***Original Research Article***

***Phytochemical & Pharmacological Activities of* *Diospyros Malabarica***

**Abstract**

*Diospyros malabarica*, is a prominent member of the Ebenaceae intimate natural to the Indian subcontinent. This paper comprehensively explores the diverse pharmacological activities attributed to various parts of *Diospyros malabarica*, shedding light on its possible as a foundation of bioactive composites for medicinal and therapeutic applications. The pharmacological properties of *Diospyros malabarica* are presented through an in-depth analysis of the scientific literature, highlighting its traditional uses, phytochemical constituents and therapeutic potential. This paper covers the wide array of bioactive compounds identified in *Diospyros malabarica*, which have been linked to its various pharmacological activities. Several studies have demonstrated its antimicrobial, antioxidant, anti-inflammatory, anti-diarrheal, anthelminthic and anti-diabetic properties. Additionally, *Diospyros malabarica* has shown promise as an anticancer agent, with its extracts exhibiting cytotoxic effects on various cancer cell lines. Furthermore, the paper underscores the importance of supplementary exploration to better understand the mechanisms of fundamental in the experimental pharmacological activities and to develop standardized formulations for clinical use. *Diospyros malabarica* emerges as a valuable botanical resource with rich pharmacological potential. Its traditional uses are supported by scientific evidence and its bioactive compounds hold promise for the development of novel therapeutic agents.

**Keywords:** *Diospyros malabarica*; Ebenaceae; Gaub plant; Malabar ebony; Gabh; Gabu; Blackwood; TNF-alpha; IL-6.

**1. Introduction**

Medicinal herbs have been employed in conventional and ethnomedical medicine globally. The genetics, evolution and phylogeny of medicinal plants are covered in this section. It also makes recommendations for the course of future research in this field. These dynamic domains investigate the origins and evolution of genotype and metabolic phenotypes in medicinal plants, the relationships between genomic diversity and metabolite diversity and the connections between the genome and ecosystem [1]. Advanced genomic technology may also be utilized to speed up the advancement of medical plants and transform them into actual manufacturers of therapeutic substances, along with agricultural plants. In biodiversity forecasting and bio prospecting, molecular phylogeny and phylogenomics are key components of natural product-based medication identification and manufacturing [2]. In geodiversity forecasting and bio advertising, molecular phylogeny and phylogenomics are key components of natural product-oriented medicine identification and commercialization. Case studies on the evolution, phylogeny and genome of therapeutic plants are compiled in this paper [3]. The examples provided show how knowledge is growing and how omics-based methodologies are becoming more popular. These techniques have improved our understanding of the development in the plant genome, paving the way for a long-term utilization of plant medicinal assets and the molecular breeding of therapeutic plants [4]. In Bangladesh, *Diospyros malabarica*, is a kind of perennial tree with ornamental properties. It can grow fruits and blossoms because it is successfully adapting to the local temperature. This specific plant is categorized as a native medicinal herb and has demonstrated strong antioxidant capabilities [5]. *Diospyros malabarica* fruit and leaves, in particular, exhibit antiproliferative and anti-inflammatory properties that have long been used for the management of atherosclerosis and high blood pressure. The extensive abundance of pharmacologically effective bio-constituents in D. malabarica may be the reason for its prospective application as a phytomedicine. According to earlier records, this plant's fruits, bark and leaves are among the parts that are utilized in medicinal formulations. This is used in many conventional medical procedures across the globe to pleasure a diversity of illnesses. The plant *Diospyros malabarica* is indigenous to Southern Europe, North Africa and Southwest Asia [6].

Some common general information about *Diospyros malabarica* has been depicted on **Table 1**.

**Table 1. General information about *Diospyros malabarica***

|  |  |
| --- | --- |
| **Some common information about *Diospyros malabarica*** | |
| **Another name** | Malabar Ebony |
| **Flowering period** | May-July |
| **Solvents used for withdrawal** | Methanol, ethanol, chloroform, N-hexane,  ethyl acetate etc. |
| **Frequently used part for insertion** | Leaves, bark, fruits, flowers, sap. |
| **Mutual habitat** | Lowland rainforests, primarily along rivers and streams |

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**Figure 1: Fruits of *Diospyros malabarica***

In this **Figure 1**, we can see the Guab (*Diospyros malabarica*) fruits.

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**Figure 2: Flowers of *Diospyros malabarica***

In this **Figure 2,** we can see the Guab (*Diospyros malabarica*) flowers.

