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Review Article

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Pharmacological and phytochemical studies on *Acacia modesta* Wall; A review

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ABSTRACT

The use of plants with therapeutic properties is as ancient as human civilization. *Acacia modesta* belongs to family Fabaceae and is a deciduous tree which has medium or small size. Traditionally, it has been used to treat leprosy, wounds, dysentery, venereal diseases, cough, body weakness, bacterial infections and backache. Many pharmacological activities have been reported viz. antibacterial, antifungal, anti-hyperglycemic, analgesic, anti-inflammatory, anti-platelet, anti-termite, antioxidant, brine shrimp cytotoxicity, haemagglutination, insecticidal, phytotoxic and spasmolytic. While various flavonoids, terpenoids, alkaloids, tannins, non-protein amino acids, fixed oils and cyclitols have been isolated from this plant. This review is an attempt to provide adequate information on ethno-medicinal uses, general morphology, pharmacological and phytochemical properties of the plant.

Keywords: *Acacia modesta*, Phulai, pharmacology, Phytochemistry.

INTRODUCTION

Throughout the ages humans have been using natural products for their basic requirements such as clothing, shelter, food and medicines [1]. Especially plants have provided humans with medicines to combat numerous diseases such as malaria, leukemia, diabetes, parasitic infections, respiratory and cardiovascular ailments [2, 3].

Acacia modesta belongs to family Fabaceae (subfamily Mimosaceae). It is commonly known as phulai and locally called palosa. It is distributed in Afghanistan, India and Pakistan. In Pakistan it is reported in Punjab, Balochistan and Khyber Pakhtunkhwa [4, 5]. The wood of *A. modesta* is durable and hard. It is used for making Persian wheels, cane crushers and agricultural implements. It is also used as fuel [6].

Taxonomy

Kingdom:	Plantae – Plants
Subkingdom:	Tracheobionta – Vascular plants
Superdivision:	Spermatophyta – Seed plants
Division:	Magnoliophyta – Flowering plants
Class:	Magnoliopsida – Dicotyledons
Subclass:	Rosidae
Order:	Fabalace
Family:	Fabaceae
Subfamily:	Mimosoideae / Mimosaceae
Genus:	*Acacia*
Species:	*modesta*
Scientific name:	*Acacia modesta* Wall
Synonyms:	*Sengalia modesta* Wall, *Mimosa obovata* Roxb, *Mimosa dumosa* Roxb.

Various stages of the plant are shown in figure 1.

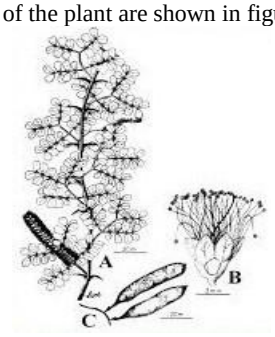

Figure 1: *Acacia modesta*: A) small branch; B) Flower; C) Fruit

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Ethno-medicinal uses

It is used to treat leprosy, wounds, dysentery and venereal diseases [7-10]. Traditionally, ash of *A. modesta* wood was employed for relieving severe body pain. Mixture of gum with wheat flour, almond and butter was given to women after delivery. Zhuble sharbat, solution of gum in water, was taken as health stimulant. Due to antimicrobial properties of *A. modesta*, its branches were used as miswak (tooth brush). Because of curative properties, gum was used for back pain and sex. Plant use was also seen in treatment of cough [11-15].

Morphology of the plant

A. modesta is a deciduous tree which has medium or small size. Bark is rough and greenish grey. Prickles are below petioles and in the form of pairs. These prickles are dark brown, compressed, shinning, recurved and 4 to 5 mm in length while they may be absent in some cases. Pinnae are usually in pairs (2-3) and hardly 1. Leaflets are also in pairs (3-5), petiolulate, obovate, obtuse, oblique, glaucous and noticeable veins. Inflorescence is pedunculate spike (3.7-7.5 cm length) while peduncle is 1.3-2.5cm. Calyx is glabrous and broadly campanulate, with 1-1.5 mm length. Corolla's length is 2-2.5 mm. Stamens are many. Pods are flat, straight, mucronate, glabrous, stipe and stipitate with variable length ranging from 5-10 mm. Number of seeds varies from 3-5 and flowering season is March to May [4, 5].

