins, terpenoids, steroids, and glycosides. Malik et al. (2019) further demonstrated that extraction time and solvent power influence the phytochemical profile and antioxidant activity of *M. charantia* fruit extracts. This supports the concept that differences between published studies may arise from extraction procedures rather than true absence of a constituent.

The comparative study by Islam and Sattar (2013) is particularly relevant because it evaluated aqueous and ethanolic extracts of *M. charantia* fruits. Their observation that certain constituents were common to both extracts while proteins and amino acids were detected specifically in the ethanolic extract demonstrates the importance of solvent selection. Similarly, the present detection of proteins and amino acids emphasizes that the extraction system used in a phytochemical investigation can influence the observed qualitative profile.

The results also correspond with the broader review by Grover and Yadav (2004): which described *M. charantia* as a phytochemically complex plant with numerous compounds associated with its reported medicinal effects. Haque et al. (2011) further emphasized

cucurbitane-type triterpenoids, glycosides, and phenolic compounds as important constituents of the species. Tan et al. (2008) and Joseph and Jini (2013) also discussed the diverse phytochemical composition and biological activities of *M. charantia*, particularly in relation to metabolic and antidiabetic effects.

Another study on *Momordica charantia* reported that fruit & seed contain Cucurbitane-type triterpenoids, Carotenoids, Carbohydrates, Protein, Phytosterols, Phenolic compounds, Alkaloids, Fatty acids, Essential oils & Carotenoids are present. Villarreal-La Torre et al., (2020). Fruits of *M. charantia* are good sources of carbohydrate and protein; these may serve as source of energy and nutrients for the body metabolic activities in addition to its medicinal properties. The carbohydrates and proteins present in the plant may be a conglomerate of bioactive sugars, glycoproteins or proteins which gives the plant its medicinal potency against certain diseases. Some plants are known to contain certain sugars which are biologically active against some diseases (Ri, B. et al.,2010).

A particularly important point is that preliminary phytochemical screening cannot establish the precise chemical identity of the detected constituents. For example, a positive glycoside test does not demonstrate the presence of a specific glycoside such as charantin, nor does a positive phytosterol test identify β-sitosterol or stigmasterol. Similarly, positive phenol and flavonoid tests do not identify individual molecules such as quercetin or luteolin. Advanced analytical methods such as HPLC, LC-MS, GC-MS, and NMR would therefore be necessary to confirm individual compounds.

The findings of the present study also support the observations of Budrat and Shotipruk (2008): who demonstrated that extraction conditions influence the recovery of phenolic compounds from *M. charantia*. The more recent phytochemical literature likewise indicates that solvent selection, extraction technique, geographical origin, plant maturity, cultivar, and plant part can produce substantial variation in phytochemical composition. Therefore, differences between the present study and previously published reports should not necessarily be interpreted as contradictions.

Overall, the present results demonstrate that indigenous *M. charantia* contains a broad spectrum of phytochemical constituents. The detection of phenols, flavonoids, tannins, saponins, glycosides, alkaloids, and phytosterols provides a plausible chemical basis for the plant's reported biological activities. The results also support the ethnomedicinal importance

of *M. charantia* and justify further investigation. However, because the current study is qualitative, the findings should be considered preliminary. Quantitative determination of total phenolic, flavonoid, tannin, and saponin contents, followed by chromatographic profiling and biological assays, would provide stronger evidence regarding the relationship between phytochemical composition and pharmacological activity.

Important thesis-consistency note: In your supplied tables, Tables 4.7 and 4.8 specifically state that tannins and flavonoids were detected in methanolic extract of *M. charantia* seeds, while the thesis title refers to fruits. This distinction should be corrected or clearly explained in the methodology and results chapters. If tannin and flavonoid tests were actually performed on fruit extract, the table headings should be corrected to "fruits." If seeds were separately analysed, the thesis should explicitly state that both fruit and seed materials were investigated. This correction is important for scientific consistency and accurate comparison with published studies.

5.0. CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

The present study was undertaken to investigate the preliminary phytochemical composition of indigenous *Momordica charantia* fruits through qualitative screening of methanolic extracts. The findings demonstrated the presence of a diverse range of phytochemical constituents, including alkaloids, carbohydrates, glycosides, saponins, phytosterols, phenolic compounds, tannins, flavonoids, proteins, and amino acids. The detection of these phytochemical groups through multiple established qualitative tests indicates that indigenous *M. charantia* represents a chemically diverse plant resource with considerable potential for pharmacological and nutraceutical research.

The detection of alkaloids, glycosides, saponins, phytosterols, phenols, tannins, and flavonoids is particularly significant because these classes of compounds have been associated in previous research with diverse biological activities, including antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and other pharmacological effects. The present findings are broadly consistent with several previously published studies on *M. charantia*, although differences in phytochemical profiles among studies may occur because of variations in plant part, geographical origin, cultivar, maturity, extraction solvent, extraction conditions, and analytical procedures.

The results provide preliminary scientific support for the traditional use of *M. charantia* as an indigenous medicinal plant. However, qualitative phytochemical screening only indicates the probable presence of broad classes of compounds and does not establish their exact chemical identities, concentrations, bioavailability, or therapeutic efficacy. Therefore, the present findings should be considered an initial phytochemical assessment rather than definitive evidence of pharmacological activity.

5.2. Recommendation

Further studies should be conducted to quantitatively estimate the major phytochemical constituents present in indigenous *Momordica charantia* fruits. Advanced analytical techniques such as HPLC, LC-MS/MS, GC-MS, and NMR should be employed to identify and characterize individual bioactive compounds. The extracts should also be evaluated for antioxidant, antimicrobial, antidiabetic, anti-inflammatory, and cytotoxic activities using validated experimental models. Standardization of plant materials, extraction methods, and cultivation conditions is recommended to ensure reproducibility. Further in vivo and clinical investigations are necessary to establish safety, efficacy, appropriate dosage, and potential therapeutic applications of *M. charantia* in herbal and pharmaceutical preparations.

6.0. Conflicts of interests

The authors do not disclose any conflicting interests.

7.0. ACKNOWLEDGMENT

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