



Acanthus montanus (Nees) T. Anderson: Review

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Abstract: The plant *Acanthus montanus* is from the Acanthaceae family and is an effective medicinal plant. It's a tiny shrub with sparse branches and a soft stem found over Africa, the Balkans, Romania, Greece, and the Eastern Mediterranean. Because of the serrated margins on the leaves, it is commonly called beer's brench or mountain thistle. Ethnomedicinally, the leaves of *Acanthus montanus* have been found useful in the treatment of wounds, furuncles, gonorrhoea, syphilis, cardiac dysfunction, hepatitis, suppuration hastening, also used as vermifuge and emmenagogue. The plant also possesses numerous phytochemicals like alkaloids and carbohydrates with traces of saponins, flavonoids, tannins, glycosides, and terpenoids. Further studies on the leaf and root extract reveal it contains numerous biochemical compounds hence the validity of the biological/pharmacological activities it elicits. Some of these activities include analgesic, anti-inflammatory, immunological, anti-fertility, antidiabetic, hepatoprotective, hepato-curative activities, etc.

Keywords: *Acanthus montanus*, phytochemicals, ethnomedicinal, biological activities.

INTRODUCTION

Plants are often referred to as medicinal plants because they are known to be useful in the prevention or treatment of ailments; they are not frequently or indiscriminately consumed as their non-medicinal counterparts, as they may cause harm, because they are regarded as "reservoirs" of crude drugs, with an unspecified dosage and method of administration (Schulz et al., 2001). They can also be found as wild plant species that grow naturally and exist without the intervention of humans, or as domestic species that result from deliberate and careful human operations such as breeding, selection, and subsequent management (Calixto, 2000).

They are the world's most abundant bioresource of traditional and modern medicines, nutraceuticals, food supplements, folk remedies, pharmaceutical intermediates, and chemical entities for synthetic pharmaceuticals (Nafiu et al., 2017). Sazada et al., (2009), evaluated preliminary phytochemicals in some of the most



important medicinal and aromatic plants. *Acanthus montanus*, a member of the Acanthaceae family, is one of these unique medicinal plants. The Acanthaceae is a big flowering plant family with over 4300 species and 346 genera worldwide (Mabberley, 2008). The majority are tropical shrubs, herbs, and twining vines, while some are epiphytes, making it one of the world's top 12 most diversified flowering plant families. The four main distribution centers are tropical, subtropical, and temperate regions of Indonesia and Malaysia, Africa, Brazil, and Central America while also found in Asia. *Acanthus* (family Acanthaceae) is a genus of flowering plants belonging to the major group of angiosperms (flowering plants), with more than 29 species found in the tropical and subtropical regions of the world, including *Acanthus montanus* (Mabberley, 2008). As a result, the focus of this review will be on *A. montanus* origin/geographical distribution, botanical description, taxonomic classification, folklore/traditional advantages, phytochemical, and biological activities.

BOTANY

The genus name "*Acanthus*" is derived from the Greek word "*akantha*" which means spine and refers to the toothed edges on some species' leaves, while the specific epithet "*montanus*" means mountains. *Acanthus* is a hardy perennial with attractive lobed foliage and tall, erect racemes of two-lipped flowers with bright bracts. (Burkill, 1985). *Acanthus montanus* (Nees) T. Anderson (Acanthaceae), often known as Bear's breeches, mountain thistle, or alligator plant, is a tiny shrub with sparse branches and a soft stem found throughout Africa, the Balkans, Romania, Greece, and the Eastern Mediterranean. It is known in Edo as àgámobo, in Igbo as àgámeebu or ogwudurun-washishi, in Ijaw as èdulèè memen, and Yoruba as ahn ékùn, and in Germany as *Gebirgs-akanthus*. In some areas, it is extensively available in some parts of Europe and Africa. (Burkill, 1985). *Acanthus montanus* is a perennial herb with thinly branching basal clusters of glossy, dark green leaves that are oblong to lance-shaped. It can grow up to 12 inches (30 cm) in length. It grows up to 6 feet (1.8 m) tall and 24 inches (61 cm) broad, with silver marks and wavy borders on the leaves. It enjoys shady areas with deep watering on occasion, although it may also endure hot, dry conditions. Leaves are serrated with small spines, shallow to deeply lobed, dark glossy green above and pale green below. Long erect spikes of pink to reddish flowers. It's great for slopes because of its strong roots. They are found in the high forest and are geographically scattered over Africa and parts of the world. (Dressler et al., 2014).

Kingdom – Plantae

Division – Tracheophyta

Class – Magnoliopsida

Order – Lamiales

Family – Acanthaceae

Genus – *Acanthus* L.

Species – *Acanthus montanus* (Nees) T. Anderson

Source: GBIF Secretariat 2021.

