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RECENT PERCEPTION OF THE ETHNOMEDICINAL IMPORTANCE OF *ACACIA ATAXACANTHA* (DC) ITS PHARMACOLOGY AND PHYTOCHEMISTRY: A REVIEW.

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ABSTRACT

The parts of *Acacia ataxacantha* has been used against digestive system disorders, chest ailments infestations, sickle cell anemia, tooth decay, bronchitis, cough and joint pain particularly infectious diseases. The literatures relevant to *A. ataxacantha* and its traditional uses were collected by searching the major scientific databases and other Botanical/ plant databases and Google Scholar. Many publications' sites were queried and dissertation search engines were put to use. The review shows only five compounds; lupeol, betulinic acid, betulinic acid-3-trans-caffeate, acthaside and α-amyrenol have been isolated so far from plant. Chemical constituents isolated from parts of *A. ataxacantha* and its extracts show some pharmacological activities which includes antifungal, antibacterial, antioxidant, antiplasmodial, nephroprotective, antiulcer and laxative properties. These activities are superficial, as many of the models employed are one-sided (either *in-silico*, *in-vitro* or *in-vivo* are used). The extract of this plant is accounted safe as the studies reveals. *A. ataxacantha* is a non-nodulating species of Acacia and its importance to bee-keeping is of great concern. The present review summarizes information concerning the ethnopharmacology, phytochemistry, biological activities, toxicological and agricultural importance of *A. ataxacantha*. This review tends to gather studies till date on this plant, so as to suggest more planned and cumulative pharmacological studies should be carried out, well lay-out clinical tests to give its upmost advantages to research and also the phytochemistry of this plant is yet to be explored.

Keywords: *Acacia ataxacantha*; infectious diseases; Ethnomedicinal; Phytochemistry;

INTRODUCTION

Medicinal plants are rich source of promising compounds used in combating diseases and growing challenges of ailments. This is a field of Chemistry called Natural product, which is drug discovery part and it is a vibrant research area traversing most fields that are scientific biased (Ramesh *et al.* 2014). Most countries of the world still rely on these plants to manage a number of ailments that they face daily and the priceless knowledge of these medicinal plants is being passed on over many generations**.** Particularly in developing countries, traditional medicine using plants to provide health care that catered for more than 80% of the population (W.H.O., 2002). In time, mostly medicinal plants were discovered for the treatment of some specific diseases; thus, medicinal plants' usage gradually abandoned the empiric framework and became founded on explicatory facts (Petrovska, 2012). Drug discovery from plants has received overwhelmingly attention recently and with the invention of more sophisticated methods and equipment, chemists have been able to isolate complex structural leads against diseases from plants in lesser time frame, with lower toxicity and higher efficacy in drug-resistance diseases

Botanical Description and Ecology

Acacia ataxacantha is found mostly in the region with higher rainfall where it normally forms bush constituent or even forest margin situations, if found in dry areas it grows along water and rivers' courses. *Acacia Ataxacantha* (Fabaceae) is easily seen in much of sub-Saharan African areas (Seigler, 2003). This species

According to Lorenzo *et al.* (2010) the family of *Fabaceae* (also known as *Leguminosae*) is represented by 730 genera including *Stylosanthes*, *Tamarindus*, *Caesalpinia*, *Acacia* and over 19400 species (Lorenzo *et al*., 2010). Adam *et al.* (2012) believes that the genus Acacia is a cosmopolitan genus which includes about 1,200 species (Adam *et al.*, 2012). *The Plant List*, (2010*)* states that 917 plant genera for the family of *Leguminosae* and further reiterates that this includes 63,525 scientific plant names of species rank for the family *Leguminosae*. Of these 23,535 are accepted species names. The genus Acacia includes 2,731 scientific plant names of species, only 1,380 are accepted species names (*The Plant List*, 2010).

