

Annona stenophylla Engl. & Diels: review of its botany, medicinal uses and biological activities

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Abstract

Annona stenophylla is a fruit plant widely used as herbal medicine throughout its distributional range in east, central and southern Africa. This study was aimed at providing a critical review of the botany, medicinal uses and biological activities of *A. stenophylla*. Documented information on the botany, biological activities and medicinal uses of *A. stenophylla* was collected from several online sources which included BMC, Scopus, SciFinder, Google Scholar, Science Direct, Elsevier, Pubmed and Web of Science. Additional information on the botany, biological activities and medicinal uses of *A. stenophylla* was gathered from pre-electronic sources such as book chapters, books, journal articles and scientific publications sourced from the University library. This study showed that the leaves, roots and twigs of *A. stenophylla* are used as blood and stomach purifier, induce labour pains, and as herbal medicine for infertility, malaria, skin infections and stomach problems. Pharmacological research revealed that *A. stenophylla* extracts have antibacterial, antifungal, anti-inflammatory, antioxidant and hypoglycaemic activities. *Annona stenophylla* should be subjected to detailed phytochemical, pharmacological and toxicological evaluations aimed at correlating its medicinal uses with its phytochemistry and pharmacological activities of the species.

Keywords: *Annona stenophylla*, Annonaceae, ethnopharmacology, herbal medicine, indigenous pharmacopeia

INTRODUCTION

Annona stenophylla Engl. & Diels is a member of the Annonaceae or custard apple or soursop family. Family Annonaceae is the largest family within the Magnoliales order with 108 accepted genera and about 2400 known species.¹⁻³ Genus *Annona* L., with several other genera such as *Anonidium* Engl. & Diels, *Asimina* Adans., *Rollinia* A. St. Hil. and *Uvaria* L. produce edible fruits.⁴⁻¹⁶ Members of the Annonaceae family are used all over the world as herbal medicines¹⁷⁻²¹, particularly for helminthiasis, dysentery, diarrhoea, asthma, cough, fever, wounds, cancer, dermatitis, diabetes, headache, peptic ulcers, mental disorders, malaria and related illnesses.²²⁻²⁸ *Annona* is one of the most important genera within the Annonaceae family due to its edible fruits and medicinal properties.²⁹ Some species of *Annona* are characterized by phytochemical and pharmacological activities such as cytotoxicity against various tumour cell lines, antiproliferative, anti-inflammatory, hypoglycemic, hepato-protective, anxiolytic, anticholinesterase, antimicrobial, analgesic, anticonvulsant, antioxidant, antiplatelet and antiparasitic, and these activities are generally attributed to the presence of acetogenins, alkaloids, essential oils, quinones, sesquiterpene lactones, sterols and terpenes.^{25,26,29-37} Tundis et al.³⁸ argued that the presence of the compound acetogenins in most members of the family Annonaceae makes the taxon one of the most promising sources of pharmaceutical and natural health products that can be used as antitumor agents. Pinto et al.³⁹ argued that *Annona* species are underutilized species as sources of food and medicinal plants. Similarly, *A. stenophylla* is an important fruit and medicinal plant in east, central and southern Africa.^{40,41} Research carried by Novotna et al.⁴² showed that *A. stenophylla* is an important medicinal plant in Angola characterized by high cultural value. The fruits of *A. stenophylla* have a pineapple-like (*Ananas comosus* (L.) Merr.) smell, is pleasantly

flavoured, tasty and local people in east, central and southern Africa eat them raw, cooked, or preserved. In the diets of those people living in the semi-arid northern areas of Botswana and Namibia, *A. stenophylla* becomes almost staple food during the dry season.⁴³⁻⁴⁵ In Tanzania, the fruits of *A. stenophylla* are much sought after by herdsmen and children and the ripe fruits are soaked in water, squeezed and filtered to produce a non-alcoholic juice [46]. The fruits of *A. stenophylla* are edible throughout the distributional range of the species in east, central and southern Africa.⁴⁷⁻⁶⁰ In Angola, the leaves of *A. stenophylla* are used as tea.⁵⁹ It is within this context that the current study was undertaken aimed at reviewing the botany, medicinal uses and biological activities of *A. stenophylla*.

