



Phytochemical and Pharmacological Activities of African Leaf (*Vernonia Amygdalina*): A Review

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ABSTRACT

African leaf (*Vernonia amygdalina*) belongs to the Asteraceae family. *Vernonia amygdalina* is one of the plants that can be widely consumed and used in traditional medicine in Asia and Africa. This plant has been widely studied for its health benefits, so obtaining information about its phytochemical content and pharmacological activity is necessary. This article summarizes research data from 2012-2022 that reports on the review of phytochemicals and pharmacological activities of *Vernonia amygdalina*. This review collected data from Google Scholar, Research Gate, and NCBI. The results showed that the *Vernonia amygdalina* plant contains phytochemical compounds flavonoids, alkaloids, saponins, triterpenoids, steroids, cardiac glycosides, tannins, anthraquinones, and oxytocin. Various bioactive compounds in this plant are used as antifertility, antioxidant, anti-diabetic, anti-cancer, antipyretic, anti-inflammatory, anti-microbial, analgesic, and hypercholesterolemia. African leaves (*Vernonia amygdalina*) show various pharmacological activities related to the content of bioactive compounds as traditional medicine.

Keywords: *Vernonia amygdalina*, Phytochemical, PharmacologicalActivities

INTRODUCTION

African leaf, with the scientific name *Vernonia amygdalina*, is one of the plants extensively researched recently. This species is the most widely cultivated from the genus *Vernonia*. *Vernonia amygdalina* is a species from Africa and is quite commonly used in various traditional medicine in Indonesia and Africa. *Vernonia amygdalina* usually does not produce seeds, so stem cuttings do its cultivation. This plant generally lives in the wild and is found along drainage systems, commercial plantations, and forests in most areas of the tropics. This plant is known as a bitter leaf because of its very bitter taste the leaves. This plant is widely cultivated in African countries such as Nigeria, Cameroon, Ethiopia, and Zimbabwe. All parts of the plant have been found naturally pharmacologically helpful [1] [2] [3].



Figure 1. African Leaf (*Vernonia amygdalina*)

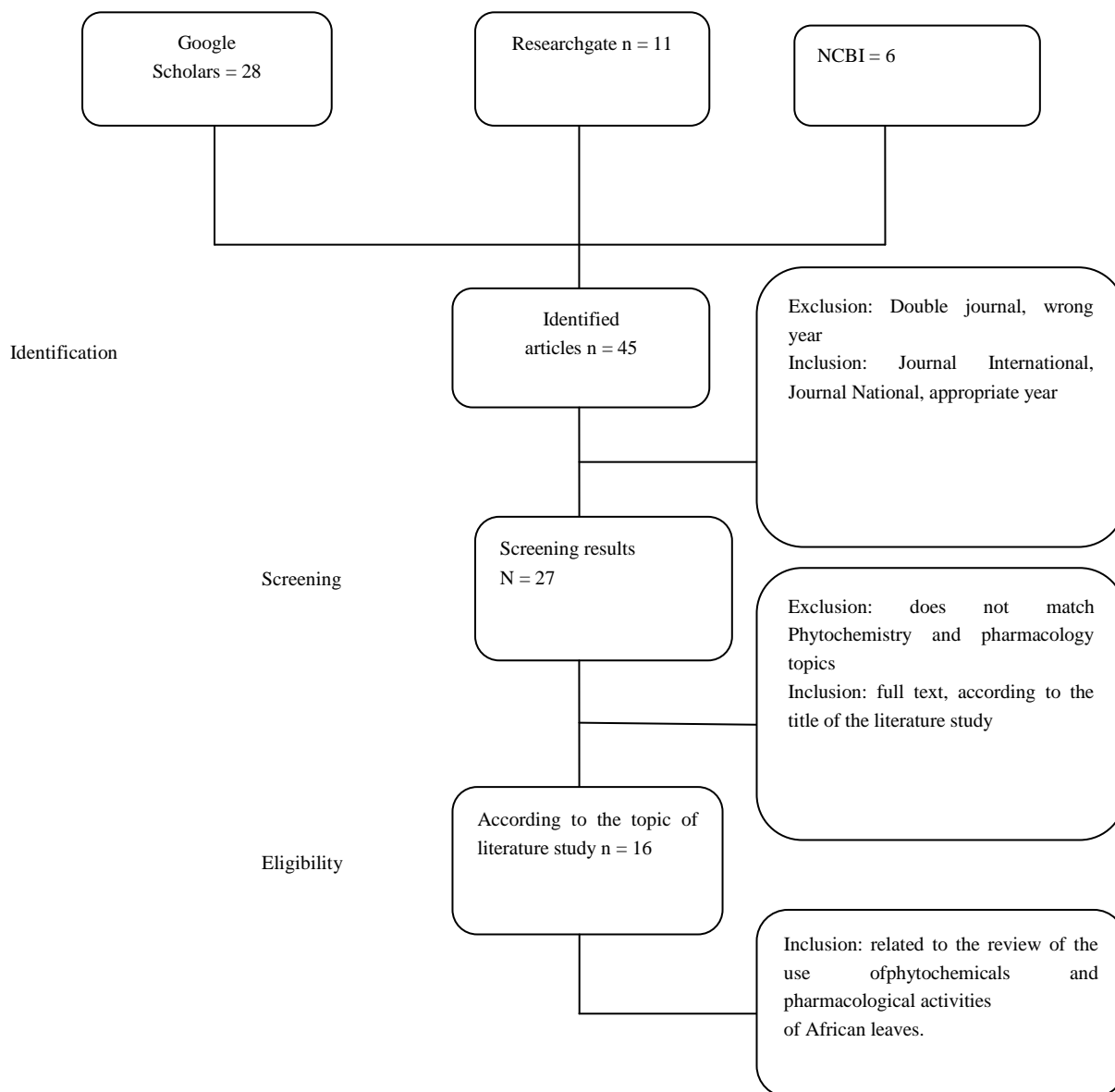
Phytochemical compounds in *Vernonia amygdalina* are flavonoids, alkaloids, saponins, triterpenoids, steroids, cardiac glycosides, tannins, anthraquinones, and oxytocin. Several researchers found various classes of bioactive compounds contained in This plant cause *Vernonia amygdalina* to have multiple activities pharmacological agents can treat various diseases such as anti-diabetic, antioxidant, antipyretic, analgesic, toxicity, antifertility, anti-cancer, anti-inflammatory, and hypercholesterolemia.