ETHNOMEDICINAL USES



Acanthus montanus has been used traditionally for several therapeutic purposes; In Nigeria, the paste of the young twigs with sugar has been applied to hasten suppuration, and a decoction of the young leaves and twigs has also been taken for indigestion and as vermifuge and emmenagogue. The leaves are taken by post-natal mothers in southern Nigeria to ensure health and vitality. The roots are used for the treatment of furuncles, leaves for boils on the fingers, and also for cough. (Igoli et al., 2005). The central portion of the twigs and leaves is applied as a hot poultice to mature abscesses and decocted leaves are used as purgative and also used for the treatment of gonorrhoea, syphilis, wounds, and boils. Also used for treating cardiac dysfunctions and hepatitis. (Okenwa & Jude, 2014). The leaves together with *Ananas comosus* and *Costus spp.* are crushed in water and used to treat urogenital infections, urethral discomfort, endometritis, urinary illness, cystitis, and leucorrhoea in the Democratic Republic of Congo (Didie, 2005). Bathing with the roots might help reduce aches and pains (Ibe & Nwifo, 2005). The plant's leaves have spasmolytic, analgesic, anti-inflammatory, and antipyretic qualities, according to documented evidence of pharmacological activities. It has been established that saponins and the gammaceranes- acanthusol and its 3-O—D-glucopyranoside (Anan, 1997) have been isolated from the plant. In Nigeria, the Igede people of Benue State (Igoli et al., 2004) and the Enugu-Ezike community of Enugu State employ the root poultice to treat furuncles. The furuncle, commonly known as a boil, is the most frequent type of abscess, and pyogenic organisms including *Staphylococcus aureus* and *Pseudomonas aeruginosa* have been linked to it (Sleigh et al., 2001). The root poultice is thought to produce "boil ripening" in local use, which is a lay term for increased pus formation in a boil, which is thought to signify that the illness has been overcome.

PHYTOCHEMISTRY

Phytochemistry is coined from the word "Phytochemicals". Hence it is the study of phytochemicals. They are biologically active compounds present in plants that are derived from the roots, leaves, stems, flowers, fruits, and seeds. They are produced from the plant's primary and secondary metabolism and are important for the plants to thrive or thwart other plants, animals, insects, and microbial pests and pathogens. They also help plants and protect them from disease and damage caused by environmental hazards like pollution, UV, stress, and draught. (Vishnu et al., 2019). The phytochemical screening of the root extract of *Acanthus montanus* yielded an abundance of alkaloids, flavonoids, steroids, carbohydrates, saponins, tannins, glycosides, and terpenoids. (Odoh et al., 2013, Orakwue et al., 2012 and Okoli et al., 2008). (Okenwa & Jude, 2014) reported that the Gas chromatography-mass spectrometry (GC-MS) analysis of ethanol leaf extract yielded nine compounds; 2,6-bis(1,1-dimethylethyl)-4-methyl phenol (13.68 %), alpha-methyl 4-methylmannoside (8.41 %), sulfurous acid cyclohexylmethyl hexyl ester (5.67 %), allyl(2-tetrahydrofuryl methoxy)dimethylsilane (3.86 %), N,N-dimethylvaleramide (18.62 %), hexadecanoic acid methyl ester (16.12 %), 11-octadecenoic acid methyl ester (19.03 %), docosane (5.85%) and 2,6,10,15-tetramethyl heptadecane (8.76%).

BIOLOGICAL ACTIVITIES

The cold water tail-flick assay was used to examine the analgesic effect of the methanol leaf extract of *Acanthus montanus* in rats, while the tail immersion, tail clip,



acetic acid-induced writhing, and formalin pain tests were used in mice. With doses of 200 and 400 mg/kg of the extract in the tail flick, tail immersion, and tail clip procedures, the results demonstrated dose-dependent and significant ($p < 0.05$) increases in pain threshold at 60 minutes post-treatment. In the same tests, the effects of the extract were considerably ($p < 0.05$) lower than those of morphine (10 mg/kg). The extract (100 - 400 mg/kg) inhibited writhing in a dose-dependent manner and also inhibited both phases of the formalin pain test significantly ($p < 0.001$). However, the first phase has a weaker influence than the second. The findings suggest that the analgesic effect of *Acanthus montanus* methanol extract is mediated in both the central and peripheral nervous systems. (Adeyemi et al., 2004).