Botanical profile of *Annona stenophylla*

There is no agreement on the meaning or origin of the genus name *Annona*. The National Research Council⁶¹ and Quattrocchi⁶² argued that the name *Annona* refers to a native Brazilian or American Indian (Taino) name while other researchers such as Palmer and Pitman,⁴³ Lizana and Reginato⁶³ argued that the genus name "*Annona*" is based on the Latin word "*Annona*" meaning "yearly produce" in reference to the edible fruits borne by some members of the genus. The specific name "*stenophylla*" means "narrow-leaved" in reference to narrowly oblong-elliptic, oblanceolate, ovate or obovate leaves characteristic of the species.⁶⁴ The genus *Annona* consists of approximately 200 species including genera *Raimondia* Saff. and *Rollinia* which are neotropical and afrotropical trees and shrubs.⁶⁵ *Annona stenophylla* is subdivided into four subspecies, subsp. *cuneata* (Oliv.) N. Robson, subsp. *longepetiolata* (R.E.Fr.) N. Robson, subsp. *nana* (Exell) N. Robson and subsp. *stenophylla*.^{64,66-69} The synonyms of *A. stenophylla* are *A. cuneata* (Oliv.) R.E.Fr., *A. longepetiolata* (R.E.Fr.) Robyns & Ghesq., *A. longepetiolata* var. *precaria* Robyns

& Ghesq., *A. nana* Exell, *A. nana* var. *sessilifolia* Exell and *A. senegalensis* Pers. var. *cuneata* Oliv.^{64,66-69}

Annona stenophylla is a low-growing suffrutex or dwarf rhizomatous shrublet ranging in height from 40 cm to 100 cm.^{44,46,68} *Annona stenophylla* has simple or branched stems, red-brown branchlets which are hairy at first and sometimes persisting.⁴⁶ The leaves of *A. stenophylla* are alternate, usually hairy, often wider towards the tip, rounded, the base narrowed or rounded to a short stalk and the blade blue-green, paler below with dense hairs, marked by green-red to purple nerves, and a dense network of smaller veins above and below.⁴⁶ The flowers are cream-yellow to brown in colour, hairy outside and hanging down on hairy stalks. The fruit is orange-yellow in colour when ripe with black and shiny seeds. *Annona stenophylla* has been recorded in Angola, Botswana, the Democratic Republic of Congo (DRC), Mozambique, Namibia, Zambia and Zimbabwe in woodland and sandy grassy slopes at the edge of wetlands.^{46,64,66-80}

Medicinal uses of *Annona stenophylla*

The leaves, roots and twigs of *A. stenophylla* are used as blood and stomach purifier, to induce labour pains, and as herbal medicine for infertility, malaria, skin infections and stomach problems (Table 1, Figure 1). In Namibia, roots of *A. stenophylla* are mixed with those of *Diospyros chamaethamnus* Mildbr., *Strychnos pungens* Soler., *Diplorhynchus condylocarpon* (Müll. Arg.) Pichon and *Bobgunnia madagascariensis* (Desv.) J.H. Kirbr. & Wiersema as herbal medicine for malaria and psychological problems.^{52,81} In Zimbabwe, roots of *A. stenophylla* are mixed with those of *Securidaca longepedunculata* Fresen. as remedy for gonorrhoea while the roots are mixed with those of *Elephantorrhiza goetzei* (Harms) Harms as remedy for syphilis.^{40,41,82,83} Roots of *A. stenophylla* are used as ethnoveterinary medicine for bloody urine and external parasites in livestock.^{40,84-88} Research by Berger⁸⁹ and Sola et al.⁹⁰ showed that *A. stenophylla* is used as a pesticide in Zimbabwe. The roots of *A. stenophylla* are mixed with those of *Securidaca longepedunculata* as snake repellent.⁴⁰

