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A Study Review of Documented Phytochemistry of Vernonia amygdalina (Family Asteraceae) as the Basis for Pharmacologic Activity of Plant Extract

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Abstract
This study was conducted to review phytochemistry of Vernonia amygdalina leaves as a basis for documented pharmacologic activity of the extract of Vernonia amygdalina. The documented phytochemical screening studies reveals the presence of Phytochemical screening of various solvent (aqueous, methanol, acetone and n-hexane) extract of Vernonia amygdalina has shown the presence of Anthraquinones (+++), Soluble tannins (++), Condensed tannins (+), Flavonoids (+), Alkaloids (+++), Indole alkaloids (+), Steroidal alkaloids (+++), Saponins (+++), Glycosides (++), Cyanogenic glycosides (-), Terpenoids (+++). Studies conducted to determine or/and ascertain the pharmacologic activities of Vernonia amygdalina extract has revealed that these aforementioned phytochemicals are responsible for the majority of these observed pharmacologic activities including but not limited to hypoglycaemic, antimalarial, hypolipidemic, anti-inflammatory, anti oxidant activities.
Keyword: Vernonia amygdalina Phytochemistry, Leave extract

Introduction

Medicinal plants are various plants thought by some to have medicinal properties, but few plants or their phytochemical constituents have been proven by rigorous science or approved by regulatory agencies such as the United States Food and Drug Administration or European Food Safety Authority to have medicinal effects.

A medicinal plant is any plant which, in one or more of its organs, contains substances that can be used for the therapeutic purposes or which are precursors for the synthesis of useful drugs[20]

A herbal remedy is one in which the main therapeutic activity depends upon the plant or fungal metabolites which it contains. Some plants are purely dietary and are necessary for health (fresh vegetables, carrots, fruits, which we now know provide essential vitamins). Many plant products are consumed in reasonable quantity as food but known to have medicinal effects (e.g., figs, prunes and mucilage acting as mild laxatives). There are some purely medicinal plants, few apparently quite safe and others more potent (e.g. containing cardioactive glycosides), which can only be consumed in small quantities but which as such dosage are suitable for the treatments of disease[16].

Preliminary Review of some Literatures

Scientific Classification of Vernonia amygdalina
Kingdom: plantae
Division: Angiosperms
Order : Asterales
Family: Asteraceae
Genius: Vernonia
Species: V**.** amygdalina
Botanical Name: Vernonia amygdalina

Synonyms, Botanical source and habitat

Vernonia amygdalina, a member of the Asteraceae family, is a shrub or small tree of 2 – 5 m with petiolate leaf of about 6 mm diameter and elliptic shape. The leaves are green with a characteristic odour and a bitter taste. No seeds are produced and the tree has therefore to be distributed through cutting[3]. It is known in Nigerian local languages as *etidot* (Efik), uzi (Ebira), *onugbu* (Igbo) and *chusar duki* (Hausa). Elsewhere in Africa, it is called *muop* or *ndole* (Cameroon), *tuntwano* (Tanzania), and *mululuza* (Uganda) [14].

Ecology Grows under a range of ecological zones in Africa and produces large mass of forage and is drought tolerant. There are about 200 species of Vernonia.

Major uses and functions The leaves are used for human consumption and washed before eating to get rid of the bitter taste. They are used as vegetable and stimulate the digestive system, as well as they reduce fever. Furthermore, are they used as local medicine against leech, which are transmitting bilharziose. Free living chimpanzees eat the leaves, if they have attacked by parasites. *Vernonia amygdalina* is also used, instead of hops to make beer in Nigeria[3]. Furthermore, is *Vernonina amygdalina* found in homes in villages as fence post and pot-herbs. It is also used in the treatment of amoebic dysentery, gastrointestinal disorders, microbial and parasitic activities, hepatotoxicities[2].

It is very unlikely that a single molecule is responsible for such varied activities; instead multiple molecules, working alone or in combination with others aforementioned, are much more likely to be responsible for each of these biological activities.