Taxonomic classification of *Diospyros malabarica* have been also depicted in the below side.

**Kingdom:** Plantae

**Subkingdom:** Tracheobionta

**Super division:** Spermatophyta

**Phylum:** Tracheophyta

**Class:** Magnoliopsida

**Order:** Ericales

**Family:** Ebenaceae

**Genus:** Diospyros

**Species:** Diospyros malabarica

* **Common names of Diospyros malabarica**

Gaub persimmon, Gabh, Holitupare, Kusarta, Panacci, Pananci, Tinduki, Gabu, Tumikicettu.

**2. Materials and Methods**

**2.1 Sample Collection**

A leaf of the *Diospyros malabarica* plant was harvested in July 2023 at Bangladesh Agriculture University **(**BAU) in Mymensingh, Bangladesh [2]. A variety of organs were taken from this location, including immature, green leaves, unripe fruit and stem, dark black bark and completely ripe fruit from only one D. malabarica sample [6]. An identification of the specimens was done by a Scientific Officer from the Botany Department of the University of Dhaka **(**DU) in Dhaka, Bangladesh. It has been maintained for research purposes by submitting a voucher specimen (10517) to the Herbarium [2].

**2.2 Plant Extract Preparation**

The specimen pieces were transported to the lab for analysis while being stored in plastic baskets and labelled containers for utilisation in a freezer at 10°C to preserve integrity. After washing to remove dust, the samples were rinsed with deionized water in preparation for analysis. The investigation took place in the Botany Department Lab at the University of Dhaka [6].

**2.3 Drying and Grinding**

The chosen cleaned plant parts (leaves, bark, stem, ripe and unripe fruit) were dried in the air at a temperature between 25°C and 30°C for a full 72 hours. After being dried, the samples were finely ground with a mortar and pestle into a powder and stored for later analysis at room temperature in clean, labeled, airtight bottles [6].

**2.4 Preparation of Extracts**

The extracts were made by sequentially extracting from less polar solvents to more polar solvents in order to extract different polarity-based chemical constituents [7]. Plant organ powder (50 g) was dissolved in 500 mL of solvent and petroleum ether (40–60°C) and stored in an airtight container. Following that, it was encouraged to be kept at room temperature with constant shaking for 72 hours, or until the soluble material had broken down to form a solution. To filter the extract, Whatman Filter paper No. 41 was utilized. After being air-dried, the leftover marc from the extraction process was extracted once more for 72 hours using dichloromethane as the solvent [6]. The extraction process uses methanol, ethanol, ethyl acetate and water added next on it. All five of D. malabarica's organ extracts were present. Each extract was fully evaporated before being dissolved in 10% dimethyl sulphoxide (DMSO) to achieve a final concentration of 50 mg/mL. The bottles were then labeled, sanitized and stored at 5°C until additional testing could be done [8].

**2.5 Reagents**

Methanol, NaOH, diluted HCl acid and concentrated H2SO4 were prepared by Sigma Chemical Co., USA. The sterile saline solution was obtained from Orion Infusion Ltd. Diclofenac sodium was manufactured by Square Pharmaceuticals Ltd. Vincristine sulphate was acquired from Polysciences, Inc. India. Streptokinase was bought from Incepta Pharmaceuticals Ltd, Bangladesh. Vin-Cristine Sulphate was provided by Celon Laboratories Pvt. Ltd. while Gonoshasthaya Pharmaceuticals Ltd. was supplied morphine sulfate [2].

**2.6 Extraction Yield**

"Crude extract performance" refers to the ratio of the dry plant extract mass obtained to the total mass of plant material processed during the experiment [9].

This yield can be calculated with the help of the following formula:

**%Yield = × 100 …... (01)**

**2.7 Phytochemical Screening**

Precipitation reactions or colouring were used as the basis for the phytochemical screening. Plant organs were immediately turned into powder form using the Houghton and Raman approach [10]. The University of Dhaka (DU), in Dhaka, Bangladesh, conducted phytochemical analyses in addition to antibacterial and antifungal activities at its Applied Chemistry Hi-Tech Laboratory. Similar biological activities were carried out at the Plant Breeding and Genetics Division (MAB Lab-1) in the Botany Department of the University of Dhaka (DU), Dhaka, Bangladesh; additionally, anti-cancer activity was studied in a laboratory at the Bangladesh Council of Scientific and Industrial Research Centre, Dhaka, Bangladesh [6].