Table 1: Medicinal uses of *Annona stenophylla*

Medicinal use	Parts used	Countries	References
Abdominal pains	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; McGregor ⁴⁹ ; Munodawafa ⁹¹
Anaemia	Leaves and roots	Angola	Lautenschläger et al. ⁵⁹
Anti-emetic	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Chagonda et al. ⁸⁷ ;
Appendicitis	Roots	Angola	Lautenschläger et al. ⁵⁹
Backache	Leaves and roots	Angola	Lautenschläger et al. ⁵⁹
Blood and stomach cleansing	Leaves and roots	Angola and Zimbabwe	Gelfand et al. ⁴⁰ ; Lautenschläger et al. ⁵⁹ ; Chagonda et al. ⁸⁷
Chest pains and hiccough	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Chagonda et al. ⁸⁷ ; Maroyi ⁹² ; Maroyi ⁹³ ; Tandi et al. ⁹⁴
Contraceptive	Twigs	Zimbabwe	Chinemana et al. ⁹⁵
Cryptorchidism	Roots	Angola	Lautenschläger et al. ⁵⁹
Diabetes	Roots	Zimbabwe	Phiri and Chagonda ⁵⁶ ; Chagonda et al. ⁸⁷ ; Verengai et al. ⁹⁶
Epilepsy	Roots	Angola	Lautenschläger et al. ⁵⁹
Eye problems	Roots	Namibia	Leffers ⁹⁷
Haemorrhoids	Roots	Angola	Lautenschläger et al. ⁵⁹
Hernia	Roots	Angola	Lautenschläger et al. ⁵⁹
Induce labour pains	Roots	Angola and Zimbabwe	McGregor ⁴⁹ ; Urso et al. ⁹⁸
Infertility	Roots	Angola and Zimbabwe	McGregor ⁴⁹ ; Lautenschläger et al. ⁵⁹
Influenza	Roots	Angola	Lautenschläger et al. ⁵⁹
Malaria	Roots	Angola	Lautenschläger et al. ⁵⁹
Malaria and psychological problems	Roots mixed with those of <i>Diospyros chamaethamnus</i> Mildbr., <i>Strychnos pungens</i> Soler., <i>Diplorhynchus condylocarpon</i> (Müll. Arg.) Pichon and <i>Bobgunnia madagascariensis</i> (Desv.) J.H. Kirbr. & Wiersema	Namibia	Von Koenen ⁵² ; Dushimemaria ⁸¹
Menstrual problems	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Van Wyk and Gericke ⁸² ; Chagonda et al. ⁸⁷
Muscle sprains	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Chagonda et al. ⁸⁷
Oedema	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Chagonda et al. ⁸⁷
Open cervix	Leaves	Angola	Lautenschläger et al. ⁵⁹
Parasitic worms	Roots	Angola	Lautenschläger et al. ⁵⁹
Post partum	Roots	Angola	Lautenschläger et al. ⁵⁹
Rheumatism	Roots	Zimbabwe	Gelfand et al. ⁴⁰