Feeding value *Vernonia amygdalina* has been observed to be eaten by goats in Central Zone of Delta State, Nigeria. However, in general has there been found, that *Vernonia amygdalina* have an astringent taste, which affects its intake. The bitter taste is due to anti-nutritional factors such as alkaloids, saponins, tannins and glycosides[2].

It has been tried to mix Vernonia with molasses to make it more palatable, but 6.6 % of DM intake had to be added to improve the intake of Vernonia. During the dry period Dairy farmers from Southern Ethiopia feed boiled Vernonia, since the boiling decreases the content of secondary plant compounds and makes the feed more palatable.

Vernonia amygdalina has also been fed to broilers, where it was able to replace 300 g kg^{-1} of maize-based diet without affecting feed intake, body weight gain and feed efficiency[2].

Pharmacology The leaf of Vernonia amygdalina extract is used in medicine as a antimalarial, antimicrobial, laxative, antihelmitic, antithrombotic and both hypoglycemic cum hypolipidaemic effect in diabetic-hyperlipidaemic and normoglycemic-hyperlipidaemic rats have been reported. The leaf extract also exhibits antimicrobial and anti-tumourigenic properties .

Phytochemical screening of the plant has revealed the presence of saponins, glycosides and tannins, which are known to be bioactive purgative principles. Flavonoids are also present in bitter leaf and three flavones – luteolin, luteolin 7-0-beta-glucuronoside and luteolin 7-0-beta-glucoside has been identified. These flavones possess antioxidant activity and may play a beneficial role in cancer prevention, and offer some protection against diabetes and atherosclerosis. Also, the high content of the antioxidant vitamin C present in *V. amygdalina* leaves may play a role in these[18]..

Medicinal Uses

Anticancer activity Vernonia amygdalina (VA) is increasingly emerging as a very strong candidate for breast cancer treatment. VA may be used alone or in combination (adjuvant) with known drugs. Previous reports show that low concentrations (microgram/ml) of water-soluble leaf extracts of a Nigerian edible plant, V. amygdalina (VA), potently retards the proliferative activities of ER+ human breast cancerous cells (MCF-7) in vitro in a concentration-dependent fashion. However, the anti-proliferative activities of VA in either ductal or ER- carcinoma cells have not been characterized[13].

Vernonia amygdalina extracts may help suppress, delay, or kill cancerous cell in many ways, such as:

- Induction of apoptosis as determined in cell culture and animal studies[21].
- Enhanced Chemotherapy Sensitivity - V. amygdalina extracts may render cancerous cells to be more sensitive to chemotherapy[22].
- Inhibition of the growth or growth signals of cancerous cells[12].
- Suppression of metastasis of cancerous cells in the body by the inhibition of NFκB is an anti-apoptotic transcription factors as demonstrated in animal studies[21].
- Reduction of estrogen level in the body by the suppression of Aromatase activity[5]. The Involvement of blood estrogen level in the etiology of estrogen receptor (ER) positive breast cancer has been widely reported[6]. Additional source of estrogen production in humans besides the ovary and adrenal gland is the conversion of testosterone to estrogen in a reaction catalyzed by Aromatase. Many studies have shown positive correlations between blood estrogen levels and breast cancer risks[6]. Therefore, compounds that inhibit Aromatase activity are used for the treatment of breast cancer.
- Antioxidants - V. amygdalina may provide anti-oxidant benefits[8].
- Enhancement of the immune system - Many studies have shown that V. amygdalina extracts may strengthen the immune system through many cytokines (including NFκB, pro inflammatory molecule) regulation[22].

Hypolipidaemic Activity

Administration of an aqueous *V. amygdalina* leaf extract to the hyperlipidaemic animals caused a decrease in plasma TC, LDL-C, TAG, and VLDL and an increase in plasma HDL-C concentration.

Results obtained reveals hyperlipidaemia was successfully induced in albino New Zealand rabbits by feeding them a basal diet supplemented with a non-phosphorylated egg yolk extract. Administration of an aqueous V. amygdalina leaf extract to the hyperlipidaemic animals caused a decrease in plasma TC, LDL-C, TAG, and VLDL and an increase in plasma HDL-C concentration. This indicates that aqueous *V. amygdalina* leaf extract may be useful for the control of these blood lipids in the prevention and treatment of CHD[18].