The highest density and the greatest diversity of this genus is mostly found in tropical and subtropical regions, from Senegal to the West and to Sudan, extending Southwards into Namibia and South Africa though it is found around the world (Gurib-Fakim*et al.*, 2010). *Acacia* and its species have numerous uses; these uses are found in the pharmacopoeia of many countries, one of these species is *Acacia ataxacantha* DC. (Alavijeh *et al.*, 2012; Mahomoodally, 2013; Kannan *et al*., 2013 and Jagtap, 2014)

is a very thorny shrub growing upto 5 to 8 m in height. The leaves are alternate, pinnate with spine that carries 5 to 12 pairs of pinnae. The flame thorn often forms impenetrable thickets - particularly in disturbed areas; it is fairly untidy, many-stemmed shrub up to 3 - 5 m in height, often scrambling. Its tree is usually small with the stem diameter of up to 20 - 30 cm in diameter (Turner, 2001). Its normal habit is that of a multi-stemmed, untidy, large shrub with a tendency for the shoots to scramble using their recurved prickles and often develops into a single-stemmed tree of 5-10 m in height and 300 mm trunk diameter. Flowers occur as clusters of off-white or cream-coloured terminal spikes which are fragrant and bloom during spring and summer (Lynette and Barbara, 1981). The leaves are alternate, pinnate with spine that carries 5 to 12 pairs of pinnae. On twigs, spines are short, clearly pointing down. The bark is greyish, sometimes with a brownish tinge, and is fissured longitudinally, often with coarse flaking. Young stems are fairly smooth with longitudinal striations on which numerous unpaired, hooked prickles up to 8 mm are borne. Small prickles are also found on the underside of the leaf axis. On twigs, spines are short, clearly pointing down. The white flowers with a long transition axillary 4 to 5 cm long and arranged on stem 10 to 15 mm are sometimes isolated in pairs (Adjanohoun *et al.,* 1989). The large, fairly droopy, compound leaves are comprised of many tiny leaflets. The fruit pods are flattened, brownish red in the dry state (Ali *et al.,* 2012).). The dough sheet is used topically in the treatment of abscesses. The foliage is generally dark green and fairly dense, with the new growth often purple-tinged. The leaf stalk is hairy and bears a distinctive stalked gland (Turner, 2001; Baravkar *et al.,* 2008). Cramer *et al*., 2007 did a study on why indigenous species of Acacia that are popular in African savannas are always found in nitrogen-rich soils. Furthermore, they discovered that most Acacia species enjoy an edge over other tree species on the nitrogen replete soils. They conducted glasshouse pot experiment and field experiment to determine the capacity of the Acacia species to nodulate. Their data confirm that some species of Acacia i.e. *A. karroo, A. nilotica, A. tortilis* and *A. nigrescens*, possesses ability to nodulate, and they do thrive in their native habitat except for *A. ataxacantha*. It was noticed that there was a decrease in nitrogen level in plants grown with grass, this indicates that nitrogen fixation was strongly enhanced by competition with grass (Cramer *et al.,* 2007). Though, *A. ataxacantha* has been reported not to nodulate (Hernández-Lucas *et al.* 1995; Harrier *et al.* 1997; Pueppke and Broughton 1999). Cramer *et al.,* (2010) further reiterates that in the absence of water constraint in the Acacia savannas, that the competition for nitrogen is one of the mail limitations imposed by grass on growth of Acacia seedlings and the ability to fix nitrogen will surmount this limitation though *A.ataxacantha* will behave poorly to this (Cramer *et al.,* 2010).

***Acacia ataxacantha* DC.**

Acacia ataxacantha has various names; Flame thorn, Benin rope acacia, whistling thorn or wattle (English), Epinpin, Ewon Igbo- Uke (Yoruba), Bagaruwar kasa, Sarƙakƙiyaa or Kwiiyaa(Hausa) depending on the geographical area. Others include Bosoni (Guinea), Ango-ka (Ghana), Wonje (Sierra Leone) and Acharam (Senegal)(Burkill, 1985).