Pharmacological Properties of *A. modesta*

Following are the pharmacological activities reports on different parts of *Acacia modesta*.

Antibacterial activity

Both gram negative and positive bacteria were used to investigate the methanolic extract of various plants for novel compounds [16]. Agar well diffusion was one of the methods used to test the antibacterial effects of *A. modesta* extract [17, 18].

Methanol extract and its various fractions showed less activity against gram positive (*Streptococcus pneumonia*, *S. epidermidis* and *S. aureus*) and gram negative *Enterobacter aerogenes*. While moderate activity was seen against gram –ive (*P. aeruginosa*, *S. typhi*, *E. coli*) and gram +ive *Bacillus pumilus*. The n-hexane and ethyl acetate fraction produced substantial activity against *Klebsiella pneumonia.* Nevertheless MIC_{50} values was between 2400-3900 µg/ml [19]. A direct relationship was observed between bacterial growth inhibition and conc. of methanol leaves extract [20].

In disc diffusion method, ethanol leaves extract exhibited a significant activity against *P. aeruginosa, E. coli, K. pneumonia, S. typhi, Proteus mirabilis, S. aureus, Streptococcus pneumonia, B. cereus* and *B. subtilis.* Likewise ethanol: H_2O (1:1) extract also showed good activity against above mentioned organisms. When MICs were calculated, it were 4.570-26.500 µg/ml for ethanol extracts and 8.90-32.50 µg/ml for ethanol: water extracts [21]. Hot and cold water extracts showed substantial activity against *S. aureus, Enterococcus faecalis, B. subtilis* and *P. aeruginosa* [22].

Root extract of ethanol showed an increase of activity from gram positive, *S. aureus* and *β-Streptococcus* to gram negative, *E. coli* and *K. pneumonia* [23]. This extract was bacteriostatic [24]. No activity was produced by essential oils of *A. modesta* [25].

Antifungal activity

Antifungal activity is vital because soil borne fungi may destroy plants and their roots [26, 27]. The activity was also seen in *A. modesta* species.

On agar tube dilution assay, methanol extract of leaves showed a growth inhibition of 11.53 and 0.80 % against *A. niger* and *A. fumigatus* respectively [20]. When disc diffusion method was employed using *C. albicans* and *Cryptococcus albidus*, ethyl alcohol and ethyl alcohol: water (1:1) extracts showed positive response. Ethyl alcohol extract exhibited MIC_{50} of 0.0055 mg/ml against *C. albicans* [21]. Against *A. flavus*, a very low effect was produced by methyl alcohol aerial parts extract and its fractions [25].

Antifungal activity was enhanced by increasing extract concentration. Root extract of ethanol had more potential against *S. cerevisiae* than hot method extract. The same ethanol extract also showed inhibitory effects against *Fusarium* sp. and *Rhizoctonia solani* [23]. Action of root extract was fungistatic as it was related to other literature reports [24].

Essential oils had revealed variable inhibitory actions on fungal species [28]. *A. modesta* oils also demonstrated moderate effects (40.0%) against *Microsporum canis*. While a less activity against *A. flavus* and *F. saloni* and no activity against *C. albicans* and *C. glaberata* were observed [29].

Anti-hyperglycemic activity

When rats were given ethanol or ethyl alcohol: water (1:1) extract of the *A. modesta* leaves, a significant lowering of blood glucose level was observed. The effects were analogous to glibenclamide. LD_{50} of these extracts were greater than 5000 mg/kg. Ethanol extract, at dose of 100 mg/kg, was 12.34% extra potent than glibenclamide (0.20 mg/kg). While no sign of toxicity was detected in tested rats [21].

Analgesic activity

Different pain models were used to investigate the *A. modesta* methanol extract.