Experiments were conducted to test the antimicrobial, anti-inflammatory, and immunological effects of a traditional furuncle treatment. The root extract of the aqueous extract showed modest antibacterial activity against the common pathogens in boils, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. The *A. montanus* aqueous root extract considerably suppressed the development of the test organisms and significantly ($p > 0.05$) decreased topical acute edema in the mouse ear (57%). It inhibited the development of acute edema of the rat paw in a dose-independent manner ($p < 0.05$) but was ineffective in decreasing the global edematous response to formaldehyde arthritis. It also prevented acetic acid-induced vascular permeability in rats, as well as heat and hypotonicity-induced hemolysis of ox RBCs. At the 800 mg/kg dose, the extract raised total leukocyte and neutrophil counts, as well as a substantial ($p < 0.05$) dose-related rise in the total number of macrophages. At 800 mg/kg dose, the extract considerably ($p < 0.05$) increased the number of macrophages with ingested *Candida albicans* and significantly ($p < 0.05$) prevented Delayed hemolytic transfusion responses (DHTR) in a dose-dependent manner. Alkaloids and sugars were found in abundance in the extract, but saponins, glycosides, and terpenoids were only found at negligible levels. An oral and intraperitoneal LD₅₀ of more than 5000 mg/kg was determined in an acute toxicity test. The extract increased the total leukocyte and neutrophil counts and caused a significant increase in macrophages. (Okoli et al., 2008).

Acanthus montanus, *Alchornea laxiflora*, *Hyptis spicigera*, *Microglossa pyrifolia*, *Piliostigma reticulatum*, and *Voacanga africana* were evaluated for anticonvulsant and sedative activity in mice using animal models (maximal electroshock (MES), N-methyl-D-aspartate (NMDA), pentylenetetrazol (PTZ), isonicotinic hydrazide acid (INH), picrotoxin (PIC), and strychnine (STR)-induced convulsions or turning behavior and diazepam-induced sleep). *Acanthus montanus* protected 66.6% of mice against MES-, PIC-, and STR-induced convulsions and 83.3% of mice from PTZ-induced convulsions. *Alchornea laxiflora* protected 75% and 87.5% of mice in the STR and NMDA tests, respectively, at a dose of 120 mg/kg. *Hyptis spicigera* protected 100 and 87.5% of mice against STR- and PTZ-induced convulsions, respectively, at a dose of 160 mg/kg. *Microglossa pyrifolia* protected 50% to 100% of mice against convulsions. *Piliostigma reticulatum* protected 62.5% to 100% of mice against convulsions and turning behavior. *Voacanga africana* protected 62.5% to 87.5% of mice against convulsions and turning behavior. All of the plants except *A. laxiflora* also exerted sedative activity by strongly increasing the total duration of sleep induced by diazepam. (Bum et al., 2009).



The effects of *A. montanus* extracts on male and female albino rats were studied. The research utilized 90 albino rats, 45 males, and 45 females, separated into 18 groups of five rats. The male and female rats were identified using alphabets and figures. Normal rat chow was given to groups A and 1, 200, 400, 600, and 800 mg/kg of aqueous extract of *A. montanus* leaves was given to groups B and 2, C and 3, D and 4, E and 5, and 200, 400, 600, and 800 mg/kg of methanol extract of *A. montanus* was given to groups F and 6, G and 7, H and 8, I and 9 respectively. The test groups revealed a dose-dependent significant increase in liver enzyme tests, but significant decreases in total protein and albumin. In comparison to the control group, there were no significant differences in total and direct bilirubin. Creatinine levels increased significantly ($p < 0.05$) in test groups, but urea levels declined. The histo-architecture of the liver and kidney in the groups subjected to 800 mg/kg aqueous extract, 400, 600, and 800 mg/kg methanol extract indicated mild to widespread abnormalities. With increased dosage, *A. montanus* leaves may cause renal and hepatic impairment; therefore, they should be detoxified before use. (Iwueke et al., 2021).

The root extract has an oral and intraperitoneal LD₅₀ of more than 5000 mg/kg in an acute toxicity investigation. (Okoli et al., 2008). It was also shown that the aqueous leaf extract of *Acanthus montanus* is non-toxic when given orally and acutely at therapeutic dosages (< 200 mg/kg). The oral acute toxicity of *A. montanus* aqueous leaves extract on Wistar rats was investigated by Paulin et al., (2007). The rats were given single doses of 0, 500, 1000, 2000, 4000, and 8000 mg/kg and then examined for 7 days for behavioral changes and mortality before being euthanized. At doses up to 4000 mg/kg, the results demonstrated that a single oral dose of aqueous extract did not cause significant changes in general behavior or death. Animals given 8000 mg/kg dosages had a diminished reactivity to pinch, and their water and food intakes were significantly reduced. The relative organ weights and body weight growth was not considerably different. When compared to the control, serum total proteins and transaminase activities increased significantly in rats given 8000 mg/kg, but serum total proteins and transaminase activities remained unchanged. Histological investigation revealed no disease in the liver or lungs, but the 8000 mg/kg treated rats' kidneys showed degenerative alterations, which were confirmed by a rise in creatinine. The findings revealed that the plant had no adverse effects in rats at doses commonly used by the wider populace. The aqueous extract of *Acanthus montanus* was tested for sub-acute toxicity in female Wistar rats at doses of 0, 125, 250, 500, and 1000 mg/kg/day for 30 days and found to not affect hematological, biochemical, or oxidative stress markers. However, nephrotoxic and hyper-creatinine effects were detected at dosages more than 500 mg/kg, which is below the nominal human value. (Djami et al., 2011).