Antidiabetic activity Previous study showed that the aqueous extract of *V. amygdalina* significantly lowered blood glucose levels after oral administration to alloxan-induced diabetic rabbits[7].

Studies conducted using streptozotocin -induced diabetic laboratory animals showed that *V. amygdalina* administration decreased blood glucose by 50% compared to untreated diabetic animals[17].

Antimalarial activity Extracts from the leaves and root bark of Vernonia amygdalina are assessed for antimalarial activity against drug-sensitive Plasmodium berghei in mice. Leaf extract produced 67% suppression of parasitaemia in the four-day test, while root-bark extract produced 53.5% suppression. These results are significant when compared to a placebo[1].

Result

Evaluation of the Antioxidant Activity and Lipid Peroxidation of the Leaves of Vernonia amygdalina[14]

This study evaluated the in vitro antioxidant activity of water (VAWE) and ethanol (VAEE) extracts of the leaf of Vernonia amygdalina. The antioxidant activity of each extract was evaluated using various radicals or oxidation systems. The total phenolic or flavonoid contents and their correlation with total antioxidant activity were also evaluated. VAEE exhibited antioxidant scavenging potential comparable to butylated hydroxyanisole (BHA), but higher than butylated hydroxytoluene (BHT) or VAWE. The total antioxidant scavenging activity of the extracts measured as the millimolar (mM) equivalent of vitamin C gave VAEE a 10.09 ± 1.63, which is comparable to BHA with a 9.31 ± 1.17, but higher than VAWE with an 8.75 ± 1.28 or BHT with a 6.14 ± 2.01. Extracts inhibited bleaching of B-carotene, oxidation of linoleic acid and lipid peroxidation induced by Fe2+/ascorbate in a rat liver microsomal preparation.

Table 1: Total phenolic and flavonoid content and total antioxidant activity of the extracts of V. amygdalina.

Vernonia amygdalina extract	Total antioxidant activity [a]	Flavonoids [b]	Phenolics [c]
Water Extract (VAWE)	8.75 ± 1.28 5	59.27 ± 3.61	271.14 ± 2.41
Ethanol Extract (VAEE)	10.09 ± 1.63 8	84.61 ± 3.58	397.48 ± 3.07
BHA 9	9.31 ± 1.17		
BHT 6	6.14 ± 2.01.		

Values are mean ± SD. n=4, significance is set at $p \leq 0.001$.
a: measured as mM equivalent of vitamin C.
b: measured as mg quercetin per 100 g dried plant material.
C: measured as mg gallic acid per 100 g dried plant material.

The Effect of Ethanolic Extract of *Vernonia amygdalina* Leaves on Some Pharmacokinetic Parameters of Chloroquine in Rats[10]**.**

Studies were done to find out if there exist significant interactions between Chloroquine and Vernonia amygdalina when the extract administered 1 hr before Chloroquine or simultaneously with Chloroquine to different group of albino rats (Whister strain). Three groups of rats were used, with each group comprising of 25 rats and one control group. The Chloroquine level was measured using UV-spectrophotometer. The results indicate significant interaction ($p<0.5$) in the group to which the extract was administered simultaneously with Chloroquine. There was a decrease in the level of drug in circulation as evidenced by lower values of AUC (297.52±8.45 vs 333.22±24.99) and C-max (74.6±1.02 vs 76.6±3.07) comparing experimental group with control.

Table 2: Serum concentration of Chloroquine

Time points (mins)	Group A (CQ only) µg/ml	Group B (VA before CQ) µg/ml	Group A (VA + CQ) µg/ml
15	22.32±6.82	26.98±17.09	24.96±21.79
30	62.10±11.71	62.37±27.55	71.33±3.27
60	75.63±3.92	75.44±2.71	70.61±2.82
120	69.31±9.27	65.19±8.05	68.14±6.55
300	67.56±1.57	59.86±1.73	51.71±5.83

*Mean ±SD n=5: *p<0.05:*
CQ only: groups to which only Chloroquine was administered (control);
VA before CQ: groups to which chloroquine was administered 1 hr after administration of Vernonia amygdalina;
CQ+VA: groups to which both Chloroquine and Vernonia amygdalina extract were administered together.