METHOD

This review is based on searching data on scientific literature databases, namely Google scholar, research gate, and NCBI. This literature review was conducted to find evidence in the literature on the phytochemical and pharmacological activity of *Vernonia amygdalina* leaves. This journal review

used online media with "Keywords: *Vernonia amygdalina*, Phytochemical and Pharmacological Activities." The entry criteria include articles original and research articles published in the range of 2012-2022 that can be accessed online and articles written in English and Indonesian.

The flow diagram of the literature search was carried out on four databases:



RESULTS AND DISCUSSION

Results

TABLE I. PHYTOCHEMICAL CONTENT AND PHARMACOLOGICAL ACTIVITIES OF AFRICAN LEAF (*Vernonia amygdalina*)

No	Plant	Method	Phytochemical Content Pharmacological	Activities	Reference
1.	Leaf	Maceration with 80% ethanol. African leaf has an antifertility effect from LSD Testing.	Flavonoids, saponins, tannins, and alkaloids.	African leaves (<i>Vernonia amygdalina</i>) and <i>papaya leaves</i> (<i>Carica papaya</i>) contain secondary metabolites, and plants are thought to have antifertility effects.	[1]
2.	Leaf	Decoct with ethanol. Its pharmacological effects as an antioxidant and anti-diabetic with DPPH testing.	Polyphenols, Flavonoids, and Tannins.	The aqueous extract of <i>Vernonia amygdalina</i> leaf has antioxidant and anti-diabetic powers.	[2]

