

## Phytochemistry and Pharmacological Activities of *Vernonia amygdalina*

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### ABSTRACT

*Vernonia amygdalina* is a small tree that can grow to a height of ten metres. It is sometimes referred to as bitter leaf due to the fact that its leaves have a bitter bitter flavour and its branches are frail. Although its natural habitat is in tropical Africa, it may be found all over the world in regions that receive an average rainfall of 750–2000 millimetres. These regions include areas that are adjacent to rivers and lakes, as well as forests and grasslands that are located up to an elevation of 2800 metres. The plant is mostly employed as a medicinal herb in the context of traditional medical practices. The plant contains a variety of phytoconstituents, the most important of which are phenol, oxalate, phytates, tannins, flavonoids, cyanogenic glycosides, alkaloids, terpenes, anthraquinone, steroids, coumarins, lignans, xanthenes, edotides, sesquiterpenes, and phenol. There are a number of advantages associated with this plant, including its capacity to alleviate fever and pain, as well as its antidiabetic, anti-inflammatory, antioxidant, chemoprotective, and cytotoxic activities.

**Keywords-** *Vernonia amygdalina*, Phytochemistry, Pharmacological activities, Bitter leaf.

### I. INTRODUCTION

*Vernonia amygdalina* is a small shrub that is native to tropical Africa. It is a member of the Asteraceae family and has petiolate leaves that are elliptic in shape and are roughly 6 millimetres in diameter[1]. It has been said by some authors that the height of the tree is between one and three metres; nevertheless, there are species that are taller than six metres that may be found in the vicinity of the Department of Wildlife and Fisheries at the University of Ibadan in Nigeria for example[2]. The moniker "bitter leaf" originates from the bitter taste that it provides to the taste buds. However, the bitterness can be eliminated by either boiling the leaves or soaking them in water that has been changed numerous times[3-5]. Among the many names that can be found in Nigerian languages are "Ewuro" (Yoruba), "Onugbu" (Igbo), "Oriwo" (Bini),

"Ityuna" (Tiv), "Chusar doki or fatefate" (Hausa), and "Etidot" (Cord River State, Nigeria). Its common name, "bitter leaf," comes from the fact that *Vernonia amygdalina* (VA) has a flavour that is described as being bitter[6]. The mature height of this little shrub, which is native to tropical Africa and some areas of Asia, can range anywhere from three to seven metres[7]. The hue of the apex of the leaves ranges from a medium to a dark green, and the width of the leaves decreases as they move below. My average measurements are 10-15 centimetres in length and 4-5 centimetres in width. Its shape can range from lanceolate to oblong, and its edge is entirely serrated the entire way around[8]. A number of traditional use of VA leaves include enhancing the flavour of stews and soups, as well as boosting hunger. It is customary in West Africa to rinse it with clean water before using it in the preparation of cuisine. This is done in order to decrease

the bitterness of the ingredient[9-10]. Tannins, glycosides, alkaloids, and saponins are some of the anti-nutritional components that are responsible for the bitter taste. It is possible to consume the green, leafy vegetable either raw or cooked; macerated leaves are frequently included in soups[11]. There are a number of different disorders that can be treated with tonics that are made from aqueous extracts of the leaves[12]. It has been demonstrated that chimpanzees in the wild will consume the leaves themselves when they are infested with parasites[13]. Herbalists and traditional healers in Africa frequently recommend the aqueous extracts of this plant for the treatment of a broad variety of medical diseases. These conditions include, but are not limited to, diabetes, nausea, dysentery, diabetes mellitus, emesis, loss of appetite, and other gastrointestinal difficulties[14].

**Table 1: Taxonomic classification of *Vernonia amygdalina***

Kingdom	Plantae
Phylum	Spermatophyta
Subphylum	Angiospermae
Class	Dicotyledoneae
Order	Asterales
Family	Asteraceae
Genus	Vernonia
Species	Vernonia amygdalina

## II. TRADITIONAL USES OF *VERNONIA AMYGDALINA*

As a green vegetable or as an aromatic component in a variety of soups, the leaves of this plant are employed in Nigeria. The bitter-leaf soup is the most popular of these soups by far. Taking freshly plucked leaves and macerating them in either cold or hot water until the bitterness is reduced to an appropriate degree is the first step in the preparation of this dish[15]. The latter are frequently used with other soup flavours, and the water extract has therapeutic applications, including as a tonic and in the prevention of sickness[16]. There is a digestive tonic created from the water extract, as well as an appetiser made from the leaves, both of which can be consumed. It is believed that the female Hausas consume large quantities of these because they believe that they make them appear more sexually appealing[17].