Table 3: Comparison of pharmacokinetic parameters

Pharmacokinetic	Group A (CQ only) µg/ml	Group B (VA before CQ) µg/ml	Group A (VA + CQ) µg/ml
AUC (µg/h/ml)	333.22±24.99	307.50±21.44	297.52±8.45
Ka (µg/h/ml)	4.25±1.68	5.45±2.23	12.78±2.82
Ke (µg/h/ml)	0.03±0.01	0.04±0.02	0.09±0.04
C_{max} (µg/h/ml)	78.60±3.07	77.40±2.24	74.60±1.02
t_{max} (h)	1.26±0.28	1.01±0.07	0.86±0.33
$t_{1/2\ el}$ (h)	32.9±19.00	21.70±11.2	8.90±2.90

*Mean ±SD n=5: *p<0.05:*

In Vivo Antimalarial Activity of *Vernonia Amygdalina*[1]

Extracts from the leaves and root bark of Vernonia amygdalina are assessed for antimalarial activity against drug-sensitive Plasmodium berghei in mice. A standard inoculums of 1 x 10^7 infected erythrocytes is used, and leaf and root-bark extracts of 500 mg/kg, 250 mg/kg or 125 mg/kg are used in a four-day suppression test and a Rane test of established infection. Leaf extract produced 67% suppression of parasitaemia in the four-day test, while root-bark extract produced 53.5% suppression. These results are significant when compared to a placebo

Effect of aqueous extract of Vernonia amygdalina leaves on plasma lipids of hyperlipidaemic adult male albino New Zealand rabbits[18]

This study investigated the effect of an aqueous extract of Vernonia amygdalina leaves on the lipid profile of hyperlipidaemic adult male albino rabbits. Three groups of rabbits were employed in the study: a healthy control group fed only 1ml groundnut oil/ kg body weight (A) and two groups (B and C), in which hyperlipidaemia was induced by feeding 100mg/ ml groundnut oil/ kg body weight of a non-phosphorylated egg yolk extract for one week. For the next 14 days Group B of the hyperlipidaemic rabbits received the egg yolk extract while Group C animals were given, in addition, 200mg/kg body weight of the aqueous extract of V. amygdalina leaves twice daily. The control group (A) received only groundnut oil. All animals were fed grower's mash and water throughout the course of the experiment. Assay of lipids showed significant difference ($P<0.05$) in total cholesterol (TC), and low density lipoprotein (LDL-C) between groups A and C. Very low density lipoprotein (VLDL), triacylglycerol (TAG) and high density lipoprotein (HDL-C) were not significantly different between the two groups. Relative to the control, treatment with the extract decreased plasma TC and LDL, but normalized VLDL, TAG and HDL-C. Change in the lipid concentration was progressive, with TC, TAG, VLDL and LDL-C being lower and HDL-C higher in the second week than in the first week after commencement of treatment.

Vernonia amygdalina: Anticancer Activity[13]

Evidence suggests that most chemotherapeutic agents are less effective as treatment in patients with estrogen receptor-negative (ER-) breast carcinomas compared to those with estrogen receptor-positive (ER+) breast carcinomas. Moreover, African American Women (AAW) is disproportionately diagnosed with ER- breast cancer compared to their white counterparts. Novel therapies effective against ER- breast carcinomas are urgently needed to ameliorate the health disparity. Previous reports show that low concentrations (microgram/ml) of water-soluble leaf extracts of a Nigerian edible plant, V. amygdalina (VA), potently retards the proliferative activities of ER+ human breast cancerous cells (MCF-7) in vitro in a concentration-dependent fashion. However, the anti-proliferative activities of VA in either ductal or ER- carcinoma cells have not been characterized. The exposure of BT-549 to increasing concentrations of VA (10, 100, and 1000 µg/mL) inhibited cell growth by approximately 14 % ($P<0.05$), 22 % ($p<0.05$), and 50 % ($p<0.005$) respectively. The cell count studies were corroborated by DNA synthesis studies. Treatments of BT-549 with 10, 100, and 1000 µg/mL VA inhibited DNA synthesis in a concentration dependent fashion by 22 %, 76 % ($P<0.05$), and 86 %

($p<0.01$) respectively. BT-549 cells were insensitive to 10 and 100 nM paclitaxel (TAX) treatments. Isolation of DNA from dried VA leaves yielded approximately 12.2 and 1 kbp genomic DNA that were Eco RI-insensitive but Hind III and Bam HI-sensitive. These pieces of information may be used to enhance the safety of medicinal botanical VA through authentication, and adulteration detection.