No	Plant	Method	Phytochemical Content Pharmacological	Activities	Reference
3.	Leaf	An aqueous suspension of <i>Vernonia amygdalina</i> extract was made fresh for each treatment using distilled water (0.8% w/v) and administered via the oral route, which has a toxicity effect with DPPH testing.	Flavonoids, Alkaloids, Saponins, Triterpenoids, Steroids, Cardiac Glycosides.	<i>Vernonia amygdalina</i> can be a potent chemoprotective agent against sodium arsenite toxicity in rats.	[3]
4.	Leaf	Extraction with absolute methanol at 30°C for 60 minutes using a rotary evaporator has a toxicity effect.	flavonoids	Flavonoids from <i>Clerodendrumvolubile</i> and <i>Vernonia amygdalina</i> maybe a viable weapon against arsenic-induced hepatorenal oxidative stress in mice	[4]
5.	Leaves and bark	Maceration with methanol solvent for 3x24 hours. African leaf has a toxicity effect on BSLT testing.	In leaves: flavonoids, triterpenoids, and steroids In stems: alkaloids, flavonoids, phenolics, triterpenoids, and steroids	Crude extract of African plants' leaves, stems, and bark was 399.85 ppm, 118.25 ppm, and 80.82 ppm, respectively. These three types of extracts are toxic (LC50 < 1000 ppm).	[5]
6.	Leaf	Extraction by sequential extraction with ethanol solvent, 50% ethanol, and deionized water. African leaf has a pharmacological effect as an anti-cancer By MTT testing.	polyphenols	This study is the first to report the anti-cancer activity of <i>Vernonia amygdalina</i> silver nanoparticles in MCF-7 cells.	[6]
7.	Leaf	Maceration with acetone solvent, antioxidant activities by ABTS, DPPH, and FRAP test	alkaloids, tannins, saponins, anthraquinones, cardiac glycosides, and flavonoids.	African plant leaf extract exhibits anti-inflammatory, antinociceptive as well as antioxidant properties.	[7]
8.	Leaf	Maceration with 80% ethanol. African leaves are known to have an anti-inflammatory effect using five male rabbits as experimental animals.	saponins, tannins, flavonoids, and steroids	The concentration of the combination of EEDA and EEDB that was most effective in healing burns as an anti-inflammatory was at a concentration of 10%,	[8]
9.	Leaf	infusion with a concentration of 10% at 90°C for 15 minutes has a pharmacological effect as an antipyretic.	flavonoids	African leaf infusion of 10% has an antipyretic effect.	[9]
10.	Leaf	Infusion with a concentration of 10%, 100 mL of distilled water with a temperature of 90°C. The method measures edema by subplantar induction of 1% carrageenan, which is anti-inflammatory.	alkaloids, flavonoids, saponins, and tannins	African leaf infusion has anti-inflammatory properties, and 200 mg/200 gBW is the most effective dose for inhibiting inflammation.	[10]

No	Plant	Method	Phytochemical Content Pharmacological	Activities	Reference
11.	Leaf	Maceration of 96% ethanol has an effect as an antioxidant by testing the cycling test.	flavonoids	African leaf extract can be formulated into lotion preparations as an antioxidant.	[11]
12.	Leaf	extraction using n-hexane by maceration method and has an anti-cancer effect.	Flavonoids, triterpenoids/steroids	This study shows that EEDA can be developed as chemotherapy in breast cancer by inhibiting the cell cycle and increasing apoptosis.	[12]
13.	Leaf	soxhlet extracted with ethanol. <i>Vernonia amygdalina</i> has analgesic and antipyretic effects using hot plate testing.	Flavonoids, tannins, alkaloids, and steroids.	It shows the medicinal potential of <i>V. amygdalina</i> and can be used as an analgesic and antipyretic agent.	[13]
14.	Leaf	The preparation of African leaf ethanol extract was made by maceration and its pharmacological effect as an anticholesterol agent through enzymatic colorimetric testing.	Flavonoids, tannins, saponins, steroids/triterpenoids, glycosides.	Administration of African leaf ethanol extract at a dose of 100 mg/kg bw, 150 mg/ kg bw, and 200 mg/kg bw can reduce total cholesterol levels	[14]
15.	Leaf	extracted with 80-95% ethanol; African leaf extract is oxytocin.	oxytocin	Extracts of <i>Vernonia amygdalina</i> and <i>Cleome gynandra</i> that increases rat contraction may be oxytocin.	[15]
16.	Leaf	Macerate for 3 hours in warm distilled water (<80 °C). This plant has an antipyretic effect with rotary use.	Saponins	The results of the plasmodial suppression test in mice are in agreement with the use of folkloric herbs for the treatment of malaria among ethnicities. The antipyretic properties as seen in tests with rats show with certainty, the reason for the herb's use in common ailments that produce fever.	[16]

Discussion

A. Antifertility

African leaf (*Vernonia amygdalina*) and Papaya leaf (*Carica papaya* L) contain secondary metabolites and are thought to have antifertility effects. This study aimed to prove *Vernonia amygdalina* leaf extract, *Carica papaya* L leaf and Combining the two extracts can reduce the number of primary and secondary follicles and tertiary follicles. Extraction is done by maceration Dosage of *Vernonia amygdalina* leaf extract and *Carica papaya* L leaf extract used was 150 mg/kg BW, 200 mg/kg BW, 250 mg/kg BW and the combined dose of African leaf extract, and Papaya leaf is 75:75 mg/kg BW, 100:100 mg/kg BW, and 125:125 mg/kg BW. KB Mainstay, with a dose of 0.000078 mg, was used as a positive control. The results showed that the administration of extract *Vernonia amygdalina* leaves, *Carica papaya* leaves, and their combination have a significant effect on a decrease in the number of primary follicles (P= 0.03), secondary follicles (P=0.032) and tertiary (P=0.033). A combination extract of *Vernonia amygdalina* leaf and *Carica papaya* leaf with a dose of 125:125 mg/kg BW has the most potential as a natural contraceptive [1].