Writhing, induced by acetic acid, was considerably diminished by injection (i.p) of the extract to the mice. The result was similar to standard diclofenac sodium. In formalin model, injection of the extract reversed both phases (neurogenic and inflammatory) of licking response in mice. These results were related to centrally acting morphine. During hot plate test, analgesia was produced by methanol extract which was again similar to morphine. Thiopental induced hypnosis test was employed to note the sedative effects of the *A. modesta* extract. In this test, pre-treatment of mice with extract significantly increased the sleep time. This outcome was comparable to standard diazepam [30].

Anti-inflammatory activity

In carrageenan induced rat paw edema model, methanol extract of the *A. modesta* exhibited striking anti-phlogistic response. This effect was analogous to diclofenac sodium [30]. Literature reports indicated that components involved.in reversal of carrageenan tempted inflammation was also active in cyclooxygenase inhibition [31].

Anti-platelet activity

Usually COX inhibitors and compounds having anti-inflammatory effects are also active against platelet aggregation [32-34]. In case of *A. modesta* MeOH extract, a dose dependent inhibition was seen against arachidonic acid induced platelet aggregation. IC_{50} was 0.80 mg/ml at the dose of 2.50 mg/ml [30].

Anti-termite activity

When anti-termite properties of the *A. modesta* were tested against *Heterotermes indicola*, a significant activity was showed by methanol extract. The experiment lasted for merely two days. Twenty two termites died on first day while no one stayed alive on day second.

Similarly the chloroform and aqueous fractions were also active against the termite [35].

Antioxidant activity

Nitric oxide (NO) is a significant messenger in many physiological and pathological processes [36]. But a high level of NO in tissues is toxic and may contribute to maladies like multiple sclerosis and carcinomas [37]. That's why plants samples are screened for nitric oxide free radical sifting. *A. modesta* MeOH extract and its ethyl acetate, n-hexane, aqueous and chloroform fractions showed modest NO radical hunting effect at 1.5 mg/ml concentration. Another model, DPPH assay, also exhibited that plant has antioxidant potential [20, 35].

Brine shrimp cytotoxicity

Cytotoxic effects of plant extracts are tested by using this bioassay because active compounds are usually fatal to *Artemia salina* [38]. In case of methanolic extract of *A. modesta*, weak toxic activity of 16.6% was seen at conc. of 1 mg/ml with LD_{50} of 4251653.00. With the aqueous and chloroform fractions, lethal effects of 40% were observed at 1000 µg/ml conc. While ethyl acetate and n-hexane fractions showed mortality of 26.6% and 20.0% respectively at 1mg/ml concentration [35].

High toxicity was shown by essential oils of the plant at the conc. of 0.10 mg /ml. When test was performed on thirty shrimps, the number of survivors was zero. This shows that oils can be utilized as cytotoxic product [29].

Haemagglutination activity

Lectins have been used to demonstrate the functional and structural roles of sugar components present on cell surfaces [39]. They have also been employed for characterization and isolation of glycoconjugates [40] and to adhere red blood cells [41].

Haemagglutination activity of *A. modesta* plant extract was determined by using human's RBCs of different blood groups. Weak or no activity was observed in all blood groups except O^{+ive} where ethyl acetate fraction exhibited moderate activity at 1:2 dilution [19].

Insecticidal activity

Synthetic insecticides, because of their toxic side effects, are a great hazard to environment. It intrigued the search for insecticides from natural sources [42]. Methanolic extract of *A. modesta* and its fractions were assessed for insecticidal effects against *Callosbruchus analis*, *Rhizopertha dominica* and *Tribolium castaneum*. All test samples exhibited no activity towards *T. castaneum*. Against *R. dominica*, low activity was observed in case of chloroform and n-hexane fractions while other samples were inactive. Significant activity of 60% was seen with n-hexane fraction against *C. analis* [19].

No activity was observed against above mentioned insects when essential oils from the plant were tested. It indicated that these essential oils didn't have insecticidal potential [29].

Phytotoxic activity

It has been realized that herbicides of natural origin are environment friendly. Consequently, efforts are made to search plant derived herbicides. *Lemna* assay is used to determine the phytotoxic activity in plants. In case of *A. modesta*, methanolic extract and its different fractions showed little or no activity [19]. While essential oils had moderate to low phytotoxic activity [29].