Evaluation of the anti-inflammatory activity of extract of *Vernonia Amygdalina*[9]

Inflammatory response was induced by topical application of croton oil dissolved in suitable vehicle on the rat ear. After 6 hrs, cutting out the ear quantified the response. The cut ear was weighed and the increase in weight relative to control group was evaluated. When co-applied with croton oil to the rat ear extract of V.A. produced a reduction in the inflammatory response when croton oil alone was applied to the rat ear. The extract produced (69.1±2.0)% reduction of the inflammatory response produced by croton oil alone, lower than the reduction of the inflammatory response produced by acetyl salicylic acid [(71.1±2.0)%].

Bioactive sesquiterpene lactones from the leaves of Vernonia amygdalina[8]

Phytochemical analysis of the leaves of Vernonia amygdalina yielded two known sesquiterpene lactones: vernolide and vernodalol. The two compounds were tested by agar dilution method against 10 bacteria strains and 5 fungi species. Both compounds exhibited a significant bactericidal activity against five Gram positive bacteria while lacking efficacy against the Gram negative strains. In the antifungal test, while vernolides exhibited high activity with LC (50) values of 0.2, 0.3 and 0.4 mg/ml against Penicillium notatum, Aspergillus flavus, Aspergillus niger and Mucor hiemalis, respectively, vernodalol showed moderate inhibitions against Aspergillus flavus, Penicillium notatum and Aspergillus niger with LC(50) values of 0.3, 0.4 and 0.5 mg/ml, respectively. Both compounds were ineffective against Fusarium oxysporum, a microbe known to be highly resistant to chemical agents. However, the antimicrobial results of this study correspond positively with the claimed ethnomedical uses of the leaves of Vernonia amygdalina in the treatment of various infectious diseases.

Phytochemical investigation on the leaves of *Vernonia amygdalina*[19]

A number of known sesquiterpene lactones have been isolated from *Vernonia* species. Some sesquiterpene lactones and flavonoids have isolated from *Vernonia amygdalina* are named below as luteolin, luteolin-7-O-glucoside by the partial characterization of *Vernonia amygdalina* methanolic extract using IR and UV spectrum.

Hepatoprotective and antioxidant activities of *Vernonia amygdalina* on acetaminophen-induced hepatic damage in mice[11]

This study evaluated the hepatoprotective and antioxidant effects of an aqueous extract of V. amygdalina leaves against acetaminophen-induced hepatotoxicity and oxidative stress in mice in vivo. Activities of liver marker enzymes in serum (glutamate-oxaloacetate transaminase, glutamate-pyruvate transaminase, lactate dehydrogenase, and alkaline phosphatase) and bilirubin levels were determined colorimetrically, while catalase activity, lipid peroxidation products, thiobarbituric acid-reactive substances (TBARS), iron, and total protein concentrations were measured in liver homogenate. Acetaminophen challenge (300 mg/kg, i.p) for 7 days caused significant ($P < .01$) increases in the levels of bilirubin, liver enzymes, TBARS, and iron, while catalase activity and total protein level were reduced significantly ($P < .01$). Pre-administration of V. amygdalina resulted in a dose-dependent (50-100 mg/kg) reversal of acetaminophen-induced alterations of all the liver function parameters by 51.9-84.9%. Suppression of acetaminophen-induced lipid peroxidation and oxidative stress by the extract was also dose-dependent (50-100 mg/kg). The results of this study suggest that V. amygdalina elicits hepatoprotectivity through antioxidant activity on acetaminophen-induced hepatic damage in mice.