B. Antioxidant & Antidiabetic

Vernonia amygdalina (Asteraceae) is a medicinal plant used in traditional medicine in Ivory Coast to treat diabetes. This research aims to identify in vitro and in vivo antioxidant activity of *Vernonia amygdalina* aqueous extract (EAVA) in healthy and diabetic mice. Dekokta method with ethanol DPPH testing. Studies of in vivo antioxidant activity in mice show that EAVA (*Vernonia amygdalina* water extract), at a dose of 1200 mg/kg BW, strengthens balance antioxidants in healthy animals and reduces the state of oxidative stress caused by injection [2].

Vernonia amygdalina is an essential medicinal plant with leaves. It is rich in vitamins and salt, so it is precious in the human diet. African leaf extract's antioxidant, anti-inflammatory, and analgesic activities were evaluated to validate its folkloric use. *Vernonia amygdalina* leaf extract is prepared by dissolving ground plant material (200g) in 1 L of acetone for 48 hours, filtered, then dried using a rotary evaporator before being used for pharmacological examination. The results of this study indicate that African leaf extract doses of 100 and 200 mg/kg caused a significant reduction in edema induced by carrageenan and histamine. Also, good antioxidant effect and activity pharmacology may be due to the presence of polyphenols and other phytochemicals contained in the plant. This study may have validated the folkloric use of this plant as a medicinal and nutritional agent [7].

African leaves contain flavonoid compounds, tannins, saponins, and terpenoids which can be used as antioxidants and anti-inflammatories and plays an essential role in the repair of cells in the body. This study aimed to determine whether the leaf extract Africa can be formulated into lotion preparations and is stable in the cycling test. The lotion is made into two formulas and two bases by the cycling test method (stored at four °C and 40°C for 24 hours which were carried out for six cycles). From research, it can be concluded that the African leaf extract can be formulated into lotion preparations [11].

C. Toxicity

Vernonia amygdalina plant, popular as the bitter leaf, is green and has a characteristic odor and a bitter taste. Environmental pollution with arsenic (As) from human and natural sources is a global problem. This study investigated the chemoprotective potential of *Vernonia amygdalina* leaf extract against sodium arsenite-induced genotoxicity and hepatotoxicity—genotoxic effect evaluated in mouse bone marrow using the micronuclei. Gamma activity glutamyl transpeptidase (GGT) and alkaline phosphatase (ALP) were tested in rat serum. *Vernonia amygdalina* extract treatment at 5 mg/kg and 10 mg/kg significantly decrease the frequency of micronucleated polychromatic erythrocytes (PCEs). GGT activities and ALP increases more than fourfold in the livers of mice treated with sodium arsenite, meanwhile were reduced by almost half when rats were given sodium arsenite fed with fresh *Vernonia amygdalina* leaf extract. Phytochemical constituents of *Vernonia amygdalina* may be responsible for radical scavenging high levels of DPPH free radicals were observed. The results of this study indicate that *Vernonia amygdalina* extra was able to suppress chromosomal aberrations caused by sodium arsenite in rats. Thus, *Vernonia amygdalina* has the potential as an agent of strong chemoprotective against sodium arsenite toxicity in rats. [3]

Clerodendrum volubile and *Vernonia amygdalina* have remarkable bioactivity common against diseases associated with oxidative stress. Therefore, this study assessed the effect of the flavonoid fraction of *Clerodendrum volubile* and *Vernonia amygdalina* (FCV and FVA, respectively) against arsenic-induced oxidative stress in mice. Three Twenty male Wistar rats (120 ± 10 g) were divided into six groups, each five; Control (distilled water), arsenic only (40 ppm sodium arsenite), FCV arsenic (100 mg/kg), FVA arsenic (100 mg/kg), FCV and FVA arsenic (50 mg/kg each), and arsenic vitamin C (100 mg/kg). Therefore, the flavonoid fraction of *Clerodendrum volubile* and *Vernonia amygdalina* can be a viable weapon against oxidative stress and arsenic-induced hepato-renal disease in rats. [4].