Nana et al., (2008) investigated the effects of methanol/methylene chloride leaves extract from *Acanthus montanus* on Wistar pregnant rats and identified the substance(s) required for these effects. Dams were given doses of 0, 250, 500, and 1000 mg/kg orally from days 6 to 15 of pregnancy (kg day). On day 20, they were either sacrificed or permitted to deliver and wean. Several parameters were evaluated. A variety of parameters were measured when the F1 generation offspring were allowed to give birth to the F2 generation. There was no toxicity in the mother or the organs, according to the findings. Embryotoxicity was seen during organogenesis as a decrease in fetal body weight, crown-rump, and tail lengths, and decreased ossification of



extremity bones. After delivery, however, these indicators of growth retardation were visible before day 5, and the treated pups' parameters returned to normal. For the F₁ and F₂ generations, all other factors were negligible. The extract's main chemical component was sitosterol, and its significance in these findings could not be overstated. This plant's MeOH/CH₂Cl₂ extract is embryotoxic at high dosages during pregnancy and a year after, although this did not appear after 5 days of post-natal survival. Sitosterol may play a key role in the extract's actions; hence patients who are pregnant can tolerate this extract.

The estrous cycle of Wistar rats was observed before, during, and after oral administration of distilled water (control) and *A. montanus* aqueous extract (62.5, 125, 250, 500, and 1000 mg/kg/day). Additionally, pregnant rats were given the above dosage of aqueous extract on days 1 – 6 (pre-implantation) or 6 – 15 (post-implantation) of gestation and sacrificed on days 8 or 20 of pregnancy respectively. Furthermore, ovariectomized rats were given aqueous extract (500 and 1000 mg/kg/day) in the presence or absence of exogenously administered estrogen and/or progesterone, and uterine weight and decidual count were assessed. The extract reversibly delayed the metestrous and on rare occasions diestrous stages of the estrous cycle regardless of dose. The extract did not affect the uterine wet weight or decidual count indicating that it has neither estrogenic nor pregestational properties. The extract induced pre-implantation losses of $36.8 \pm 6.5\%$ ($p < 0.05$), at 1000 mg/kg/day, but none of the doses caused post-implantation losses. The extract also caused fetal growth to be slowed. (Asongalem et al., 2008).

Patrick-Iwuanyanwu & Wegwu (2008) revealed that the ethanol and aqueous extracts of the leaf and stem of *A. montanus* may prevent liver damage induced by Carbon tetrachloride (CCl₄) in rats. Uroko et al., 2019 investigated the hepato-curative properties of the methanol extract of *Acanthus montanus* leaves on acetaminophen-induced liver failure in mice and found that the extract caused no adverse reactions or death in the mice. The extract reduced alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) activities and total bilirubin concentrations in rats with acetaminophen-induced liver failure, and significantly ($p < 0.05$) increased total protein, albumin, direct bilirubin concentrations, and improved liver histomorphology that were negatively affected by acetaminophen toxicity. The results of this investigation reveal that the methanol extract of *A. montanus* leaves has hepato-curative properties capable of reversing liver failure and alleviating hepatotoxic side effects.

The effects of *A. montanus* methanol extract on several smooth muscle preparations were investigated in this study. The extract caused rabbit jejunum to relax and suppress spontaneous contractions in a concentration-dependent manner. On guinea-pig taenia coli, the extract altered the concentration-response curves of CaCl₂ to the right in a concentration-dependent way. The findings pointed to the presence of a non-specific smooth muscle relaxant. (Adeyemi et al., 1999).

The in-vitro egg hatch and larval growth suppression assays were used to assess the anthelmintic efficiency of crude aqueous leaf extract of *A. montanus* against strongyle nematodes of small ruminants. The parasitological analysis of fecal samples taken via rectum from sheep and goats was carried out using the McMaster counting



technique, which yielded 700 eggs per gram (E.P.G.) of feces. With a yield of 13.01 % w/w, the crude aqueous leaf extract of *A. montanus* was extracted by cold water extraction. At a dosage of 25 mg/ml of extract, an egg hatch assay demonstrated a 91.75 % reduction in egg hatch. At a dosage of 200 mg/ml, the extract showed a 100% inhibitory effect, comparable to 3.125 mg/ml albendazole activity. However, 0% inhibition was observed in the distilled water control. The extract inhibited larval growth by 67.02% and 85.26% respectively, in a larval growth inhibition experiment on Day 1 at 25 mg/ml and 200 mg/ml doses. On Day 2, all concentrations of the extract produced 100% inhibition except 25 mg/ml which produced 88.30%. On Day 2, albendazole, on the other hand, demonstrated 100% larval suppression at all dosages. On Day 3, the 25 mg/ml dosages completely (100%) inhibited the larvae. At 200 mg/ml, the extract inhibited larval growth by 92.63% which was comparable to the standard anthelmintic (albendazole) at 12.50 mg/ml (92.28%). These findings demonstrated that the ethnomedicinal claim of *A. montanus*' anthelmintic action had a pharmacological basis. (Adamu et al., 2010).