It is a tonic that is known as "Chusar Doki" in Hausa, and it has been a mainstay in horse feed in northern Nigeria for a very long time. It is a strengthening or fattening tonic. Since ancient times, the leaves have been utilised as hops in the Ethiopian beer recipe known as tela. It is standard practice in Nigeria and other African countries to use the leaves as an alternative to quinine for the treatment of temperatures.

Traditional medicine practitioners have relied on the young leaves for a variety of purposes for a long time[18]. These goals include relieving worms, improving fertility in women who are unable to conceive, and treating parasites such as worms and malaria. It has been proven that certain wild chimpanzees in Tanzania use this herb to treat ailments that are caused by parasites. There have been a number of herbalists and naturopathic physicians who have recommended the aqueous extracts for the treatment of gastrointestinal tract conditions such as emesis, nausea, diabetes, dysentery, lack of appetite-induced abrosia, and other conditions[19].

## III. PHYTOCHEMISTRY

In accordance with the findings of the phytochemical examinations, VA was discovered to include phenol, oxalate, phytates, tannins, saponins, flavonoids, cyanogenic glycosides, alkaloids, terpenes, anthraquinone, steroids, coumarins, lignans, xanthonenes, edotides, and sesquiterpenes[20]. One of the saponins that can be detected in VA leaves, stigmastane, may be responsible for the bitter taste that is present in the leaves. The following chemicals have been isolated from *Vernonia amygdalina*: Tricosane, Isorhamnetin, Luteolin, Vernodalol, Vernodalinol, Vernomyoside A, Vernomyoside B, Vernomyoside C, Vernomyoside D, Vernolide, Epivernodalol, Squalene, Phytol, Hexadecanoic acid ethyl ester, and Glucuronolactone[20].

Numerous studies have demonstrated that VA includes these phytochemicals, and they have also demonstrated that it contains other phytochemicals, including xanthonenes, anthraquinones, phenolic acids, lignans, and terpenes. Not only do the leaves of the VA plant contain phytochemicals, but they also contain peptides. Additionally, it is feasible that these phytoconstituents will collaborate in order to tackle diseases that could potentially be lethal. Researchers have determined the precise quantity of these phytochemicals that are present in a number of different extracts[21]. In addition to providing a quantifiable measurement of the extract that is required to obtain improved treatment outcomes, these investigations offer scientific evidence in favour of the long-standing use of this plant[22]. The medicinal properties of this herb have been highly regarded for a very long time. In accordance with the findings of the investigations, crude protein can be found in *Vernonia amygdalina* [23].

#### IV. PHARMACOLOGICAL ACTIVITIES

##### Antioxidant activity

In order to investigate the antioxidant and cytoprotective capabilities of nine edible vegetables that were cooked, cold, and methanolic extracts, researchers Iwalewa et al[24]. employed the 1,1-diphenyl-2-picrylhydrazyl free radical test and the hemagglutination assay in bovine erythrocytes, respectively[25]. These tests were conducted in Southwest Nigeria. Even though it was also present in *Solanum americanum* and *Vernonia amygdalina*, the highest level of antioxidant activity was found in *Crassocephalum rubens*, which accounted for 56.5% of the total[26]. After this, Iwalokun and colleagues demonstrated that an aqueous extract of the leaves of *Vernonia amygdalina* protected mice from the oxidative stress and hepatotoxicity that were brought on by acetaminophen[27]. It was found that all of the liver function measurements were reversed in a dose-dependent manner when *Vernonia amygdalina* was administered prior to the administration of paracetamol[28]. A further benefit was that the oxidative stress and lipid peroxidation that were brought on by paracetamol were diminished. According to the findings of the study, *Vernonia amygdalina* offered mice antioxidant protection against the hepatic damage that was brought on by acetaminophen. Current research conducted by Adesanoye and Farombi lends credence to the antioxidant mechanism that *Vernonia amygdalina* possesses. *Vernonia amygdalina*, which has previously been shown to stimulate antioxidant and phase 2 enzymes, was found to protect the liver from damage caused by carbon tetrachloride in this particular study[29].

