

# Pharmacological and Biochemical activities of plantago major L

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## Abstract:

Throughout human history, natural remedies have been sought to treat diseases. The therapeutic wounds of plants are accepted worldwide as a result of many studies and research. Medicinal plants have started to be used in the pharmaceutical sector due to the chemical compounds contained in their structures. One of the potential plants that can be used in traditional medicine is the broadleaf plantain, white man's footprint, waybread, or greater plantain. Scientifically known as *Plantago major*, it is a wild plant belonging to the Plantaginaceae family that can reach a height of about 15 cm.

*Plantago major* leaves have been used for centuries almost everywhere in the world as a wound healer and in the treatment of many diseases other than wound healing. Among them are treatments for skin, respiratory organs, digestive organs, reproduction, circulatory diseases, infections, and cancer. It is also used as a decongestant and analgesic. *Plantago major* contains biologically active compounds such as polysaccharides, lipids, caffeic acid derivatives, flavonoids, iridoid glycosides, and terpenoids. Alkaloids and some organic acids have also been detected. There are several biological activities from plant extracts, including wound healing activity, anti-inflammatory, analgesic, antioxidant, weak antibiotic, immune modulating, and antiulcerogenic activity.

The widespread use of *Plantago* species in food and traditional medicine has attracted the attention of researchers looking for active principles and mechanisms of action. However, more studies are needed to better prove the medical applications, phytochemical properties, and pharmacological properties of this breed.

**Key words:** aflatoxin; brown rice; basmati; elisa; quality management

## Introduction

The broadleaf plantain, white man's footprint or waybread, whose scientific name is *Plantago major* L, also known as the greater plantain, belongs to the Plantaginaceae family. It is a plant with a wide geographical distribution in temperate grasslands of the world [1]. It is a well-established, short-lived perennial plant from Europe, temperate Asia, and North Africa. It has been used for centuries for various medicinal purposes and more recently as a forage plant. It is widely naturalized in temperate regions and is a weed of grasses and disturbed

areas in South Australia and North America [2]. It can reach a height of about 15 cm, but its size varies greatly depending on its growing environment. The leaves grow in the form of rosettes and are parallel-veined, from oval to elliptic in shape. The leaves are glabrous and the edges are completely or irregularly toothed. The flowers are brownish green on small, unbranched long stems [3,4]. The general appearance of *Plantago major* L. is shown in Figure 1.



**Figure 1:** Plantago major (4)

Plantago is an important medicinal plant that contains different compounds, such as phenolic compounds (caffeic acid derivatives), flavonoids, alkaloids, terpenoids, vitamin C, antioxidants, and anti-inflammatory agents. The World Health Organization has approved the use of Plantago as a laxative to treat hypercholesterolemia and lower blood sugar. Plantago consumption may also have side effects such as bloating and allergic reactions. Plantago has interactions with carbamazepine, lithium, warfarin, iron supplements, minerals, and vitamin B12 supplements [1]. Plantago major (Plantaginaceae) is widely used to treat tumors, and infections and is often used in the treatment of anemia as a blood purifier [5].

The widespread use of Plantago species in food and traditional medicine has attracted the attention of researchers looking for active principles and mechanisms of action. However, there is no comprehensive review summarizing the medical applications, phytochemical properties, and pharmacological properties of this genus [6].

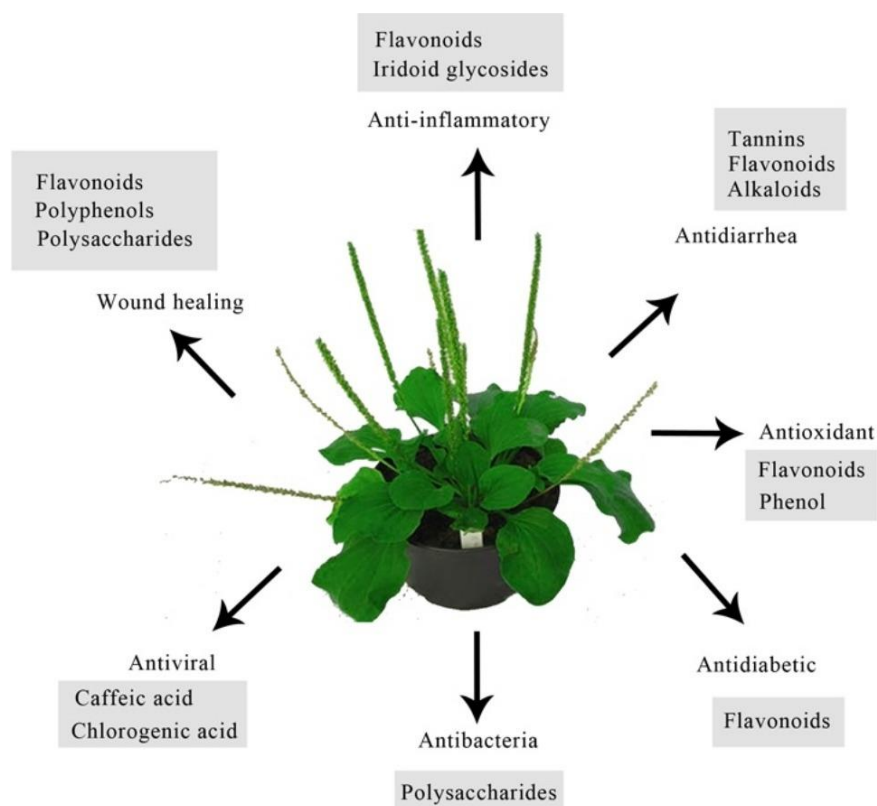
#### Specialities of the plantago major I. Plant