**2.8 Pharmacological Properties**

*Diospyros malabarica* has been reported to exert antioxidant, anti-inflammatory, anthelmintic, antidiabetic, antimicrobial, antidiarrheal, analgesic, antipyretic, antifungal and anti-hypertensive activities [11].

**2.8.1 Antioxidant activity**

The antioxidant activity of *Diospyros malabarica* is of interest due to the potential health benefits associated with antioxidants [12].

Research on the antioxidant activity of *Diospyros malabarica* has shown that it contains various bioactive compounds, which are known for their antioxidant properties [13].

Here are some key findings related to the antioxidant activity of *Diospyros malabarica* [14].

**Total Antioxidant Capacity:** Studies have assessed the total antioxidant capacity of *Diospyros malabarica* extracts. These assessments often involve using methods of radical scavenging assay to measure the ability of the plant's compounds to neutralize free radicals [15].

**Phenolic Compounds:** The plant is known to be rich in phenolic compounds, which have potent antioxidant properties. These compounds can help protect cells from oxidative stress [16].

**Flavonoids:** Flavonoids are a subclass of polyphenols found in *Diospyros malabarica* and they are known for their antioxidant and anti-inflammatory properties [17].

**Tannins:** Tannins found in *Diospyros malabarica* are also associated with antioxidant activity. They can scavenge free radicals and help prevent cell damage [12].

**2.8.2 Anti-inflammatory activity**

The anti-inflammatory activity of *Diospyros malabarica* is accredited to the incidence of various bio-active compounds [18]. These compounds have been shown to possess anti-inflammatory, antioxidant and immunomodulatory properties [19].

Here are some ways in which *Diospyros malabarica* may exhibit anti-inflammatory activity [20].

**Anti-inflammatory Cytokine Modulation:** *Diospyros malabarica* extracts have been studied for their ability to modulate the production of pro-inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-alpha) and interleukin-6 (IL-6) [18]. By regulating these cytokines, the plant may help control inflammation [21].

**Inhibition of Inflammatory Enzymes:** Some studies have suggested that *Diospyros malabarica* extracts can inhibit the activity of enzymes like cyclooxygenase-2 (COX-2) and lipoxygenase (LOX), which are involved in the synthesis of pro-inflammatory compounds like prostaglandins and leukotrienes [21].

I**mmune System Modulation:** *Diospyros malabarica* may also have immunomodulatory effects, helping to balance the immune response and prevent excessive inflammation [22].

It's important to note that while there is some scientific evidence supporting the anti-inflammatory potential of *Diospyros malabarica*, additional investigation is desirable to better understand its appliances of exploitation, efficacy and safety [23].

**2.8.3 Anthelminthic activity**

*Diospyros malabarica's* potential as an anthelminthic agent has drawn interest from the fields of pharmacology and conventional medicine. The observed properties can be accredited to the miscellaneous spectrum of bio-active composites found in various plant components [24]. Numerous studies have demonstrated these chemicals ability to effectively battle parasitic worms, including nematodes and trematodes. *Diospyros malabarica's* functional chemical makeup is partially responsible for its anthelminthic efficacy [25]. This plant contains tannins, which have been shown to significantly affect the anthelminthic qualities. It has been demonstrated that these compounds cause damage to parasites tegument, which ultimately leads to their expulsion from the host organism [26].

*Diospyros malabarica's* flavonoids have also demonstrated anthelminthic qualities through interfering with parasitic worms’ metabolism and movement. These substances hinder the parasite’s ability to reproduce and survive inside their host by interfering with their regular physiological functions [27]. Furthermore, *Diospyros malabarica* may be helpful in both the treatment and avoidance of helminthic illnesses due to its capacity to enhance the host’s immune system reaction. It's likely that the plant will help drive out parasitic worms and avoid recurrence by increasing immune system activity [19]. *Diospyros malabarica's* anthelmintic properties are particularly helpful in regions where parasitic worm-related illnesses are prevalent and pose a serious threat to the health of the general population. These infections can lead to several health issues in kids, such as impeded development of cognition, anemia and malnourishment [24]. Although *Diospyros malabarica* has a promising anthelminthic potential, more research is required to fully understand its mechanisms of action and evaluate its safety and effectiveness in different contexts. However, the plant's historical application and recent scientific findings highlight its significance as a possible natural treatment for helminthic diseases, providing an intriguing path for further study and public health initiative [28].