It has been suggested by Igile et al. that flavonoids are the agents responsible for the antioxidant properties of *Vernonia amygdalina*. Through the utilisation of spectroscopic techniques, the flavonoids that were discovered in *Vernonia amygdalina* had been identified and defined in previously conducted study[30]. Through the utilisation of chemical and spectroscopic techniques, the flavones that were discovered were luteolin, luteolin 7-O- $\beta$ -glucuronoside, and luteolin 7-O- $\beta$ -glucoside. After conducting tests to determine the antioxidant capacity of the three flavones, the researchers discovered that luteolin was the most effective of the three. for the reason that flavonoids have been known to possess antioxidant capabilities for a very long time. It is conceivable that these flavonoids are the ones responsible for the antioxidant properties that *Vernonia amygdalina* possesses. The fact that flavonoids are able to pass through the blood-brain barrier contributes to the fact that neurotoxic studies have demonstrated that this antioxidant activity is beneficial. According to Owoye et al., a methanolic extract of *Vernonia amygdalina* leaves proved to be effective in

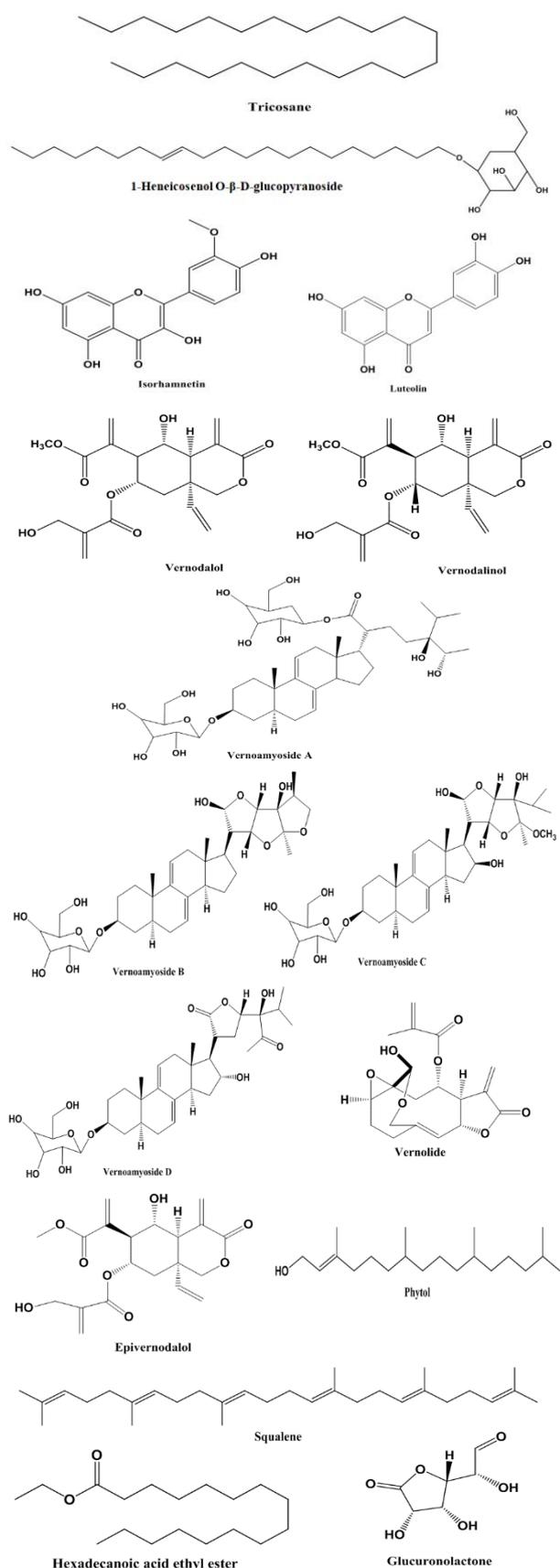


Fig 1: Chemical structures of isolated compounds from *Vernonia amygdalina*

protecting the cerebellum of Wistar rats against the harmful effects of gamma radiation[31].