The African plant (*Vernonia amygdalina*) is a medicinal plant widely used by the community. The purpose of this study is to determine the content of secondary metabolites contained in crude extracts of leaves, stems, and African plant bark (*Vernonia amygdalina*) and assess the level of toxicity (determining the LC₅₀ value of the three crude extracts) using the BSLT—method (Brine Shrimp Lethality Test).

The results obtained from this study are metabolites. Secondary content contained in the crude extract of African leaves are flavonoids, triterpenoids, and steroids; in crude extracts of African plant stems, namely alkaloids, flavonoids, and steroids, as well as in the crude extract of the bark of African plants, namely alkaloids, flavonoids, phenolics, triterpenoids, and steroids. The LC₅₀ value of African plants' crude extract of leaves, stems, and bark is 399.85 ppm, 118.25 ppm, and 80.82 ppm, respectively. These three types of extracts are toxic (LC₅₀ < 1000 ppm) [5].

D. Anti-cancer

Vernonia amygdalina (VA) is a traditional African herbal medicine reported to have anti-cancer properties. This study aims to test and evaluate the anti-cancer activity of *Vernonia amygdalina* leaf extract and silver nanoparticles of *Vernonia amygdalina* in the human breast cancer cell line MCF-7. *Vernonia* Leaves amygdalina was extracted using ultrasound-assisted sequential extraction using three different solvents: ethanol, 50% ethanol, and deionized water. Nanoparticles of silver were synthesized with an aqueous extract of *Vernonia amygdalina*. Ethanol extract and nanoparticles *Vernonia amygdalina* silver inhibited MCF-7 cell proliferation with an average value of half-maximal inhibition (IC₅₀) 67 µg/mL and 6.11 µg/mL, respectively, after 72 hours of treatment. Ethanol extract and *Vernonia amygdalina* silver nanoparticles cause G1 phase cell cycle arrest, inducing apoptosis and nuclear fragmentation in MCF 7 cell. *Vernonia amygdalina* ethanol extract and *Vernonia* silver nanoparticles amygdalina decreased cell viability in MCF-7 cells in a time- and dose-dependent manner by inducing apoptosis and causing DNA damage. Further research is needed to explain the mechanism of action of *Vernonia amygdalina* leaf extract and *Vernonia amygdalina* silver nanoparticles. This study is the first to report the activity of anti-cancer silver nanoparticles of *Vernonia amygdalina* in MCF-7 cells [6].

African leaf (*Vernonia amygdalina*) has medicinal effects against various disease threats and has recently been suggested to have anti-cancer effects. Therefore, this study tested the anti-cancer activity of African leaf extract against resistant T47D cells. Determination of cytotoxic activity in vitro has been determined using the 3-(4,5-dimethylthiazole-2-yl)-2,5-diphenyl tetrazolium bromide. Cell cycle analysis and apoptosis were determined by the flow cytometry method. Cytotoxicity examination of n-hexane leaf extract Africa (ENDA), African leaf ethyl acetate extract (EEADA), and African leaf ethanol extract (EEDA) against T47D cells were indicated by IC₅₀ values of 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. Therefore, EEADA has the most active activity as an anti-cancer. The molecular evolution test produces resistant T47D cells. EEADA toxicity test against T47D cells the resistance showed an IC₅₀ value of 59.19 ± 0.55 g/mL. EEADA maybe can inhibit the cell cycle in the G₀-G₁ phase and increase apoptosis of resistant T47D cells. This study shows that EEDA can be developed as chemotherapy in breast cancer by inhibiting the cell cycle and increasing apoptosis [12].

E. Anti-inflammatory

African leaf (*Vernonia amygdalina*) and Wake-up leaf (*Coleus amboinicus* Lour) are traditional medicinal plants. This study was to determine the effectiveness of the healing effect of burns. African Leaf and Wake-Bangun were taken purposively without comparing samples from the region. Then the plant was macerated with 80% ethanol, and tested the effectiveness of the gel extract was for healing burns on rabbit backs. Then on the back, rabbits were given a burn pattern with a diameter of 2 cm, then each of them was smeared with gel twice a day for 11 days, and the wound diameter

was measured for each group Combination of ethanol extract from EEDA and EEDB with a concentration of 16%+10% is given effective for healing burns in rabbits and showed no difference if compared to Bioplacenton gel [8].