Scientific Classification Kingdom:

Plantae Division: *Magnoliophyta*
Class: *Magnoliatae* or *Rosidae*
Order: *Fabales*
Family: *Fabaceae*
Sub-family: *Mimosoideae*
Genus: Acacia Species: *Ataxacantha*
Binomial Name: *Acacia ataxacantha* DC or *Senegalia ataxacantha* (DC.) Kyal. &Boatwr

Review Methodology

Over forty literatures and works were reviewed for the ethnobotanical and medicinal importance of *A. ataxacantha* in various cultures around the world. Various key words were used for searching i.e. *acacia aataxacantha*, traditional uses of *acacia ataxacantha*, biological activities of*acaciaataxacantha*, isolated constitutents of *acacia ataxacantha* and phytochemistry of *acacia ataxacantha*, antimicrobial activities of *acacia ataxacantha*. The literature relevant to the title was collected by searching the major scientific databases including SciFinder, Sciencedirect, Pubmed, Medline, google, SCOPUS, EBSCO, PROTA and also other Botanical/ plant databases and Google Scholar. Many publications' sites were queried like Springer, Elsevier and dissertation search engines like Open-thesis, OATD, ProQuest and EthOs were put to use.

Ethnomedicinal Importance

Acacia ataxacantha is broadly used in the management and treatment of pneumonia, chickenpox, yellow fever and excessive cough in herbal remedies (Cheikhyoussef *et al.,* 2011; Hedimbi and Chinsembu, 2012; Oladunmoye and Kehinde, 2011; Dambatta and Aliyu, 2011). It is also used in some communities in the Northern part of Nigeria to treat dysentery and back-ache (Kadiri*et al*., 2008).The leaf decoction is used orally in febrile convulsions. Its bark is used against tooth decay, by inhalation in case of bronchitis and cough (Cheikhyoussef *et al.,* 2011). The tribe of Wolof and Serer from southern Senegal make the leaves into powder mix it with various other medicinal plants, against syphilis and other sexual related diseases. In the Central Republic of Congo, the air-dried and powdered leaf is applied to chancres [syphilitic] on the penis. Bark-infusion is prepared in the Sudano-guinean region as a mouth wash for carious and aching tooth, the mouth being rinsed out with copious quantities to relieve the pain; the leaf is used in fumigations for maladies of the respiratory tract, especially when accompanied by chest-pains (Burkill, 1985). An aqueous macerate of the root in association with *Cappari stomentosa* (Capparaceae) and *Securidace longipedunculata* (Polygalacea) is taken in draughts and for embrocation by Fula in Senegal for hernia, helminthiasis, sores and wounds (Burkill, 1985). In traditional medicine for the treatment of tooth decay, dysentery,

bronchitis, cough and joint pain (Adjanohoun *et al.,* 1989; MacDonald *et al.,* 2010; Kereru *et al.,* 2007). Amujoyegbe *et al.,* (2016), reported *A. ataxacantha* as one of the plant species used in the management of sickle cell anemia in Southern part of Nigeria, the parts used are the leaves and stem bark (Amujoyegbe *et al.,* 2016).Ethnobotanically *A. ataxacantha* leaves and roots have been used for vitamins, minerals, digestive system disorders, chest ailments infestations, pain and respiratory system disorders. The roots used to protect infants from witchcraft. The roots have been documented for its use in Kenya as a treatment for joint and back ache (Kereru *et al.,* 2007). *Acacia ataxacantha* pods and seeds have also been documented to be used as a stomachic herbal drug and for dysentery in Abeokuta, southwestern Nigeria, some Senegalese herbal practitioners claim that the leaves are used in the treatment of gastric ulcer (Erhenhi and Obadoni, 2015). *Acacia ataxacantha* have been reported to be used to ethnomedicinally to manage eyes' related diseases (Arise *et al.,* 2016).