Spasmolytic activity

When experiment was performed on isolated tissue of rabbit's jejunum by using methanolic extract of *A. modesta*, a dose dependent relaxing effect was observed. With the increase in dose, a decrease was seen in persistent KCl induced contractions and spontaneous movements. In case of KCl produced contractions, activity was detected at dose of 0.1 mg/ml with EC_{50} of 6.8±0.53. This proposed the muscle relaxant effect of the extract [25, 43].

Phytochemistry of *A. modesta*

Reports on *A. modesta* aerial parts exposed the presence of flavonoids, alkaloids, terpenoids and tannins [25, 30]. Long chain alcohols [octacosanol (**1**), nonaeicosanol (**2**) and hentriacontanol (**3**)], hydrocarbons [hentriacontane (**4**) and octacosane (**5**)], 4-hydroxy benzoic acid (**6**) and palmitone (**7**) were also reported [25, 44].

Flavonoids

Flavonoids are polyphenolic compounds. The word "flavonoid".is derived from "flavus" (yellow), a Greek word. These compounds have a diversity in their chemistry and found abundantly in plants. Consequently, they are important part of our food. More than 4000 flavonoids are known. There major groups are flavones, isoflavones, flavanones, flavonols, dihydroflavonols, catechins, chalones and anthocyanidins [45]. Whereas Quercetin (**8**) and kaempherol (**9**) were extracted from *A. modesta* [46].

Terpenoids

Terpenoids are vital group of phytochemicals and derived from isoprene units ($-C_5H_8$). They may be in the form of mono-, sesqui-, di, tri-, tetra-terpenoids, essential oils and phytosterols [47].

Lupeol (**10**) was extracted from *A. modesta* [25]. Betulin (**11**) and α-amyrin (**12**) were present in benzene extract of the stem bark. All of these three compounds are pentacyclic triterpenes. A phytosterol, β-sitosterol (**13**), was also obtained from *A. modesta* [44]. When aerial parts of the plant were explored for essential oils, 38 components were obtained [29].

Non-protein amino acids

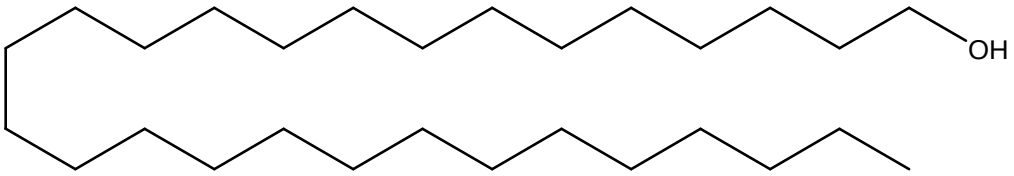
These are frequently present in seeds and leaves of *Mimosoideae* plants [48]. Neurolathyrogen/ α-amino-β-oxalylaminopropionic acid (**14**), was obtained from *A. modesta* [49].

Fixed oils

In *Acacia species*, oils differ a little in their composition. Their triglycerides mainly contain linoleic and oleic acids. Both are unsaturated fatty acids. Seed of *A. modesta* contained 26 and 27% linoleic acid (**15**) and oleic acid (**16**) respectively [50].

Cyclitols

Cyclitols are basically cycloalkanes. They contain –OH group on each of ring atoms [51]. Pinitol (**17**) is an important cyclitol having antidiabetic effects [52]. It was found in ethanolic extract of *A. modesta* heartwood [44].



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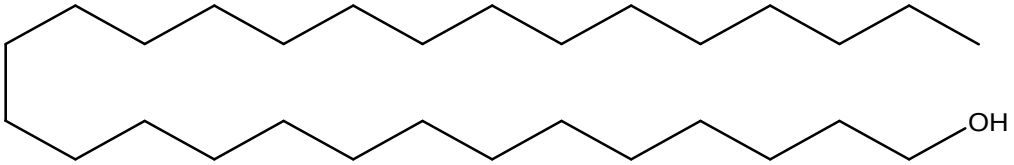