To evaluate the anti-diabetic effect based on ethnomedicinal claims, the roots of *Acanthus montanus* were extracted with methanol and the extract was then extracted with n-hexane, petroleum ether, ethyl acetate, diethyl ether, and chloroform. The ethyl acetate fraction (EAF) was evaluated against alloxan-induced diabetic rats in a pilot investigation. Intraperitoneally, preliminary phytochemical analyses and acute toxicity investigations were performed in mice. Thin layer chromatography was used to try to separate the EAF into its constituents (TLC). The anti-diabetic study found that both normoglycemic and hyperglycemic rats had a significant dose-dependent reduction ($p < 0.05$) in blood sugar levels. When 100, 200, and 300 mg/kg of EAF were given intraperitoneally to alloxan-induced diabetic rats, blood sugar levels decreased considerably (21.91, 38.12, and 49.20% respectively) compared to glipalamide's sugar-reducing effect (51.78%). EAF (100, 200, and 300 mg/kg) significantly reduced blood sugar levels in normal rats by 19.20, 27.80, and 40.74 % respectively, while glipalamide induced a 49.94% drop. Alkaloids, flavonoids, glycosides, steroids, saponins, tannins, and terpenoids were found in phytochemical tests. The extract was found to be safe in an acute toxicity test in mice using Lorke's methodology with no deaths reported at a dose of 5000 mg/kg. According to the findings, the extract of the EAF of *A. montanus* in normoglycemic and alloxan-induced diabetic rats had a considerable and dose-dependent hypoglycemic effect thus providing a pharmacological basis for the use of *A. montanus* root is used in folk medicine to treat diabetes. Among the chromatographic solvent systems studied, chloroform: ethyl acetate (6:4) had the best EAF resolution and the most spots. (Odoh & Ezugwu, 2013).

The leaves of *Acanthus montanus* are used to cure gonorrhoea, syphilis, wounds, and boils in traditional herbal therapies in Southeastern Nigeria and other parts of West Africa. Hypertension, cardiac dysfunctions, hepatitis, and heart disorders are all treated with *A. montanus* in ayurvedic medicine. Using the Gas Chromatography-Mass Spectrometry (GC/MS) technology, the chemical components of the ethanol extract of *A. montanus* leaves were analyzed, and nine substances were found, including 2,6-bis(1,1-dimethyl ethyl)-4-methyl phenol (13.68 %), allyl(2-tetrahydrofuryl methoxy)dimethyl silane (3.86 %), sulfurous acid cyclohexylmethyl hexyl ester (5.67%), alpha-methyl 4-methylmannoside (8.41%), hexadecanoic acid methyl ester

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(16.12%), 11-octadecenoic acid methyl ester (19.03%), docosane (5.85%), N, N-dimethylacetamide (18.62%) and 2,6,10,15-tetramethyl heptadecane (8.76%). *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus cereus*, *Escherichia coli*, *Salmonella typhi*, and *Proteus mirabilis* were all susceptible to the extract. The Disc Diffusion Technique was used to determine the susceptibility of each test microorganism to the extract. The presence of these bioactive chemicals in the leaves of *A. montanus* could explain its antibacterial properties as well as its use in Nigerian herbal medicine for the treatment of illnesses and infections. (Okenwa & Nnaji, 2014).