**2.8.4 Antidiabetic activity**

*Diospyros malabarica* has piqued the interest of both conventional medicine and contemporary pharmaceutical studies due to potential anti-diabetic properties. *Diospyros malabarica* has therefore received a lot of attention lately. *Diospyros malabarica* is believed to have anti-diabetic properties due to its rich phytochemical content [29]. This phytochemical component can be discovered throughout the plant and is made up of glycosides, alkaloids, flavonoids, phenolic compounds, along with additional secondary metabolites [30].

While there is some research on the potential antidiabetic activity of *Diospyros malabarica*, it's significant to communication that the scientific suggestion is imperfect and supplementary investigation is desired to create its efficacy and safety for diabetes management [31].

Some potential antidiabetic properties of *Diospyros malabarica* include [32].

**Hypoglycemic Effects:** Some studies have suggested that extracts from diverse fragments of *Diospyros malabarica* may have hypoglycemic (blood sugar- lowering) effects. These effects could be accredited to the company of bioactive compounds with antidiabetic properties [29].

**Antioxidant Activity:** *Diospyros malabarica* contains antioxidants, which can help reduce oxidative stress and inflammation associated with diabetes. Antioxidants may also protect pancreatic beta cells and improve insulin sensitivity [20].

**Insulin-Mimetic Properties:** Certain compounds in *Diospyros malabarica* may have insulin- mimetic properties, which means they can help cells take up glucose and regulate blood sugar levels in a manner like insulin [33].

**Alpha-Glucosidase Inhibition:** Some studies have reported that *Diospyros malabarica* extracts may inhibit alpha-glucosidase enzymes, which are responsible for breaking down carbohydrates into simple sugars. Embarrassment of these enzymes can slow down the absorption of glucose in the digestive tract and help control blood sugar levels [34].

*Diospyros malabarica* has been demonstrated to have antidiabetic properties in laboratory experiments and this may have consequences for those who have been given the diagnosis of diabetes [35]. It is generally known that the plant was once used in Ayurvedic medicine to treat hyperglycemia. Current scientific research, nevertheless, is clarifying the precise mechanisms through which it functions and its potential for therapeutic uses [36]. The increasing prevalence of diabetes globally has led scientists to investigate potential supplementary and alternative approaches to manage this illness [37]. In this regard, research into the bioactive compounds present in *Diospyros malabarica* has shown promise [38].

**2.8.5 Antimicrobial activity**

Diospyros genus has shown antiviral activity. Further research is needed to determine if this property applies to D. malabarica. The alkaloids found in *Diospyros malabarica* are another factor in the plant's antibacterial properties [39]. They have the capability to modify the permeability of microbial membranes, inhibit important enzymes and interfere with microbial DNA replication, all of which strengthen the plant's defenses against microbial infections [40]. Current scientific research is clarifying the precise mechanisms through which it functions and its potential for therapeutic uses [41].

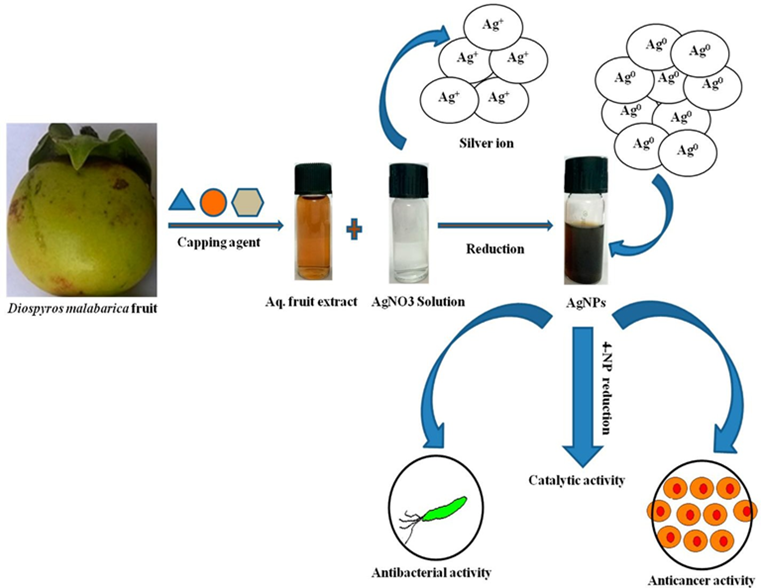
Research on the antimicrobial activity of *Diospyros malabarica* is limited but there have been some studies examining its potential. Here are some findings from the available literature [42].