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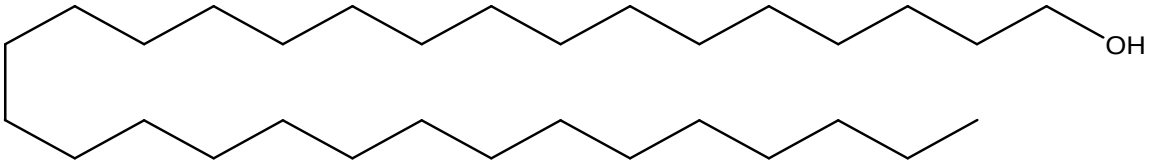

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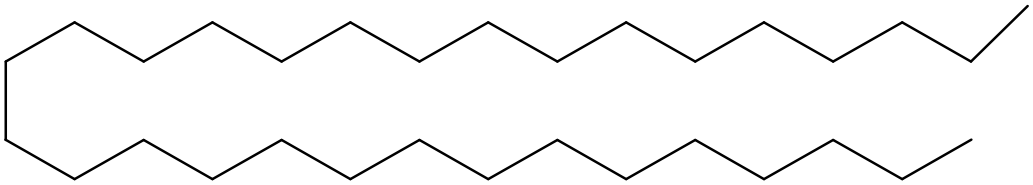

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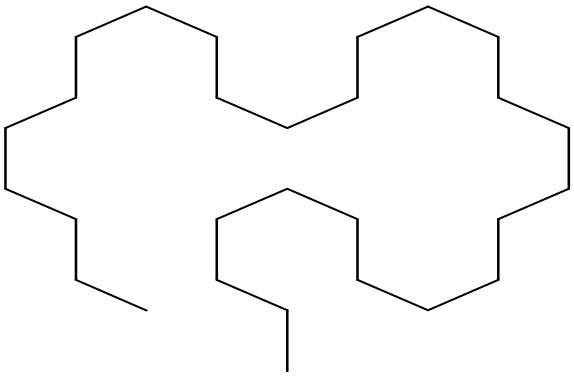

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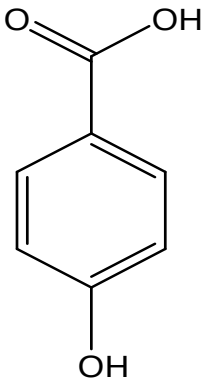

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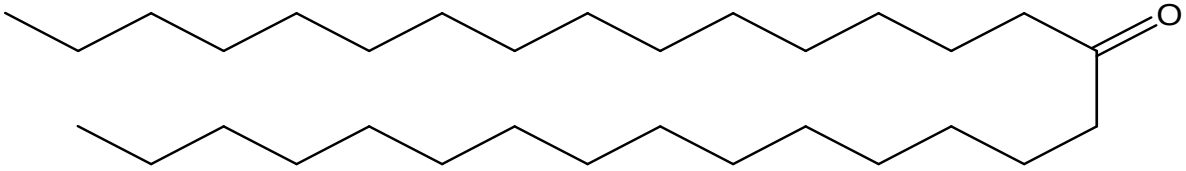

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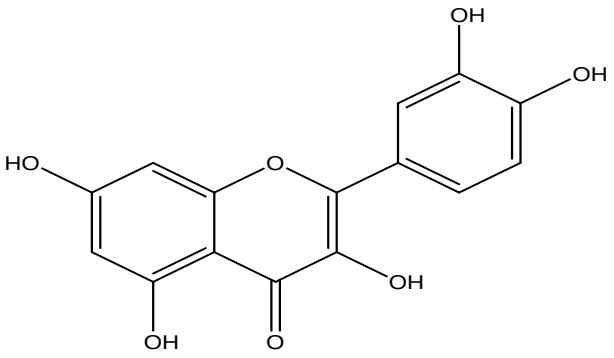

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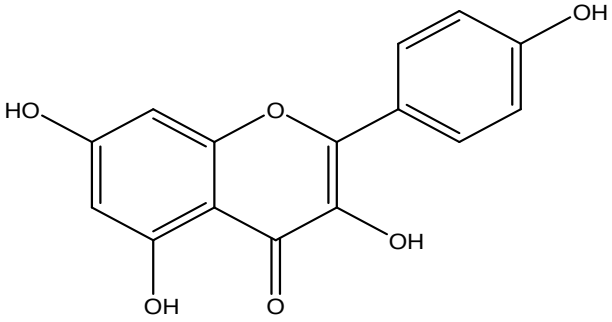