The biochemical content of *Acanthus montanus* leaves was studied after they were processed. The raw vegetable had 59.15, 1.85, 2.32, 3.76, 2.04, and 34.65 g/100 g of moisture, crude protein, fat, fiber, ash, and total carbohydrate, respectively. The raw vegetable contained 5.35, 4.04, 1.10, 3.53, 2.87, and 1.27 g/100 g saponin, alkaloid, tannin, flavonoid, phenol, and anthocyanin, respectively, as well as 2.65 mg/100 g calcium, 1.14 mg/100 g magnesium, 7.66 mg/100g potassium, 350.75 g/g vitamin A, 50.87 mg/100g vitamin C, and 0.25% titratable acidity. Protein, lipid, fiber, ash, saponin, alkaloid, tannin, phenol, anthocyanin, calcium, magnesium, potassium, vitamin A, vitamin C, and titratable acidity of boiled or boiled + sun-dried *A. montanus* leaves were significantly reduced ($p < 0.05$); significant elevation of moisture contents but significant reduction of total carbohydrate contents of the boiled; and significant reduction of moisture contents of the boiled + sun-dried vegetable comparison. The total carbohydrate content of the boiled + sun-dried leaves increased significantly ($p < 0.5$); the moisture, saponin, alkaloid, and vitamins A and C content of the sun-dried vegetable decreased significantly ($p > 0.5$); and there were no significant differences ($p > 0.5$) in the lipid, calcium, potassium, and ash, but significant increases ($p < 0.5$) in the protein, crude fiber, total carbohydrates, tannins, flavonoids, phenols, anthocyanin. The release of some essential bioactive chemicals in *A. montanus* leaves was either preserved or augmented by sun drying alone. Furthermore, the sun-dried vegetable's lower moisture content combined with its enhanced titratable acidity will render it uninhabitable for microbes, extending its shelf life. (Igwe & Eleazu, 2017).

Nine compounds were identified from a phytochemical screening of an alcoholic extract of aerial parts, eight of which had varying degrees of insecticidal action. At two doses, 1.25 g/mg and 0.63 g/mg, eight of the isolated compounds were tested for action against female *Aedes aegypti* adults. They include -sitosterol glucoside (1) and palmitic acid (2), which were the most active showing 100% and 90% mortality, respectively, at 1.25 $\mu\text{g}/\text{mg}$ concentration, followed by linarioside (3) 80%, acetoside (9)70%, protocatechuic acid (7) 40%, and homoplantagenin (3) 30%. At concentration 0.63 $\mu\text{g}/\text{mg}$, compounds (1), (2), (3), and (6) were active showing 90%, 80%, 70%, and 10% adulticidal activity, respectively. Acetone and Permethrin were utilized as negative and positive controls, causing 0% and 100% mortality at the studied doses, respectively. LD_{50} of permethrin is 4.9×10^{-5} . (Rahuman et al., 2000.) reported palmitic acid's larvicidal effectiveness against *Culex quinquefasciatus*, *Anopheles stephensi*, and *Aedes aegypti*. However, this is the first report of these chemicals' adulticidal activity. (Elham et al., 2012).

The ability of crude aqueous and ethanol leaf extracts of *Acanthus montanus* (ACMO), *Asystasia gangetica* (ASGA), *Emilia coccinea* (EMCO), and *Hibiscus rosasinensis* (HIRO), as well as their combinatorial formulations, to reduce

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hyperglycemia in Type I diabetic rats was investigated. Hyperglycemia was induced by injecting 120 mg/kg BW of alloxan monohydrate in phosphate buffer saline (PBS) solution (pH = 7.4) intraperitoneally. For 14 days, individual hyperglycemic rats (HyGR) were given independent dosages of ACOM, ASGA, EMCO, or HIRO, as well as their combinatorial formulations (AAEH). The four herbal samples' aqueous extracts (AQx) and ethanol extracts (ETHx) were prepared using established techniques. The glucose oxidase spectrophotometric method was used to quantify the fasting blood glucose concentration (FBGC) of 12 h post-fasted rats at regular intervals of 24 h for 14 days. ETHx of the herbal samples had a better capacity to lower FBGC in HyGR than the aqueous and ethanol extracts of AAEH had the highest capacity to lower FBGC in HyGR by 53.55 ± 1.04 %, whereas AQx of EMCO had the lowest capacity to lower FBGC by 36.19 ± 0.88 %. The study found that ethanol extracts of herbal samples were more effective than aqueous extracts as glycemic control and hyperglycemia treatment agents. Furthermore, combining the herbal extracts boosted the therapeutic potential of the separate herbal extracts synergistically. (Ojiako et al., 2015).

The effect of an aqueous extract of *A. montanus* leaves on spermatogenesis in Swiss albino mice was studied by Orlu & Obulor (2014). The extract enhanced spermatogenic activity reversibly regardless of dose, with 500mg/kg-1b.wt showing the best results. Independent of the rise in the concentration of *A. montanus* extract, no significant reduction in body weight or weight of reproductive organs was found, and the gonado-somatic index remained stable. The extract's ability to increase spermatogenic indices and overall spermatogenic yield suggests that it could be used as an herbal therapy for spermatogenic malfunction.