Medicinal use	Parts used	Countries	References
Scoliosis	Leaves and roots	Angola	Lautenschläger et al. ⁵⁹
Sexually transmitted diseases, gonorrhoea and syphilis	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Chagonda et al. ⁸⁷ ; Munodawafa ⁹¹ ; Maroyi ⁹³ ; Tandi et al. ⁹⁴ ; Kambizi and Afolayan ⁹⁹
Gonorrhoea	Roots mixed with those of <i>Securidaca longepedunculata</i> Fresen.	Zimbabwe	Gelfand et al. ⁴⁰ ; Van Wyk and Gericke ⁸² ; Maroyi ⁸³
Syphilis	Roots mixed with those of <i>Elephantorrhiza goetzei</i> (Harms) Harms	Zimbabwe	Gelfand et al. ⁴⁰ ; Schmidt et al. ⁴¹ ; Van Wyk and Gericke ⁸² ; Maroyi ⁸³
Skin infections, boils and inflammation	Roots	Angola, Namibia and Zimbabwe	Gelfand et al. ⁴⁰ ; Maroyi ⁹² ; Maroyi ⁹³ ; Chinsembu and Hedimbi ¹⁰⁰ ; Twilley and Hall ¹⁰¹ ; Pompermaier ¹⁰²
Antidote and snake repellent	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Chagonda et al. ⁸⁷ ; Maroyi ⁹³
Snake repellent	Roots mixed with those of <i>Securidaca longepedunculata</i>	Zimbabwe	Gelfand et al. ⁴⁰
Stomach problems, constipation and diarrhoea	Roots, stems and twigs	Angola, Namibia and Zimbabwe	Gelfand et al. ⁴⁰ ; Lautenschläger et al. ⁵⁹ ; Chagonda et al. ⁸⁷ ; Chinemana et al. ⁹⁵ ; Urso et al. ⁹⁸ ; Chinsembu et al. ¹⁰³
Toothache	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Munodawafa ⁹¹
Typhus	Leaves	Angola	Lautenschläger et al. ⁵⁹
Ethnoveterinary medicine (bloody urine and external parasites)	Roots	Zimbabwe	Gelfand et al. ⁴⁰ ; Chavhunduka ⁸⁴ ; Guèye ⁸⁵ ; Adedeji et al. ⁸⁶ ; Chagonda et al. ⁸⁷ ; Mohammed ⁸⁸

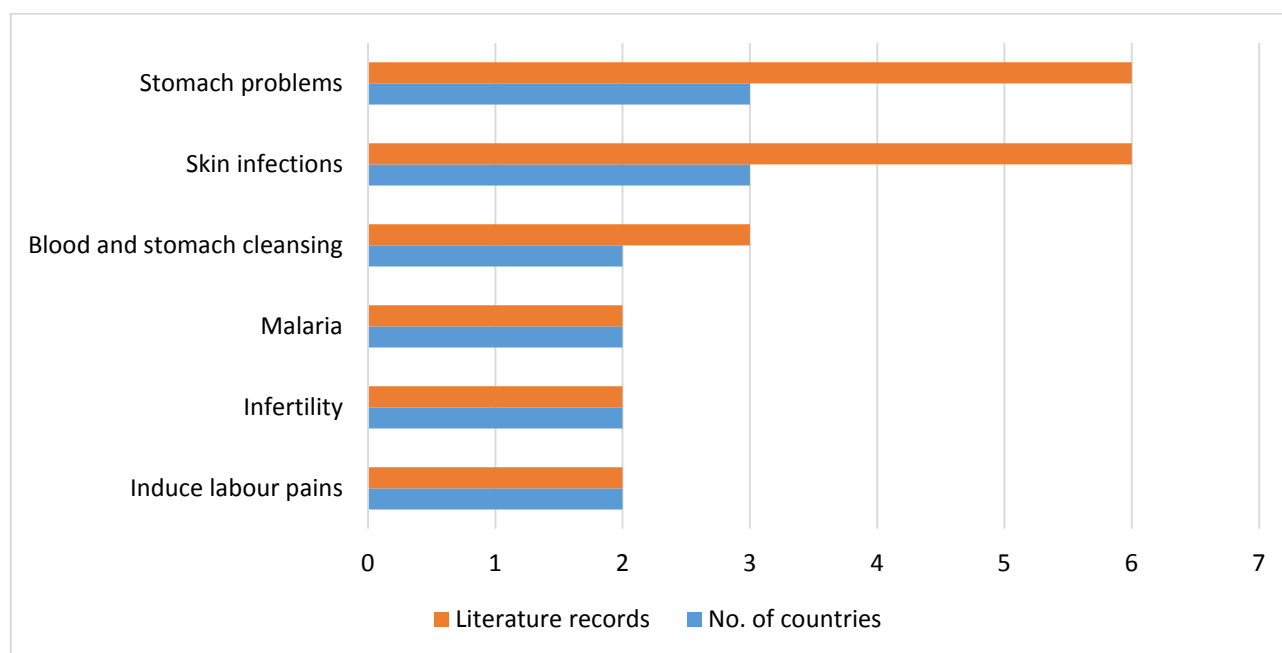


Figure 1. Medicinal applications of *Annona stenophylla* derived from literature records

Biological activities of *Annona stenophylla*

The following biological activities have been reported from the leaf, root and root bark extracts of *A. stenophylla*: antibacterial,^{91,104} antifungal,^{91,104} anti-inflammatory,¹⁰² antioxidant^{91,105} and hypoglycaemic^{56,96,106,107} activities.