Hypoglycemic activity of *Vernonia amygdalina*[2].

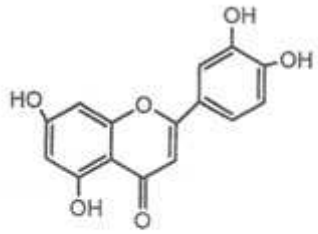
Study conducted showed that the aqueous extract of *Vernonia amygdalina* significantly lowered blood glucose levels after oral administration to alloxan-induced diabetic rabbits. Also, studies conducted using streptozotocin-induced diabetic laboratory animals showed that *V. amygdalina* administration decreased blood glucose by 50% compared to untreated diabetic animals.

Phytochemical screening of aqueous extract of *Vernonia amygdalina*[4]

Table 4: Phytoconstitution of *Vernonia amygdalina* aqueous extract.

Phytoconstituent	*Qualitative abundance*
Anthraquinones	+++
Soluble tannins	++
Condensed tannins	+
Flavonoids	+
Alkaloids	+++
Indole alkaloids	+++
Steroidal alkaloids	+
Saponins	+++
glycosides	++
Cyanogenic glycosides	+
Terpenoids	+++

Levels of phytoconstituents were qualitatively determined based on chemical group reactions and thin-layer chromatography on the following scale: , absent(-) present at low levels(+), present at moderate levels(++), present at high levels(+++).



luteolin

Sesquisterpenes

Discussion

Phytochemicals differ from phytonutrients in that they are not a necessity for normal metabolism and absence will not result in deficiency disease. Phytochemicals are not required for the functioning of the body, but they are of benefit on health and play an active role in the treatment of diseases. The presence of phytochemicals such as sesquiterpene lactones and flavonoids namely vernolide and vernodalol, luteolin and luteolin- 7-O-glucoside isolated from *Vernonia amygdalina* has been revealed using various solvent system for extraction and analytic techniques such as chromatography, IR and NMR for partial characterization.

Phytochemical screening of various extract of *Vernonia amygdalina* has shown the presence of Anthraquinones (+++), Soluble tannins (++), Condensed tannins (+), Flavonoids (+), Alkaloids (+++), Indole alkaloids (+), Steroidal alkaloids (+++), Saponins (+++), Glycosides (++), Cyanogenic glycosides (-), Terpenoids (+++). Studies conducted to determine or/and ascertain the pharmacologic activity of *Vernonia amygdalina* extract has revealed that these aforementioned phytochemicals are responsible for the majority of these observed pharmacologic activities.

Antioxidant Activity Of *Vernonia amygdalina*

The total flavonoids and phenolic contents correlated positively with total antioxidant activity. The total flavonoid content also correlated well with total phenolic content. Extracts of *V. amygdalina* contain natural antioxidants; have the potential to act as antioxidants against aqueous radicals and reactive species ions.

Phytochemical screening of the leaves of *V. amygdalina* showed the presence of saponins, tannins, anthracene glycoside, and flavonoids. In recent years, there has been increased interest in *V. amygdalina* due to its biological activities, especially regarding its antioxidant, anticancer, antiviral, and anti-inflammatory activities. The biological activity may be due to its flavonoid content, a natural polyphenolic antioxidant that occurs in fruits and vegetables and exhibits a number of biological activities .Thus, interest in natural antioxidants has been on the increase with much attention on plant flavonoids as possible therapeutic agent against free radical mediated diseases.

The Effect of Ethanolic Extract of *Vernonia amygdalina* Leaves on Some Pharmacokinetic Parameters of Chloroquine in Rats.

There was increase rate of elimination of drugs between the experimental group and control group Ke (.088±0.035 vs 0.027±0.017). There was no significant pharmacokinetic interaction ($p>0.5$) when the extract was administered 1 hr before Chloroquine.

The result indicates that concomitant administration of Chloroquine with *Vernonia amygdalina* results in significant interaction ($p<0.5$) and should be avoided to maintain good plasma level of the drug and also to prevent development of *Plasmodium* resistance secondary to subclinical concentration of the drug in blood.