#### **Anti inflammatory activity**

The anti-inflammatory effects of VA extract were compared to those of acetylsalicylic acid, which was an anti-inflammatory agent. The irritation was brought on by a mixture consisting of four parts pyridine, one part distilled water, five parts di ethyl ether, and ten parts croton in diethyl ether (volume to volume). Following the application of the vehicle to the right ear, all of the animals were given a mild anaesthetic, and their ears were cut before being weighed on a delicate scale. This took place six hours after the vehicle had been applied. The level of inflammation that was produced by each group was evaluated and compared. A significant reduction in inflammation was observed when the VA extract was compared to the inflammatory response that was brought about by croton oil on its own[32].

#### **Anti microbial activity**

The development of bacteria such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* was shown to be prevented by the Virginia extract, according to the findings of the researchers[33]. The hot VA extract was demonstrated to be the most effective against *P. aeruginosa*, with a zone of inhibition measuring 13.00 mm when administered at a dosage of 200 mg/ml. *S. aureus* also exhibited a suppression zone measuring six millimetres when administered at the same dose. The only organism that can be effectively attacked by cold extract is *P. aeruginosa*, which has a zone of inhibition that measures 10.50 millimetres. When the heated ethanolic extract was administered in doses of 50 and 125 mg/mg, bactericidal effects were observed respectively. The efficiency of the ethanolic VA extract against *S. mutans* was shown to be greater than that of the extract that was based on water. The zone of inhibition for *S. aureus* was 2.00 mm at 25 mg/ml, 3.00 mm at 50 mg/ml, 6.00 mm at 100 mg/ml, and 10.00 mm at 200 mg/ml, respectively. On the other hand, the ethanolic extract of VA demonstrated a low level of sensitivity to the bacteria[34].

#### **Anticancer activity**

*Vernonia amygdalina*, sometimes known as VA, is a traditional African herbal treatment that has been shown to have anti-cancer benefits[35]. The objective of this study is to ascertain whether or not the leaf extract and silver nanoparticles of *Vernonia amygdalina* possess any anti-cancer properties when applied to the MCF-7 human breast cancer cell line. To extract the amygdalina from the leaves of *Vernonia*, a technique known as ultrasound-assisted sequential extraction was utilized[36]. This technique involved the utilisation of three different solvents: ethanol, 50% ethanol, and deionized water. In order to produce silver nanoparticles, an aqueous extract of *Vernonia amygdalina* was utilised. After 72 hours of treatment, the

proliferation of MCF-7 cells was inhibited by ethanol extract and nanoparticles of *Vernonia amygdalina* silver[37]. The average half-maximal inhibition (IC50) value for these two substances was 67µg/mL and 6.11µg/mL, respectively. Ethanol extract and *Vernonia amygdalina* silver nanoparticles are responsible for the G1 phase cell cycle arrest that leads to the induction of apoptosis and nuclear fragmentation in MCF 7sel cells[38]. This was accomplished by inducing apoptosis and DNA damage in MCF-7 cells by the use of *Vernonia amygdalina* ethanol extract and *Vernonia* silver nanoparticles amygdalina. The survival of MCF-7 cells was decreased in a manner that was dependent on both the dose and the amount of time. Additional research is necessary in order to have an understanding of the mechanism of action of *Vernonia amygdalina* silver nanoparticles and leaf extract. According to the findings of this groundbreaking research, *Vernonia amygdalina* silver nanoparticles were able to significantly limit the proliferation of cancer cells in MCF-7 cells. In addition to its many other use in medicine, there is some evidence to suggest that the African leaf, which is scientifically referred to as *Vernonia amygdalina*, may possess anti-cancer qualities. Using T47D cells that were resistant to cancer, the purpose of this study was to discover whether or not African leaf extract had any anti-cancer properties. In vitro determination of cytotoxic activity has been accomplished by researchers through the utilisation of 3-(4,5- dimethylthiazole-2-il)-2,5-diphenyl tetrazolium bromide[39]. For the purpose of analysing the cell cycle and determining apoptosis, flow cytometry was utilised. During the cytotoxicity evaluation of n-hexane leaf extract Africa (ENDA), African leaf ethyl acetate extract (EEADA), and African leaf ethanol extract (EEDA) against T47D cells, the effective concentration (IC50) values were determined to be 164.85±1.88 g/mL for ENDA, 55.50±0.79 g/mL for EEADA, and 311.72±4.15 g/mL for EEDA. That being the case, EEADA is the anti-cancer agent that possesses the highest level of activity. Molecular evolution is a technique that is utilised in order to develop T47D cells that are resistant. An IC50 value of 59.19±0.55 g/mL was observed in the EEADA toxicity test being conducted against T47D cells, which demonstrated the presence of resistance[40]. In addition to these potential effects, EEADA may also cause an increase in the rate of apoptosis in resistant T47D cells and an inhibition of the G0-G1 phase of the cell cycle. The findings of this study indicate that EEDA has the potential to be developed as a chemotherapeutic for breast cancer. This is demonstrated by the fact that it increases apoptosis and slows the cell cycle[41].