Inflammation is one of the main responses of the immune system to infection and irritation. This study aims to determine the effectiveness and effective dose of African leaf infusion as an anti-inflammatory in carrageenan-induced male white rats. With a concentration of 10%, this study weighed a powder of African leaf simplicia as much as 10grams and added 100 mL of aquadest in the infusion pan, 2x aquadest weight simplicia heat for \pm 15 minutes at a temperature of 90 ° C, filter paper. This study shows that the administration of African leaf infusion has anti-inflammatory properties, and a dose of 200 mg/200 gBW is the most effective dose for inhibiting inflammation [10].

F. Analgesic and antipyretic

African leaves are used in traditional medicine by the community to reduce fever by drinking boiled water. This study aims to determine the antipyretic effect of African leaf infusion on Wistar rats. The treatment was given to 3 groups of 5 mice consisting of group I: 1% Na CMC as the negative control, group II: Paracetamol 180 g/2.5 mL as the positive control, and group III: 10% African leaf infusion. Wistar rats are made to have a fever by injecting peptone 20% intraperitoneally as long as the temperature rises 1.5 °C from the initial temperature. Research results showed that there was an effect of treatment on Wistar rats ($p < 0.05$), so that concluded that 10% African leaf infusion has an antipyretic effect [9].

Vernonia amygdalina Del has traditionally been used to relieve pain and inflammatory conditions and treat febrile diseases by local communities in the east Nigerian sea. Therefore, this study aims to evaluate the content of phytochemical, antipyretic, and analgesic properties of *Vernonia amygdalina*. *Vernonia amygdalina* leaves were soxhlet with ethanol and partitioned sequentially using solvents of different polarities. Research shows the presence of tannins, phlobatannins, saponins, carbohydrates, cardioactive glycosides, flavonoids, alkaloids, steroids, and terpenes. These results show the potential of the *Vernonia amygdalina*, which can be used as an analgesic and antipyretic agent. Phytochemicals such as flavonoids, tannins, alkaloids, and steroids appear to be involved in the pharmacological activity [13].

Herbal medicines are made from plant ingredients susceptible to contamination, deterioration, and compositional variations. This study aims to evaluate the pharmacognosy and pharmacological properties of *Vernonia amygdalina* leaves. The method used includes standard procedures for macroscopic and microscopic examination. Data showed the presence of calcium oxalate and anomicytic stomata. Studies agree with using folkloric leaf extract in malarial fever but showed antipyretic properties substantially from *Vernonia amygdalina* [16].

G. Hypercholesterolemia

African leaves (*Vernonia amygdalina*) belonging to the Asteraceae family contain flavonoids, saponins, and tannins that can treat cholesterol and reduce the risk of cardiovascular disease. This study aimed to examine the effect of Anticholesterol of African leaf ethanol extract in rats—preparation of African leaf ethanol extract made by maceration. The screening results showed the presence of flavonoids, saponins, tannins, steroids/triterpenoids, and glycosides in the extracts. The research shows that the ethanolic extract of African leaves at 100 mg/kg BW, 150 mg/kg BW and 200 mg/kg BB can reduce total cholesterol levels significantly ($p < 0.05$) compared to the negative control. From the results of this study, it can be concluded that the administration of African leaf ethanol doses of 100 mg/kg BW, 150 mg/kg BW and 200 mg/kg BW can reduce total cholesterol levels [14].

H. Oxytocin

More than 80% of pregnant women in Western Uganda give birth at home with assistance, especially from traditional birth attendants who use herbal remedies to solve childbearing in rural communities. Specifically, this research examines the Biological activity of *Vernonia amygdalina* and *Cleome gynandra*, which are common medicinal plants used in traditional medicine in reproductive health services. Mash finely ground, extracted with 80-95% ethanol, then dry in an oven at 45°C, put into a conical flask, and cool in the air for 10- 15 minutes, filter with a suction pump, and cotton. The filtrate is stored at 20°C and then frozen or oven-dried in small portions. [15].

CONCLUSION

Based on the results of the journal analysis can be concluded that the *Vernonia amygdalina* extract has been used as a traditional medicine. The phytochemical test showed the presence of tannins, saponins, glycosides, flavonoids, alkaloids, steroids, and glycosides cardiac, phenolic, anthraquinone, polyphenol, triterpenoid, flavonoids, and oxytocin. *Vernonia amygdalina* has been identified as a useful plant in the genus *Vernonia*. *Vernonia amygdalina* has several activities, including anti-diabetic, anti-plasmodial, analgesic, antipyretic, toxic, antioxidant, anti-microbial, antifertility, anti-inflammatory, anti-cancer, hypercholesterolemia, and oxytocin.

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