Antibacterial activities

Munodawafa⁹¹ and Munodawafa et al.¹⁰⁴ evaluated the antibacterial activities of leaf and root methanol extracts of *A. stenophylla* against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Staphylococcus*

Group A using the agar well-diffusion method with ampicillin, amoxicillin, gentamicin and tetracycline as positive controls. The leaf extract was active against *Staphylococcus aureus* and *Staphylococcus* Group A with zone of inhibition ranging from 1.0 mm to 1.5 mm, and root extract was active against *Pseudomonas aeruginosa* and *Staphylococcus* Group A with zone of inhibition ranging from 2.8 mm to 3.0 mm and positive controls exhibiting zone of inhibition ranging from 4.0 mm to 13.0 mm. The minimum inhibitory concentration (MIC) values ranged from 10.0 mg/ml to >10.0 mg/ml.^{91,104}

Antifungal activities

Munodawafa⁹¹ and Munodawafa et al.¹⁰⁴ evaluated the antifungal activities of leaf and root methanol extracts of *A. stenophylla* against *Aspergillus niger* and *Candida albicans* using the agar well-diffusion method with amphotericin B as the positive control. The root extract exhibited activities against tested pathogens with zone of inhibition ranging from 1.5 mm to 3.8 mm against 6.4 mm to 6.8 mm exhibited by the positive controls. The MIC values ranged from 2.5 mg/ml to >10.0 mg/ml.^{91,104}

Anti-inflammatory activities

Pompermaier et al.¹⁰² evaluated anti-inflammatory activities of methanol root extracts of *A. stenophylla* at different concentrations of 100 µg/mL, 50 µg/mL and 10 µg/mL to assess their inhibition on cyclooxygenase (COX)-2 expression and on nitric oxide (NO) release in lipopolysaccharide (LPS)-stimulated J774A.1 macrophages. Pompermaier et al.¹⁰² also evaluated anti-inflammatory activities at a lower concentrations of 5 µg/mL, 2.5 µg/mL and 1.25 µg/mL for their potential on inhibition of tumour necrosis factor- α (TNF- α) and interleukin 6 (IL-6) release. At 10 µg/mL to 100 µg/mL concentrations, inhibition on COX-2 expression and NO release ranged from 68.8% to 81.1%. At 1.25 µg/mL to 5.0 µg/mL concentrations, inhibition on COX-2 expression and NO release ranged from 31.0% to 54.4%. The effects of the extract on TNF- α and IL-6 release ranged from 9.9% to 42.4%.¹⁰²

Antioxidant activities

Munodawafa⁹¹ and Munodawafa et al.¹⁰⁵ evaluated the antioxidant activities of methanol leaf and root extracts of *A. stenophylla* using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay with β -carotene as the positive control. The antioxidant activity of the extract was 81.2% to 83.3% inhibition which was comparable to 98.6 % inhibition exhibited by the positive control.^{91,105}

Hypoglycaemic activities

Phiri and Chagonda⁵⁶ evaluated the hypoglycaemic activities of aqueous root bark extracts of *A. stenophylla* by administering intra-peritoneally a dose of 100 mg/kg body weight and glibenclamide at a dose of 0.2 mg/kg body weight against alloxan-induced diabetic mice (120 mg/kg body weight) for one week. The effects of the extract on blood glucose levels of diabetic mice was determined at two hour intervals for eight hours after intra-peritoneal administration of the extract. The glucose levels of diabetic mice progressively and significantly decreased with time implying that *A. stenophylla* has a hypoglycemic effect in diabetic mice and its effect was comparable to glibenclamide, the positive control.⁵⁶ Taderera et al.¹⁰⁶ evaluated the hypoglycaemic activities of aqueous root bark extracts of *A. stenophylla* by assessing inhibition of α -glucosidase and α -amylase on KAT reagents in the presence of sucrose and maltose substrates using acarbose as positive control. The extract and acarbose inhibited α -amylase in a dose dependent manner, and the half maximal inhibitory concentration (IC₅₀) values for α -amylase and α -glucosidase in the presence of sucrose or maltose ranged from 0.1 mg/ml to 1.2 mg/ml which were