#### **Analgesic and antipyretic activity**

In order to bring down a fever, practitioners of traditional medicine in this region propose consuming water that has been heated and infused with African plants. The fundamental objective of this study venture is to determine whether or not the administration of

African leaves to Wistar rats results in an antipyretic effect. 1% Na CMC was administered to group I as a negative control, 180 g/2.5 mL of paracetamol was administered to group II as a positive control, and 10% African leaf infusion was administered to group III as their treatment[42]. A therapy of this kind was administered to each group of five mice. The administration of peptone 20% intraperitoneally to Wistar rats will result in the development of a fever if the temperature rises by 1.5 degrees Celsius from the origin. Based on the findings of the inquiry, it was determined that the therapy had an effect on Wistar rats ( $p < 0.05$ ), which led to the conclusion that the 10% infusion of African leaves has an effect capable of reducing fever. *Vernonia amygdalina* Del has been used for the treatment of pain, inflammation, and fever diseases by the local communities that are located in the east Nigerian sea during the course of history. In light of this, the objective of this study is to evaluate the phytochemical, antipyretic, and analgesic properties of *Vernonia amygdalina*[43]. Through the process of soxhletting the leaves of *Vernonia amygdalina* with ethanol, it was possible to divide the plant material in a sequential manner utilising solvents with increasing degrees of polarizer. According to the findings of the research, the substance contains a variety of compounds, including tannins, phlobatannins, saponins, carbohydrates, cardioactive glycosides, flavonoids, alkaloids, steroids, and terpenes. It has been demonstrated through these investigations that *Vernonia amygdalina* have the ability to act as both an analgesic and an antipyretic. It would appear that phytochemicals including steroids, alkaloids, tannins, and flavonoids are involved in the pharmacological effect. The composition of herbal remedies can be altered, they can become polluted, or they can become damaged. Herbal medicines are made from plant-based ingredients. In this inquiry, the pharmacognosy and pharmacological properties of *Vernonia amygdalina* leaves are the primary focus of attention. The methodology takes into consideration the standards for examination at both the macroscopic and microscopic levels. Based on the findings, it was discovered that antimicrobial stomata and calcium oxalate were present. Researchers have discovered that *Vernonia amygdalina* possesses potent antipyretic properties, and they also provide evidence for the utilisation of traditional leaf extract as a viable treatment for malaria fever[44].

## V. CONCLUSION

The analysis demonstrates that *V. amygdalina* is composed of a great deal of bioactive compounds that have pharmacological effects. It has been demonstrated via extensive research into its therapeutic potential that it is highly beneficial and does not present any risks to one's health. It is possible that tropical illnesses can be managed with the assistance of *V. amygdalina*, which is

a herb used in ethnomedicine. However, genetic testing may be required for this plant because it possesses a great number of other pharmacological characteristics. A significant amount of research has been conducted on the leaves of *V. amygdalina*, including their phytochemical, pharmacological, toxicological, and action mechanism properties. On the other hand, the stems and roots of the plant have received a significantly smaller amount of attention. It is therefore necessary to do additional study in order to identify and validate the potential of the roots and stems of the *V. amygdalina* plant.

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