Phytochemistry

Most medicinal plants make numerous and diverse types of constituents and compounds which are referred to as secondary metabolites. This result from defensive mechanism or as a result of the lasting evolution means, all these is for the plants to adjust and adapt to its biological and ecological environment. The role that these secondary metabolites play in connection between the plants and its natural habitats together is so important (Verpoorte, 2000) and they can be grouped into seven classes which includes; alkaloids, flavonoids, phenylpropanoids, quinones, steroids, tannins, terpenoids and their glycosides. Amoussa *et al.,* (2016) isolated and identified three compounds from *A. ataxacantha*; lupeol (**1**), betulinic acid (**2**) and betulinic acid-3-trans-caffeate (**3**). The ethyl acetate extract of root-bark of *A. ataxacantha* led to isolation of α-amyrenol **(4)** (3β-Urs-12-en-3-ol) (Venkataswamy*et al.,* 2010). Amoussa *et al.* (2016) further isolated a compound named Acthaside (**5),** the compound was gotten from ethyl acetate extract of the bark, which was previously reported to display various bioactivities, including antibacterial, antifungal and antioxidant (Amoussa *et al*., 2016). So far only five compounds have been isolated and established from this plant.

Pharmacological Studies

Antioxidant

Studies have shown that several species of the genus Acacia are rich in antioxidants, these works prove the need to exploit its phytochemicals responsible for this (Pal *et al.,* 2012; Abdel-Farid *et al.,* 2014 and Osman *et al*., 2014). Amoussa *et al.,* (2015) reported an investigation to estimate the total polyphenols content (TPC), flavonoids and flavonols contents and to evaluate antioxidant capacities in different extracts from *A. ataxacantha* barks (Amoussa *et al.,* 2015). The antioxidant abilities were determined in the forms of DPPH (2,2-diphenyl-1-picrylhydrazyl) and FRAP (Ferric Reducing Antioxidant Power) by spectrophotometric methods. Ethyl acetate extract showed higher values of TPC, flavonoids and flavonol contents 74.18 mg GAE/100mg of Dry Plant, 26.65 mg QE/100 mg DP and 23.14 mg QE/100 mg DP. DPPH radical scavenging activity ranged from 0.66 to 92.62 % and FRAP capacity (1273.63 µmolAAE g-1), these were highest in Ethyl acetate. Other authors ascertain the antioxidant activity of *A. ataxacantha* through *in vitro* and *in vivo* studies (Amoussa*et al.,* 2014; Arise *et al.,* 2016). Amoussa *et al.,* (2016) evaluated the compounds **1, 2** and **3** isolated from the bark of *A. ataxacantha* for antioxidant activity, Compound **3** had an interesting antioxidant activity with an IC_{50} of 3.57 µg/ml compared to the IC_{50} of the control; quercetin (1.04 µg/ml) (Amoussa*etal.,* 2016). Antioxidant activity of this plant has been assessed using different biological models i.e. *in-silico*, *in-vitro* and *in-vivo*, the compound responsible for this effect has been further isolated.

Normolipidaemic and Antidiabetics

Arise *et al*. (2016) reported the lipid profile, antidiabetic and antioxidant activity of *Acacia ataxacantha* bark extract in streptozotocin-induced Diabetic Rats. The ethanolic extract of the bark of *A.ataxacantha* bark at the dose of 125 mg/kg body weight displayed a promising antidiabetic activity in streptozotocin-induced diabetic rats. The ethanolic extract of the plant, at all doses administered to the diabetic rats significantly reduced the low density lipoprotein cholesterol (LDL-C) and atherogenic index in treated diabetic rats compared to untreated diabetic rats; it enhances the total cholesterol (TC) to normal levels, with a good improvement of high density lipoprotein cholesterol (HDL-C) in treated diabetic rats compared to untreated diabetic rats. The reduction in atherogenic index is due to the raise in HDL-C levels after treatment. The protective mechanism against the development of atherosclerosis, especially in diabetic condition noticed may be as the result of the antihyperglyceamic and anti-dyslipidemic activity of ethanolic extract of *A. ataxacantha* bark and this may prove to be of clinical importance in the management of type 2 diabetes. Though the authors agreed that the plant extract may not be safe at higher doses (Akapa *et al*., 2015; Arise *et al*., 2016). Most of the authors reviewed in this study only carried out *in-vitro* studies, this model only cannot justify antidiabetic effect of this plant ethanolic extract. More recent and popular models could be employed to ascertain this claim though this result complements its cultural application.