In Vivo Antimalarial Activity Of *Vernonia amygdalina*

The study show that in vivo administration of an ethanol extract of V. amygdalina is capable of suppressing parasitaemia, especially during early infection; the antimalarial action being attributed to sesquiterpene lactones. However, under the experimental conditions employed, the extracts failed to eliminate P. berghei parasites completely.

Effect of Aqueous Extract of *Vernonia amygdalina* Leaves on Plasma Lipids of Hyperlipidaemic Adult Male Albino New Zealand Rabbits

Relative to the control, treatment with the extract decreased plasma TC and LDL, but normalized VLDL, TAG and HDL-C. Change in the lipid concentration was progressive, with TC, TAG, VLDL and LDL-C being lower and HDL-C higher in the second week than in the first week after commencement of treatment.

Results obtained reveals hyperlipidaemia was successfully induced in albino New Zealand rabbits by feeding them a basal diet supplemented with a non-phosphorylated egg yolk extract. Administration of an aqueous V. amygdalina leaf extract to the hyperlipidaemic animals caused a decrease in plasma TC, LDL-C, TAG, and VLDL and an increase in plasma HDL-C concentration.

The results of this study clearly indicate that the administration of aqueous extract of V. amygdalina leaves produced a hypolipidaemic effect in hyperlipidaemic rabbits, even when they were still being fed the atherogenic egg yolk extract. There are many bioactive constituents present in the extract and hence, at present, it is not certain which of them is/are responsible for the observed effect. However, some reports have shown that flavonoids, tannins and saponins may play some roles in antioxidant and hypolipidemic effects. As has already been mentioned, elevated plasma LDL cholesterol concentrations are associated with increased risk of CHD.

However, the atherogenicity of the LDL particle increases after oxidative modification of its polyunsaturated fatty acids[15]. The antioxidants present in the leaves may help to prevent LDL oxidation resulting in a decrease in its atherogenicity and a reduction of CHD risk.

Anticancer Activity of *Vernonia amygdalina*

The exposure of BT-549 to increasing concentrations of VA (10, 100, and 1000 μg/mL) inhibited cell growth by approximately 14 % ($P<0.05$), 22 % ($p<0.05$), and 50 % ($p<0.005$) respectively. The cell count studies were corroborated by DNA synthesis studies. Treatments of BT-549 with 10, 100, and 1000 μg/mL VA inhibited DNA synthesis in a concentration dependent fashion by 22 %, 76 % ($P<0.05$), and 86 % ($p<0.01$) respectively. BT-549 cells were insensitive to 10 and 100 nM paclitaxel (TAX) treatments. Isolation of DNA from dried VA leaves yielded approximately 12.2 and 1 kbp genomic DNA that were Eco RI-insensitive but Hind III and Bam HI-sensitive. These pieces of information may be used to enhance the safety of medicinal botanical VA through authentication, and adulteration detection.

Evaluation of the anti-inflammatory activity of extract of *Vernonia Amygdalina*

Findings suggest that extract of V.A. exhibits anti-inflammatory activity and may explain the usefulness of the leaves of this plant in the treatment of inflammatory disease conditions by traditional healers.

Conclusion

The review of phytochemical screening reveals presence of bioactive phytoconstituents in methanol, ethanol, n-hexane and aqueous extracts of *Vernonia amygdalina*. This study review has revealed that the observed pharmacologic activities of *Vernonia amygdalina* is due to the singular or combined action of one or more of these phytoconstituents detectected during phytochemical screening of various extract of *Vernonia amygdalina* has shown the presence of Anthraquinones, Soluble tannins, Condensed tannins, Flavonoids, Alkaloids, Indole alkaloids, Steroidal alkaloids, Saponins, Glycosides, Cyanogenic glycosides, Terpenoids. Vernolide and vernodalol, luteolin and luteolin- 7-O-glucoside are sesquisterpene lactones and flavonoids responsible for majority of observed pharmacologic activities amongst which are but not limited to antidiabetic activity, anti-inflammatory activity, antiparasitic activity, antioxidant and lipid peroxidation activity, hepatoprotective activity, anticancer activity.

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