Using carrageenan-induced paw edema in mice, the anti-inflammatory efficacy of the aqueous extract of *Acanthus montanus* was tested and compared to that of diclofenac, a non-steroidal anti-inflammatory medication, and L-Nitro arginine methyl ester (L-NAME), a nitric oxide inhibitor. The carrageenan-induced mouse paw was considerably decreased by the extract at dosages ranging from 100 to 400 mg/kg p.o., diclofenac (50 mg/kg, p.o.), and the NO synthase inhibitor NG-nitro-L-arginine methyl ester (L-NAME; 100 mg/kg, s.c.). At a dose of 300 mg/kg, L-Arginine, a precursor of nitric oxide, significantly antagonized the extract's (76.00 %) and L-(85.00 NAME's %) anti-inflammatory effects. Diclofenac's anti-inflammatory action is unaffected by L-Arginine. These findings show that nitric oxide (NO) inhibition may be responsible for *Acanthus montanus* aqueous extract's anti-inflammatory properties. These results support the ethnopharmacological use of the plant in the treatment of diverse inflammatory ailments. (Foyet et al., 2008).

The study examined crude extracts of six Cameroonian medicinal herbs for antimycobacterial activity in vitro against the pathogenic H37Rv strain. *Acanthus montanus*, *Beilschmeidia obscura*, *Cissus petiolate*, *Enantia chlorantha*, *Urera repens*, and *Garcinia preussii* were all active, with minimum inhibitory concentrations (MICs) ranging from 31.25 g/ml to 250 g/ml. *B. obscura* was the most active at MIC 31.25. The MIC of *Acanthus montanus* was 62.5 g/ml, with growth inhibition of 95.06 %. These findings imply that the anti-inflammatory properties of *Acanthus montanus* aqueous extract may be attributable to the suppression of nitric oxide (NO). (Nkenfou et al., 2015).



Using established protocols, the effects of aqueous extracts of *Emilia coccinea*, *Acanthus montanus*, *Hibiscus rosasinensis*, and *Asystasia gangetica* on serum glucose concentration, amylase activity, and lipid profiles of normal, diabetic, and liver-damaged rabbits were investigated. For 28 days, a mixture of the four plants' aqueous extracts were given orally in two doses: 120 mg/kg body weight and 240 mg/kg body weight. With no changes in amylase activity, the medication caused dose- and duration-dependent significant ($p < 0.05$) decreases in serum glucose, total cholesterol, triacylglycerol, and LDL-cholesterol, as well as significant ($p < 0.05$) elevations in HDL-cholesterol concentrations. These findings support the crude drug's hypoglycemic, antihyperlipidemic, and hepatoprotective properties, and hence validate its use in ethnomedicine for diabetes control. No changes in amylase activity were seen at these doses. (Ojiako et al., 2015). Further investigation into the hypoglycemic activity found that methanol inhibited both -amylase and -glucosidase more effectively than ethanol. The methanol extract inhibited both -amylase and -glucosidase in a non-competitive and competitive manner, according to the Lineweaver-Burk plot. This suggests that the hypoglycemic action of *A. montanus* extracts could be due to the inhibition of these enzymes (-amylase and -glucosidase). The presence of phytochemicals in the extracts may have prompted this observation. (Anugweje et al., 2012).

The ability of single and combinational herbal formulations of *Acanthus montanus*, *Asystasia gangetica*, *Emilia coccinea*, and *Hibiscus rosa-sinensis* leaf extracts to repair renal and hepatic damage in alloxan-induced hyperglycemic Wistar rats was examined. Herbal therapies improved cellular integrity and reversed glomeruli atrophy and turf disarrayment, as well as blood biochemical indicators that suggested cellular integrity was restored. The results demonstrated that single and combined benefits had variable capacities for restoring renal and hepatic damage in hyperglycemic rats. (Ojiako et al., 2015).

The uterine contractile activity of *A. montanus* extract was investigated in female Wistar rats using the *Ugo Basile* organ bath model 4050. The uterus of rats was significantly contracted by oxytocin and acetylcholine. Extract administration resulted in a dose-dependent ($p = 0.5$) reduction in oxytocin and acetylcholine-induced contractions. The methanol extract of *A. montanus* was found to have an anti-contractile effect on uterine smooth muscles in non-pregnant rats, corroborating its usage in the treatment of spontaneous abortion. The absence of death at 5000 mg/kg of methanol extract indicates that the lethal dose is more than 5000 mg/kg, which could indicate that the plant is safe. (Okieimen et al., 2018).