**Antibacterial Activity:** *Diospyros malabarica* extracts have demonstrated antibacterial activity against a range of pathogenic bacteria [43]. In vitro studies have shown that different parts of the plant contain compounds with antibacterial properties. These compounds may be effective against common bacterial strains [44].

**Antifungal Activity:** Some studies have reported antifungal activity of *Diospyros malabarica* extracts against fungal pathogens. This suggests that it may have potential applications in treating fungal infections [45].

**Antiviral Activity:** While there is limited research on the antiviral properties of *Diospyros malabarica*, some compounds found in plants of the Diospyros genus have shown antiviral activity. Further research is needed to determine if this property applies to D. malabarica. The alkaloids found in *Diospyros malabarica* are another factor in the plant's antibacterial properties. They have the capability to modify the permeability of microbial membranes, inhibit important enzymes and interfere with microbial DNA replication, all of which strengthen the plant's defenses against microbial infections [40]. The increasing prevalence of diabetes globally has led scientists to investigate potential supplementary and alternative approaches to manage this illness [36]. In this regard, research into the bioactive compounds present in *Diospyros malabarica* has shown promise.

It has been demonstrated that *Diospyros malabarica* tree extracts exhibit antimicrobial action versus a broad range of pathogens, notably parasitic living things, fungus like Candida species and both Gram-positive and Gram-negative bacteria [36]. Investigation conducted by scientists has demonstrated this. These findings emphasize the significance of the plant's possible function as an origin of naturally generated antibacterial chemicals [46].



**Figure 3: Antimicrobial activity of *Diospyros malabarica***

In this **Figures 3,** we can illustrate the mechanism of action of *Diospyros malabarica* against microorganism.

**2.8.6 Antidiarrheal activity**

It has been used in traditional medicine for various purposes and there is some limited evidence to suggest that *Diospyros malabarica* may have antidiarrheal properties, although more research is needed to confirm its efficacy and safety [1].

The potential antidiarrheal activity of *Diospyros malabarica* is often attributed to its various phytochemical constituents. These compounds may possess anti-inflammatory, antimicrobial and astringent properties [47]. One of the main hypothesized causes of *Diospyros malabarica's* capacity for avoiding diarrhea is the tannin content of the plant. Tannins are known for their astringent properties, which may help to stop the gut from leaking too much fluid [27]. By forming compounds with proteins and mucus in the intestinal tract, tannins help to slow intestinal motility and facilitate the consolidation of stools. We call this procedure "complex creation." Alkaloids, which are also present in *Diospyros malabarica*, have been demonstrated to have antimotility and antisecretory properties on the gastrointestinal tract [48]. By interacting with gastrointestinal tract receptors and ion channels, these alkaloids may prevent diarrhea. The prolonged onset of diarrhea decreased gastrointestinal motility and suppression of prostaglandin synthesis seen in the present investigation lend credence to the conventional utilization of D. malabarica bark [49]. The extract's gallic acid content as well as other ingredients including tannins and polyphenols may be potentially responsible for the effects mentioned above [50].

**2.8.7 Analgesic and Antipyretic effect**

In traditional medicine, various parts of this plant have been used for their potential medicinal properties.

**Analgesic Effects:** Some parts of *Diospyros malabarica*, have been traditionally used to relieve pain. This is attributed to the presence of certain bioactive compounds, which may possess analgesic properties [47]. While there may be anecdotal evidence of pain relief associated with the use of *Diospyros malabarica*, scientific studies specifically investigating its analgesic effects are limited. More research is needed to confirm and better understand its potential analgesic properties [51].

**Antipyretic Effects:** *Diospyros malabarica* has been used to lower body temperature and reduce fever symptoms. The mechanism of action is not well-understood and there is limited scientific evidence to support the antipyretic effect. Traditional use of *Diospyros malabarica* should be approached with caution and it is essential to consult with a healthcare professional for appropriate treatment of fever [52].

It's important to note that traditional herbal remedies should be used with caution and their safety and efficacy should be confirmed through rigorous scientific studies [5].