comparable to IC₅₀ values of 0.1 mg/ml to 1.2 mg/ml exhibited by acarbose.¹⁰⁶ Taderera et al.¹⁰⁷ evaluated the antidiabetic activities of aqueous root extract of *A. stenophylla* on non-diabetic control and alloxan-induced diabetic male Sprague dawley rats by measuring food consumption, body weight, glucose, and insulin levels after oral glucose tolerance tests (OGTT) and subchronic repeated treatments for four weeks. The rats underwent OGTT as well as a 28 day sub-chronic repeated treatment with extract (100 mg/kg body weight), glibenclamide (2.5 mg/kg i.p) and insulin (200 µg/kg body weight) subcutaneously and blood glucose levels for OGTT were measured at 0, 30, 60, 90 and 150 minutes after treatments. Food consumption, body weight, blood glucose and serum insulin levels (ELISA) were then measured for four weeks. The extract decreased the glucose levels of alloxan-diabetic, diabetic and non-diabetic control rats in the OGTT study and the extract, glibenclamide and insulin were antihyperglycaemic in the long term study and insulin levels were higher at the end in comparison with the control.¹⁰⁷ Verengai et al.⁹⁶ evaluated the hypoglycaemic activities of aqueous root bark extract of *A. stenophylla* only or in combination with *Citrus limon* (L.) Osbeck and *Zingiber officinale* Roscoe on alloxan-induced diabetic rats over 14 days with glibenclamide administered at 0.2 mg/kg body weight used as a positive control. The extracts exhibited a dose dependent decrease in plasma glucose levels of the alloxan diabetic rats with 150 mg of *A. stenophylla* causing a decrease in plasma glucose levels by 48.4% and 900 mg showed a decrease of 61.6% after a period of seven days. The glucose levels of diabetic rats treated with all the plant species combined showed a reduction of 59.2%, while *A. stenophylla* combined with *Citrus limon* showed a reduction of 42.9%. These reductions in glucose levels were comparable to glibenclamide positive control which showed a 61.0% reduction.⁹⁶

Toxicity activities

Chagonda et al.⁸⁷ evaluated acute and sub-acute oral toxicity of the hydroethanolic root extract of *A. stenophylla* in Sprague Dawley rats by administering the extract daily in the range of 250 mg/kg to 2000 mg/kg body weight and the animals were examined for physical, histopathological and clinical biochemistry changes. There were no behavioural changes or deaths in the acute toxicity tests up to 2000 mg/kg body weight over 14 days. The biochemical tests on alanine aminotransferase (ALT), aspartate amino transferase (AST), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), glucose, creatinine, total bilirubin, histopathological tissue sections of the pancreas and liver revealed no significant differences compared with the control over 28 days.⁸⁷ Munodawafa⁹¹ and Munodawafa et al.¹⁰⁸ evaluated toxicity of leaf and root extract of *A. stenophylla* using the brine shrimp lethality test with *Nerium oleander* L. as a positive control. The extract exhibited median lethal concentration (LC₅₀) values of 1190 µg/ml to 2300 µg/ml was higher than LC₅₀ value of 141.7 µg/mL exhibited by *Nerium oleander*, the positive control.^{91,108}

CONCLUSION

The present review summarizes the botany, medicinal uses and biological activities of *A. stenophylla*. Detailed phytochemical evaluations are lacking and future studies should focus on phytochemical, pharmacological, toxicological and in vivo studies of both crude extracts and chemical compounds isolated from the species. There is also need to correlate the medicinal uses of the species with its phytochemistry and pharmacological activities.

Conflict of interest

The author declares that he has no conflict of interest.

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