The effects of *Acanthus montanus* aqueous extract, fractions, and *Acanthus sulfate ester* (ASE) - a newly discovered sulfate ester - on the rat uterus were studied for the first time in this study. An organ bath containing an isolated unpregnant rat uterus suspended in De Jalons physiological solution and aerated with Carbogen (95% O₂ + 5% CO₂) was used in this *in vitro* study. Following equilibration, the extract, fraction, and ASE were individually introduced to the tissue and compared to standard uterine agonists in the absence and presence of standard antagonists. A two-channel *Ugo Basile* recorder was used to capture the responses. The extract displayed a biphasic activity, first relaxing spontaneous uterine contractions (IC₅₀ = 3.00 mM) and then stimulating



the same tissue ($IC_{50} = 0.63$ mM). Depending on the polarity of the extraction solvent, its percentage displayed both relaxation and contraction. The uterus was constricted by 100 % methanol fraction ($IC_{50} = 150.0$ M) and ASE (131.0 M). The IC_{50} s of the remaining fractions were inconsistent. PGF_2 , acetylcholine, diazoxide, oxytocin, and histamine all had lower stimulatory actions. Phentolamine, prazosin, pyrilamine, indomethacin, and verapamil, but not atropine, inhibited the extract, methanol fraction, and ASE. Propranolol had little effect on the extract, whereas tetraethylammonium stimulated it slightly. Quinacrine did not affect the activity of the extract and MeOH fractions. The most powerful inhibitor was verapamil. Both external and intracellular calcium and potassium ionic channels were shown to be implicated in the mechanism of action of ASE as they are most likely connected. (Asongalem et al., 2019).

Uroko et al., (2019) assessed the acute toxicity of a methanol extract of *A. montanus* leaves in mice. The extract had no deleterious effects on the mice and no death was recorded. The extract reduced ($p > 0.05$) alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) activities and total bilirubin concentrations in rats with acetaminophen-induced liver failure, and significantly ($p < 0.05$) increased total protein, albumin, direct bilirubin concentrations, and improved liver histomorphology that were negatively affected by acetaminophen toxicity. The study's findings revealed that a methanol extract of *A. montanus* leaves has hepato-curative properties capable of reversing liver failure and alleviating hepatotoxic side effects.

CONCLUSION

The numerous phytochemical and biological reports of *Acanthus montanus* could be seen to strongly validate its ethnomedicinal claims. It can be concluded that the reports from this plant suggest further exploitation of the parts of this plant to unveil more of its potential uses for therapeutic purposes.

DECLARATION OF CONFLICT OF INTEREST

No conflict of interest to declare.

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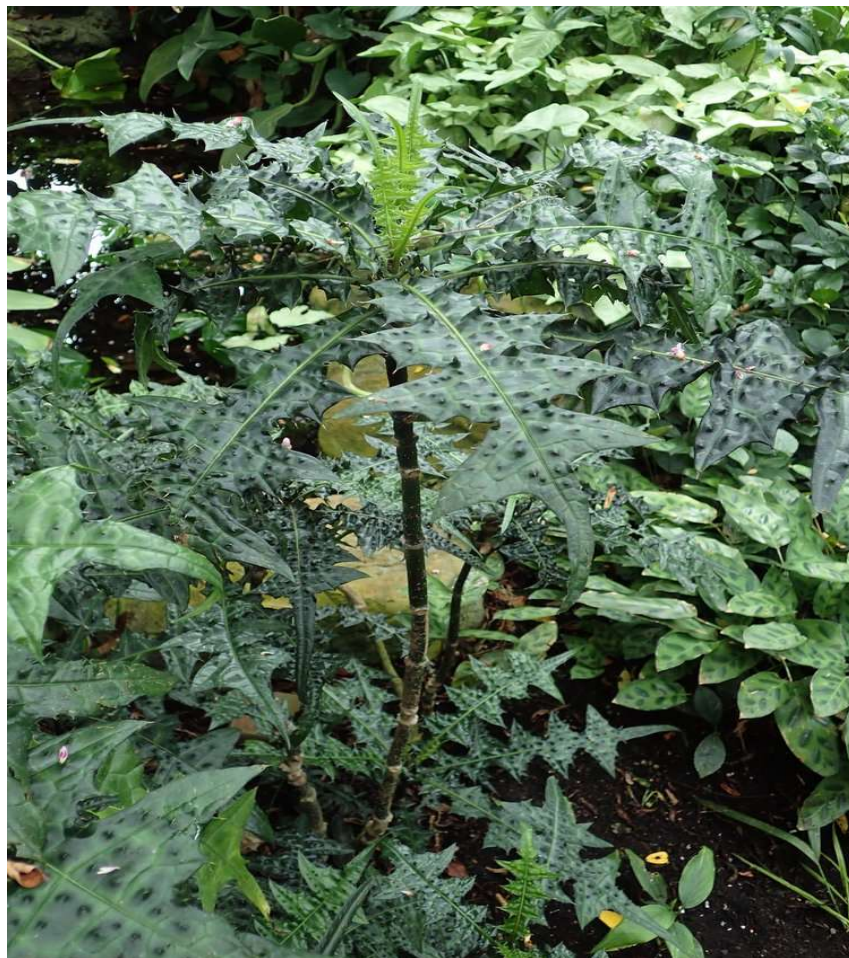
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APPENDIX



Acanthus montanus