Plantago is the largest genus of the Plantaginaceae family, which consists of about 250 single-annual and perennial species that are widespread around the world. Plantago is a cosmopolitan breed that is concentrated in temperate and high-altitude tropical regions. The taxonomy of the Plantago is very difficult due to its reduced morphology, which includes a relatively small number of characters for species classification. Most Plantago species are small, with elliptical leaves and spikes containing tiny flowers. Although the plantago species is widely considered a weed, it has been used as a medicinal plant for centuries. Some Plantago species

are listed as safe plants in the pharmacopeias of many countries, while others are used as food and animal feed [6, 7]. Plantago major consists of a short stem, broad leaves, roots, flowers, fruits, and seeds. It has broad leaves, usually about 15-30 cm in diameter, oval in shape, 4-9 cm wide and 5-20 cm long, rarely 17 cm wide and 30 cm long. There are about five to nine prominent veins on the leaves. The flowers are greenish-brown in color with purple stamens and are small. The plant has small oval-shaped seeds that have a slightly unpleasant bitter taste [8].

Plantago seeds have 17.4% protein, 6.7% fat, 24.6% total dietary fiber, 19.6% insoluble fiber, 5.0% soluble fiber, and a burning temperature of 4.75 kcal/g. The oil obtained from plantago seeds has high levels of linoleic acid (40.6%), oleic acid (39.1%), and a small amount of linolenic acid (6.9%) (9).

Plantago major is an important therapeutic herb containing a variety of bioactive compounds, including flavonoids, alkaloids, terpenoids, phenolic compounds (caffeic acid derivatives), iridoid glycosides, fatty acids, polysaccharides, and vitamins. These compounds can be found in almost all parts of the plant, such as seeds, leaves, flowers, and roots. The bioactivities of Plantago major are based on these chemical components (Figure 2) [8]. It has been reported that the ethanol or methanol extract of the whole plant does not have antiviral activity [10]. Plantago major L, a popular traditional Chinese medicine, has long been used in the treatment of various diseases, from the common cold to viral hepatitis. This plant has been shown to contain five classes of biologically active compounds: benzoic compound (vanillic acid), flavonoids (baicalein, baicalin, luteolin), iridoid glycoside (aucubin), phenolic compounds (caffeic acid, chlorogenic acid, ferulic acid, p- coumaric acid) and triterpenes (oleanolic acid, ursolic acid) [3, 11].



**Figure 2.** Chemical components and medicinal benefits of *Plantago major* [8].

### Uses of the Plantago Plant in Traditional Medicine

*Plantago major* leaves have been used for centuries almost everywhere in the world as a wound healer and in the treatment of many diseases. These include treatments for skin, respiratory organs, digestive organs, reproduction, circulatory-related diseases, infections, and cancer. It is also used as a decongestant and analgesic. It has been suggested that polyphenols are responsible for many of the medicinal properties attributed to *Plantago major*. *Plantago major* contains biologically active compounds such as polysaccharides, lipids, caffeic acid derivatives, flavonoids, iridoid glycosides, and terpenoids. Alkaloids and some organic acids have also been detected. Several biological activities, including wound healing activity, anti-inflammatory, analgesic, antioxidant, weak antibiotic, immune modulating, and antiulcerogenic activity, have been found in plant extracts [3, 12]. *Plantago major* is widely used in Taiwan as a folk remedy for the treatment of infectious diseases related to the respiratory, urinary, and digestive tracts [13]. In the screening of anticancer activity of Chilean plants, it was found that 50% ethanol extract of leaves, stems and seeds of *Plantago major* did not show *in vivo* activity against lymphocytic leukemia in mice [14]. It was reported in the study that the preparation major is effective in a screening system for prophylactic oncology. The effect includes antimetastatic activity in models of tumor metastasis in mice. The details of this study are not explained [15]. In another study, an aqueous extract was shown to have a prophylactic effect on breast cancer in mice [16].