**2.8.8 Antifungal effect**

Some of the compounds found in *Diospyros malabarica* have demonstrated antifungal activity, but it's important to note that research on this plant's antifungal effects is limited and more extensive studies are needed to fully understand and harness its potential benefits. The antifungal effect of *Diospyros malabarica* can be attributed to secondary metabolites and other bioactive compounds present in the plant. These compounds may exhibit inhibitory effects on the growth and development of various fungal species. Research has suggested that the leaves and bark of *Diospyros malabarica* may be effective against certain fungal pathogens [53].

The potential applications of *Diospyros malabarica* in antifungal treatments are still in the early stages of exploration and the specific mechanisms of action and the range of fungal species that it can effectively combat are not well-established. To use *Diospyros malabarica* or its extracts for antifungal purposes, further research is necessary to determine the optimal extraction methods, dosages and potential side effects. As with any natural remedy, it's important to exercise caution and consult with a healthcare professional before using *Diospyros malabarica* or any herbal treatment for fungal infections. In such cases, conventional medical treatments are often the most effective and reliable options [11].

**2.8.9 Anti-hypertensive effect**

Some studies have investigated the potential anti-hypertensive (blood pressure-lowering) effects of *Diospyros malabarica*, although it's important to note that research on this topic may be limited and the efficacy and safety of using *Diospyros malabarica* for hypertension have not been fully established [54].

The potential anti-hypertensive effects of *Diospyros malabarica* may be attributed to various bioactive compounds found in the plant, which have been associated with cardiovascular health benefits [55].

Some of the mechanisms through which these compounds might help lower blood pressure include:

**Vasodilation:** Certain compounds in *Diospyros malabarica* may help relax and dilate blood vessels, reducing resistance to blood flow and thus lowering blood pressure.

**Antioxidant Properties:** The plant's bioactive compounds can have antioxidant effects, which may help reduce oxidative stress and inflammation in the cardiovascular system, potentially contributing to lower blood pressure [28].

**ACE Inhibition:** Some studies have suggested that *Diospyros malabarica* may have angiotensin- converting enzyme (ACE) inhibitory properties. ACE inhibitors are a class of medications commonly used to treat hypertension by relaxing blood vessels [56].

**Diuretic Effects:** Certain plant components might have diuretic effects, which can help the body eliminate excess sodium and fluids, thus reducing blood pressure.

It's essential to highlight that while there may be some promising indications of *Diospyros malabarica's* potential anti-hypertensive effects, more research is needed to establish its efficacy and safety [54].

**2.9 Statistical Analysis**

The mean ± standard deviation of three independent experiments was used to account for the values. Descriptive statistics were used to analyze and arrange the resulting data. Two-route ANOVA with replications was employed in the data analysis [6]. XL-STAT programming was used to examine the significance of the data by using the Turkey (HSD) test at p < 0.05 and, when appropriate, p < 0.01 for fluctuation. Additionally, data was subjected to principal component analysis using Microsoft Excel PC programming in conjunction with XLSTAT Version 2019.1.02, Copyright Add in Software 1995-2019 (http://www.xlstat.com).

**3. Results**

**3.1 Extraction Yield Value**

The yield percentage shows the extract amount gained from the extraction method stated in gram (g) of extracts found from per 100 gram (g) of crude plant powder and shown in **Table 2**.

**Table 2. Extraction yield (% w/w) of *Diospyros malabarica* extracts prepared using different solvents**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Solvents** | **Extract** | **Powdered mass (g)** | **Extracted mass (g)** | **Yield value**  **(%)** |
| Petroleum ether | | 50 | 2.1 | 4.2 |
| Dicholoro methane | | 50 | 2.3 | 4.6 |
| Ethyl acetate Bark | | 50 | 2.6 | 5.2 |
| Ethanol | | 50 | 7.1 | 14.2 |
| Methanol | | 50 | 8.9 | 17.8 |
| Aqueous | | 50 | 2.3 | 4.6 |
| Petroleum ether | | 50 | 1.0 | 2.0 |
| Dicholoro methane | | 50 | 1.2 | 2.4 |
| Ethyl acetate Stem | | 50 | 1.3 | 2.6 |
| Ethanol | | 50 | 2.2 | 4.4 |
| Methanol | | 50 | 3.3 | 6.6 |
| Aqueous | | 50 | 1.4 | 2.8 |
| Petroleum ether | | 50 | 1.3 | 2.6 |