Table 1: Ethnomedicinal Importance of *Acacia ataxacantha*

	Parts Used	Country	Ethopharmacology	Biological Activity	Method	Isolated Compounds	Toxicity	References
1	Leaves and roots	Kenya	Joint pain and back ache, disorders caused by allergy to some vitamins, minerals and digestive system disorders, chest ailments infections, stomach, Respiratory system disorders	Antidiabetic and Normolipidaemic	*In vitro*			Kereru *et al.*, 2007, Adjanohoun*et al.*, 1989; Arise *et al*., 2016
2	Leaves	Senegal	Gastric Ulcers	Ulcero-protective and laxative nature	*In vivo*			Erhenhi and Obadoni, 2015; MacDonald *et al.*, 2010; Akapa*et al*., 2015
3	Pods and Seeds	Nigeria, Benin	Stomachic herbal drug and dysentery					Erhenhi and Obadoni, 2015; Kadiri*et al*., 2008
4	Leaf decoction and the barks	Nigeria, Benin	Febrile convulsions, against tooth decay, by inhalation in case of bronchitis and cough					Cheikhyousse*fet al.*, 2011; Kereru *et al.*, 2007
5	Leaves and stem bark	Nigeria	In management of sickle cell anemia					Amujoyegbe*et al.*, 2016
6	Roots with *Cappari stomentosa* and *Securidace longipedunculata*	Senegal	For embrocation by Fula against hernia, helminthiasis, sores and wounds.					Burkill, 1985; Hedimbi and Chinsembu, 2012
7	the air-dried and powdered leaf	Central Republic of Congo	Used against chancres [syphilitic] on the penis	Antibacterial and antifungal activities by	*In vitro*	α-amyrenol, acthasidebetulinic acid	Not toxic (2000 mg/kg b. w.) *in vivo*	Burkill, 1985; Aba *et al*., 2015;Amoussa*et al*., 2016; Venkataswamy*et al.*, 2010
8	The bark-infusion	Burkina Faso, Senegal and Guinea Bissua	Used as mouth and teeth cleanser and to relieve any oral pain					Burkill, 1985

9	Concoction of the Leaves	Burkina Faso, Senegal and Guinea Bissua	maladies of the respiratory tract, especially when accompanied by chest-pains	Antioxidant activity	*in vitro* and *in vivo* studies	Lupeol, betulinic acid, betulinic acid-3-trans-caffeate	Burkill, 1985; Dambatta and Aliyu, 2011; Amoussa*et al.*, 2014; Arise *et al.*, 2016
10	Leaves and stem	Nigeria, Benin	pneumonia, chickenpox, yellow fever.				Cheikhyousse*et al.*, 2011; Hedimbi and Chinsembu, 2012; Oladunmoye and Kehinde, 2011; Dambatta and Aliyu, 2011

Antiulcer and Laxative

Akapa *et al*., (2015) stated the ulcero-protective nature of the methanol extract of the leaves of *A. ataxacantha* on indomethacin and stress induced gastric ulcer models. The study validated the ulcero-protective potentials of *A. ataxacantha* leaves, albino rats pretreated with methanol extract of *A. ataxacantha* leaves at doses of 100 and 200 mg/kg body weights showed significant reduction in ulcer index to indomethacin and stress induced ulcer models in a dose dependent manner when compared to the negative control group, the general effect of the extract was compared with a standard drug (ranidine). The result gives a scientific justification for its use in Senegalese folk medicine (Akapa *et al.,* 2014). The laxative potential of the aqueous extract of *A. ataxacanta* was evaluated against loperamide induced constipated rats. The extract was administered orally, it produced significant laxative activity and lowered loperamide induced constipation in dose dependent manner as seen in the increase of fecal output while the dose 400 mg/kg body weight gave the best result (Amoussa *et al*., 2014).