*Plantago major* leaves have been associated with various biological properties ranging from anti-inflammatory, antimicrobial, and antitumor to wound healing. The mechanism of action of *Plantago major* leaves associated with increasing immune function is still not clarified. Endotoxin-free methanol extracts obtained from *Plantago major* leaves at

doses of 50, 100, 250, and 500  $\mu\text{g/mL}$  were found to be associated with an increase in nitric oxide (NO) production and an increase in TNF- $\alpha$  production by rat peritoneal macrophages in the absence of IFN- $\gamma$  (Interferon-gamma) or lipase (LPS). NO and TNF- $\alpha$  production by untreated macrophages were found to be at negligible levels. The regulation of immune parameters induced by plant extracts may be clinically important in a large number of diseases, including chronic viral infections, tuberculosis, AIDS, and cancer [17].

A study was conducted by adding aqueous, methanol, chloroform, and hexane extracts of the above-ground parts of *Plantago major* to CD1 mouse bone marrow and spleen cultures incubated at 37°C for 72 hours, as well as *Escherichia coli*, *Bacillus subtilis*, and *Candida albicans* cultures, methanol extract dilutions to HTC-15, OVCAR, UISO and KB cell line cultures. Doses of 0.4 and 0.2 mg/mL of aqueous and methanol extracts increased bone marrow cell concentration by 2.70 and 3.15 times, respectively, and spleen cell concentration by 3.38 and 6.39 times, respectively. Aqueous extract inhibited *Bacillus subtilis* growth from 78% to 21%; hexane extract inhibited *Escherichia coli* growth, and methanol and chloroform extracts weakly inhibited *Bacillus subtilis* and *Escherichia coli* growth, respectively. Methanol extract (1  $\mu\text{g/mL}$ ) reduced UISO and OVCAR cell concentrations to 59% and 82%, respectively. Data show for the first time that *Plantago major* has hematopoietic activity *in vitro* [5].

Aqueous extract of dried *Plantago major* leaves given orally (72°C, 30 minutes) has shown anti-inflammatory and analgesic activities associated with inhibition of prostaglandin synthesis in mice and rats. Anti-inflammatory activity in rats has been demonstrated by the inhibition of paw edema induced by carrageenan. The extract did not affect the edema produced by dextran, which suggests that the mechanism involves

inhibition of cyclooxygenase synthesis rather than an antihistamine activity. The extract also inhibited the exudate formation and leukocyte mobilization induced by intrapleural carrageenan injection, the latter of which is a known activity of non-steroidal anti-inflammatory compounds. The activity against chronic inflammation was measured as the inhibition of exudate in the air sac after oral treatment with the extract [3].

In a recent study conducted to investigate the use of broad-leaved banana (*Plantago major*) leaves as a treatment for gouty arthritis in the community of Tirtasari, Margasari village, Buahbatu district, interviews were conducted with a sample of 15 people selected using sequential sampling techniques and documentation and literature study approaches. It has been revealed that the Tirtasari community uses this broad-leaved banana plant in two ways for alternative treatment of gouty arthritis (9 examples by direct rubbing method, and 6 examples by rubbing crushed spoon leaves on the aching body). These two forms of use have the same treatment effect but differ in terms of texture and absorbency. This broadleaf banana has been found to have many compounds that are beneficial for body health, such as anti-inflammatory, diuretic, and antioxidant compounds [18].

*P. major* has been included in the screening studies of plants used in folk medicine in the fight against bacterial and fungal infections of the skin or in the treatment of gastrointestinal disorders. *P. major*, there seem to be some moderately polar or non-polar substances with relatively low molecular weight that have antibiotic activity against some gram-negative and gram-positive bacteria in addition to weak antimycotic activity [3].

*Plantago major* L. is a medicinal plant used to reduce pain and inflammation. In a study conducted to confirm the pharmacological effects, an aqueous extract was prepared from dried ground leaves. Pretreatment with aqueous extract (1 g/kg, po) reduced the squirming caused by acetic acid in mice, but it was observed that it did not change tail kick responses to heat nociceptive stimuli. In rats, the aqueous extract (1 g/kg, po) reduced karagenin-induced paw edema and pleurisy but did not change dextran-induced paw edema. The effect of the aqueous extract on the inflammatory responses of karagen was observed to be more intense than that obtained on ear edema caused by croton oil in mice. In October, daily Aqueous extract treatment (1 g/kg/day for 8 days, po) inhibited the exudative process caused by croton oil injected into the air sacs of rats. The results show that the aqueous extract of *Plantago major* has effective anti-inflammatory and analgesic activities [19].

The role of *Plantago* species in traditional medicine has inspired many pharmacological evaluations of extracts and isolated compounds in terms of their potential antioxidant, anti-inflammatory, and wound healing activities, among other properties. Polysaccharides obtained from *Plantago* seeds have received great attention in recent years because they have various pharmacological properties related to their unique structural properties. Polysaccharides increase the consistency and stability of natural systems by forming a strong gel, which makes them useful both in pharmaceutical formulations and in foods. For example, *Plantago* seed husk (psyllium) has been recommended as a disintegrant in the formulation [6].

Further research is required to elucidate the active ingredient/components of *Plantago major* and evaluate their clinical application.

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