**Table 2. Extraction yield (% w/w) of *Diospyros malabarica* extracts prepared using different solvents (Contd.)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Solvents** | **Extract** | **Powdered mass (g)** | | **Extracted mass (g)** | | **Yield value**  **(%)** |
| Dicholoro methane | | | 50 | | 1.5 | | 3.0 |
| Ethyl acetate Leave | | | 50 | | 1.9 | | 3.8 |
| Ethanol | | | 50 | | 6.6 | | 13.2 |
| Methanol | | | 50 | 6.9 | | 13.8 | |
| Aqueous | | | 50 | 1.9 | | 3.8 | |
| Petroleum ether | | | 50 | 1.3 | | 2.6 | |
| Dicholoro methane | | | 50 | 1.5 | | 3.0 | |
| Ethyl acetate Unripe fruit | | | 50 | 1.7 | | 3.4 | |
| Ethanol | | | 50 | 4.3 | | 8.6 | |
| Methanol | | | 50 | 4.9 | | 9.8 | |
| Aqueous | | | 50 | 2.2 | | 4.4 | |
| Petroleum ether | | | 50 | 1.4 | | 2.8 | |
| Dicholoro methane | | | 50 | 1.6 | | 3.2 | |
| Ethyl acetate Ripe fruit | | | 50 | 1.8 | | 3.6 | |
| Ethanol | | | 50 | 3.8 | | 7.6 | |
| Methanol | | | 50 | 4.4 | | 8.8 | |
| Aqueous | | | 50 | 2.0 | | 4.0 | |

**Table 2. Extraction yield (% w/w) of *Diospyros malabarica* extracts prepared using different solvents (Contd.)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Solvents** | **Extract** | | **Powdered mass (g)** | **Extracted mass (g)** | **Yield value**  **(%)** |
| Petroleum ether | | 50 | | 0.5 | 1.0 |
| Dicholoro methane | | 50 | | 0.6 | 1.2 |
| Ethyl acetate Root | | 50 | | 0.9 | 1.9 |
| Ethanol | | 50 | | 3.4 | 6.8 |
| Methanol | | 50 | | 4.9 | 8.1 |
| Aqueous | | 50 | | 1.9 | 3.8 |

**3.2 Phytochemical Constituents**

It's important to note that traditional herbal remedies should be used with caution and their safety and efficacy should be confirmed through rigorous scientific studies that have been shown in **Table 3**.

**Table 3. Medicinal uses of some phytochemicals**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Phytochemical name** | | **Structure** | | **Medicinal Uses** | |
| Alkaloid | | Alkaloid A | C18H25NO5 | CID 5372257 - PubChem | | Anesthetics, cardioprotective and anti- inflammatory activity | |
| Flavonoid | | anthohumol, flavonoid, chemical structure (Pubchem, 2018e). | Download  Scientific Diagram | | Anticancer, antioxidant, anti-inflammatory and antiviral activity | |
| Tannin |  | | Anticancer, virucides, antioxidant, antimicrobial and anti-inflammatory, antidiarrheal and antidiabetic activity. | |

**Table 3. Medicinal uses of some phytochemicals (Contd.)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Phytochemical name** | **Structure** | | **Medicinal Uses** | |
| Saponin | | Saponin | C58H94O27 | CID 198016 - PubChem | | Antidiabetic, anticancer, thrombolytic, antitumor, analgesic activity | |
| Phenol | | Phenol | C6H5OH | CID 996 - PubChem | | Anticancer, antioxidant, antimicrobial, antiviral, anthelminthic and neuropharmacological activity | |
| Quercetin | | Quercetin | C15H10O7 | CID 5280343 - PubChem | | Cardiotonic, anti-tumor, anti-cancer, anti- inflammatory activity | |

**Table 3. Medicinal uses of some phytochemicals (Contd.)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Phytochemical name** | **Structure** | | **Medicinal Uses** | |
| Glycoside | | Pueraria glycoside | C21H20O10 | CID 5748205 - PubChem | | Analgesic, anti-inflammatory, cardiotonic, antibacterial, antifungal, antiviral and anticancer effects. | |

**3.3 Pharmacological Activities**

**3.3.1 Inhibition of Albumin Denaturation**

% inhibition of albumin denaturation was calculated as follows:

**％inhibition = × 100 …... (02)**

**Where, Abs control is the absorbance without sample and Abs sample is the absorbance of plant extract/standard.**

**A graph of the amount of vitamins

Description automatically generated**

**Figure 4: Graphical representation on Albumin denaturation inhibitory activity of different *Diospyros malabarica* extracts**

In this **Figure 4,** we can show the curved line on Albumin denaturation inhibitory activity of different *Diospyros malabarica* extracts in a graph.