Antimicrobial

Amoussa *et al.,* (2015) evaluate the antifungal activities of *A. ataxacantha* against six strains of *Aspergillus* and toxicity of hydroalcoholic extract in rat models. The study concluded that *A. ataxacantha* significantly inhibit the growth of mycelial and sporulation of *Aspergillus* strains and that hydroalcoholic extract of this plant is not toxic at all, with up to 2000 mg/kg body weight (Amoussa *et al.,* 2015). Amoussa*et al*. (2016) further isolated compounds **1-3** (Figure 1), wherein compound **3**, isolated from *A. ataxacantha*, exhibited promising antimicrobial activity against Gram-positive and Gram-negative bacteria and yeast, especially against *C. albicans* (Amoussa *et al*., 2016). The root-bark of *A. ataxacantha* was investigated for its antibacterial and antifungal activities by Aba *et al*., (2015), different polarities of the extract were employed. The Ethyl acetate fraction proved to be the most active, with MIC of 2.5 mg/mL against *B. subtilis, E. coli, S. Typhi* and *K. pneumonia*. This fraction gave a compound named α-amyrenol (3β-Urs-12-en-3-ol), the MIC and MBC/MFC of α-amyrenol was found to be 12.5 and 25 µg/mL respectively against test organisms (Venkataswamy *et al.,* 2010).

Association with bees

Dukku, (2003) reported that *Acacia ataxacantha* is a plant of special importance to bees and bee-keeping. It produces abundant nectar, thus facilitating rapid colony growth that culminates in massive swarming by the bees. Nectar production occursmostly between two dearth periods in the Sudan savanna of northern Nigeria periods. Honey are harvested in large quantities mostly during this brief period (September to October) by the Beekeepers. The visit of Bees to the plant is peak between 10.00 h and 13.00 h and throughout the day. The author further reported the preference of *A. ataxacantha* over some other plants by Bees. He cited an observation that when *Ziziphus mucronata* and *A. ataxacantha* grow together, the bees completely avoid *Z. mucronata*, even though they forage very well on this plant when the two species grow separately (Dukku, 2003).

Toxicological Assessment

There are many unknown species of Acacia which may contain poisonous cyanogenic glycosides, Dewick, (2009) reports that great precaution should be considered in preparation and consumption of these species (Dewick, 2009). Some of the species containing poisonous cyanogens include; *Acaciaerioloba*, *Acacia cunninghamii*, *Acacia obtusifolia*, *Acacia sieberiana* and *Acacia sieberiana* var. woodii (David and John, 1987). For this reason, it is not advisable that one consume any part of an Acacia plant until the species is confirmed (Voogelbreinder, 2009). Toxicity studies are done to know the result of an action, drug or extract on a biological system which can be of great importance to determine the doses. The purpose of toxicity studies as per Barle *et al.* (2012) is 'to know clearly the effect of a drug or extract on a biological system which may be of great importance later to ascertain the doses and its resultant effects on humans. Abbas, (2015) reported the oral median lethal dose (LD_{50}) of the methanol extract of *A. ataxacantha* in both mice and rats were found to be greater than 5000 mg/kg body weight, while the intraperitoneal LD_{50} was calculated to be 565.69 mg/kg and 1264.91 mg/kg in mice and rats respectively. This shows that the plant' extract is safe when administered orally and it is not toxic but when administered intraperitoneally, it is slightly toxic (Loomis and Hayes, 1996; Lorke 1983). Amoussa *et al*., (2015) reported the acute toxicity evaluation of ethyl acetate extract of *A. ataxacantha*, at dose of 2000 mg/kg body weight did not produce any organ swelling, atrophy, hypertrophy and death. The animals used were physically active and no deaths of rats were observed during the study (Amoussa *et al.,* 2015). The plant can be said to be safe from these studies.

CONCLUSION

This detailed review on *A. ataxacantha* gives a robust biological potential of this plant. It is deeply assumed that extensive evidences shown in this review on the ethnomedicinal, phytochemical, pharmacology and agricultural importance of this plant might give proof to the use of different parts of this plant for various ailments.To date only five compounds have been identified in this plant. It is evident from the present study that extracts have been the object of relatively few and superficial investigations, while bioactive extract/pure compounds of this plant have so far been neglected by phytochemists and pharmacologists. Future phytochemical investigation may be focused on identifying bioactive moieties, such as the normolipidaemic and antidiabetics principle reported and the constituents responsible for other effects also. It is expected that future research on *A. ataxacantha* will emerge as a result of this study which will rapidly enlarge their chemical constituents, increases its farming applications and gives more pharmacological benefits.