**3.3.2 Inhibition of Protein Denaturation**

The % inhibition of protein denaturation was determined with the following formula:

**％inhibition = × 100 …… (03)**

**% inhibition = the results were organized by using Soft-Max Pro software (Molecular Device, USA).**

A diagram of a plant seedling

Description automatically generated

**Figure 5: Graphical representation on Protein denaturation inhibitory activity of different *Diospyros malabarica* extracts**

In this **Figure 5,** we can show the curved line on Protein denaturation inhibitory activity of different *Diospyros malabarica* extracts in a graph.

**3.3.3 Inhibition of α-amylase**

The α-amylase inhibition was calculated as % inhibition using the equation as follows:

**％inhibition = × 100 …… (04)**

**A graph of growth and growth of fruit

Description automatically generated with medium confidence**

**Figure 6: Graphical representation on α-Amylase inhibitory activity of different *Diospyros malabarica* extracts**

In this **Figure 6,** we can show the curved line on α-Amylase inhibitory activity of different *Diospyros malabarica* extracts in a graph.

**4. Discussion**

The study aims to achieve the following objectives:

* + **Compilation of Existing Knowledge:** To gather and synthesize the existing body of scientific literature, research and data related to *Diospyros malabarica*, consolidating information from various sources.
  + **Identification of Active Compounds:** To identify and document the phytochemical constituents of *Diospyros malabarica*, including alkaloids, flavonoids, terpenoids and other bioactive compounds, which may be accountable for its pharmacological properties.
  + **Exploration of Medicinal Properties:** To systematically analyze and present the range of pharmacological activities associated with *Diospyros malabarica*, which may include but are not limited to antimicrobial, anti-inflammatory, antioxidant, antidiabetic, analgesic and other therapeutic effects.
  + **Mechanistic Insights:** To delve into the mechanisms underlying the observed pharmacological activities, providing a deeper understanding of how *Diospyros malabarica* interacts with biological systems and its potential for use in drug development.
  + **Safety and Toxicological Considerations:** To evaluate the safety profile of *Diospyros malabarica*, including any reported adverse effects or toxicity concerns, in order to assess its suitability for use in traditional medicine and modern healthcare.
  + **Future Research Directions:** To suggest potential areas for future research, including clinical studies, isolation and characterization of active compounds and investigations into novel applications of *Diospyros malabarica* in the field of medicine.
  + **Highlighting Traditional Uses:** To acknowledge and discuss the traditional and indigenous uses of *Diospyros malabarica* in different cultures and folk medicine, recognizing its historical significance.
  + **Implications for Healthcare and Drug Development:** To discuss the potential implications of *Diospyros malabarica* in the development of novel drugs or complementary therapies, with a focus on its possible contributions to healthcare.

**5. Conclusion**

*Diospyros malabarica* has been a subject of interest for researchers due to its diverse array of bioactive compounds and their therapeutic applications. Throughout this paper, we have explored the various pharmacological activities associated with *Diospyros malabarica*, including its antioxidant, anti-inflammatory, antimicrobial, anticancer, antidiabetic, antidiarrheal and anthelminthic belongings. These happenings can be attributed to the presence of phytochemicals such as flavonoids, tannins, alkaloids and other secondary metabolites in different parts of the plant.

Furthermore, *Diospyros malabarica* has been utilized in traditional medicine systems for centuries and modern scientific research conducted in recent years provides substantial evidence to support its ethnos medicinal use. This reinforces the importance of bridging the gap between traditional knowledge and contemporary scientific investigations.

However, while the potential of *Diospyros malabarica* is promising, it is essential to acknowledge that further studies are required to fully understand the mechanisms of action, optimize extraction techniques and determine the safety profiles of its bioactive compounds. Additionally, efforts should be made to conserve this plant species, which is often under threat due to deforestation and habitat destruction. *Diospyros malabarica* holds great promise as a source of novel pharmacological agents and its exploration provides a valuable opportunity for the development of new drugs and natural products. By continuing research in this field, we can unlock the full potential of *Diospyros malabarica* for the benefit of human health and contribute to the preservation of biodiversity.

**Disclaimer (Artificial intelligence)**

**Option 1:**

**Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.**

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**Details of the AI usage are given below:**

**1.**

**2.**

**3.**

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