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Conflicts of interest statement

The authors declared no conflicts of interest.

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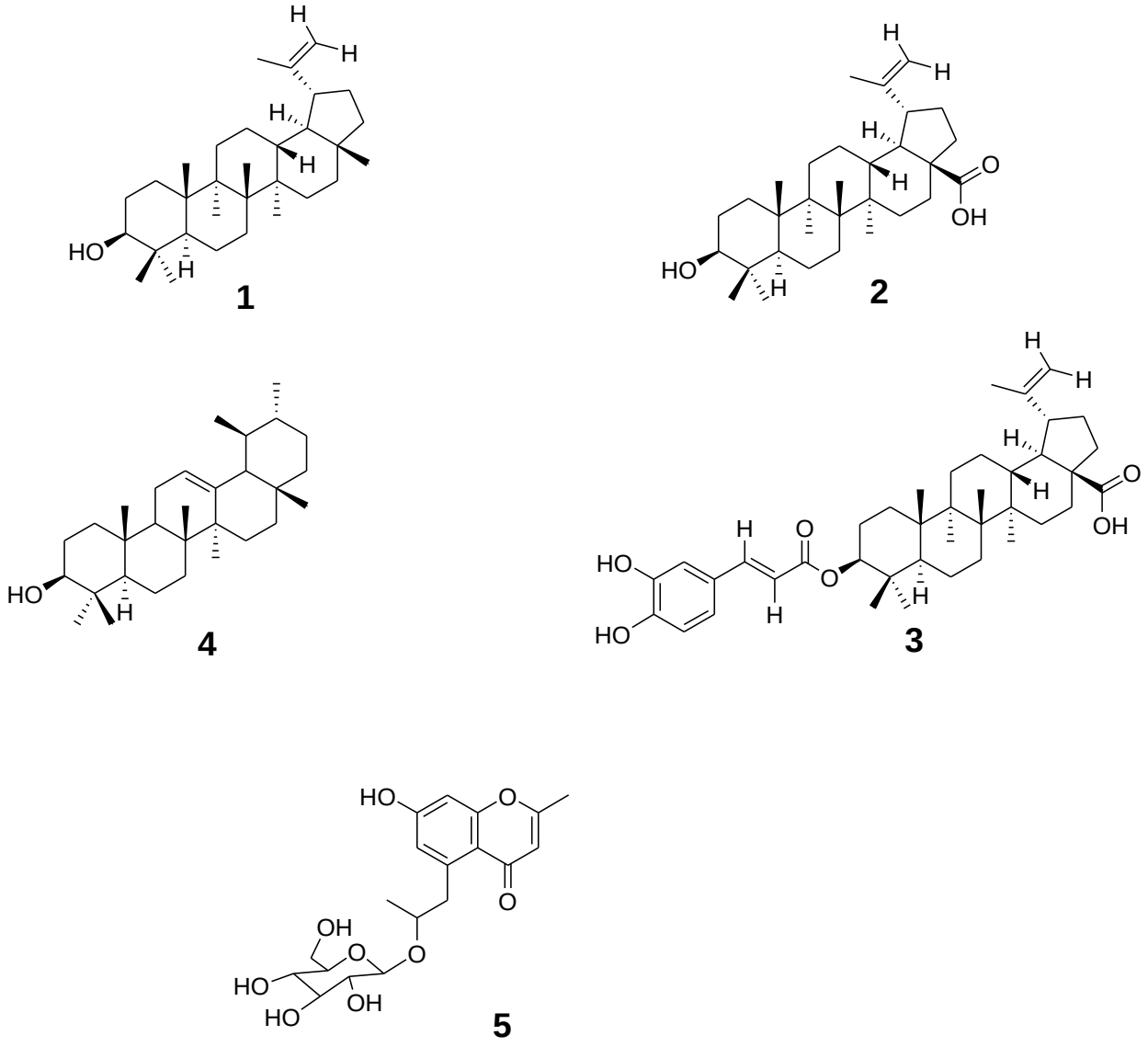

Fig. 1: Isolated Compounds from *A. ataxacantha*