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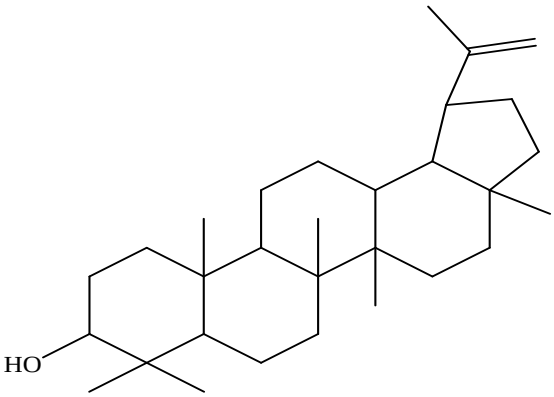

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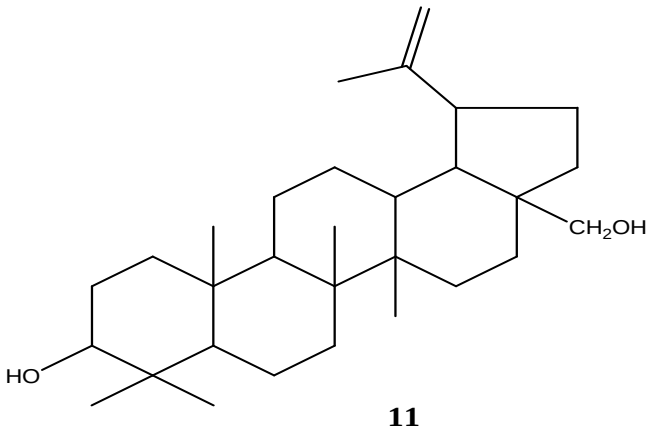

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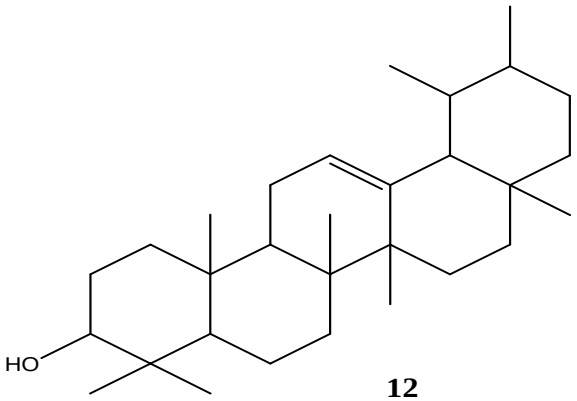

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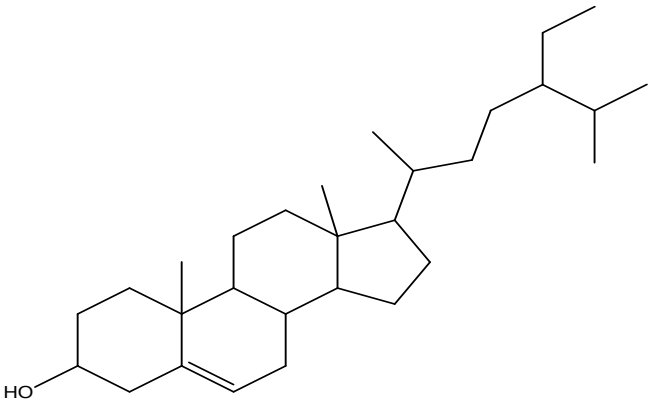

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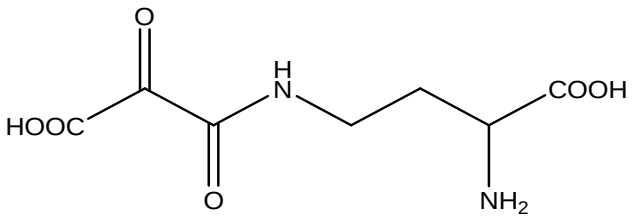

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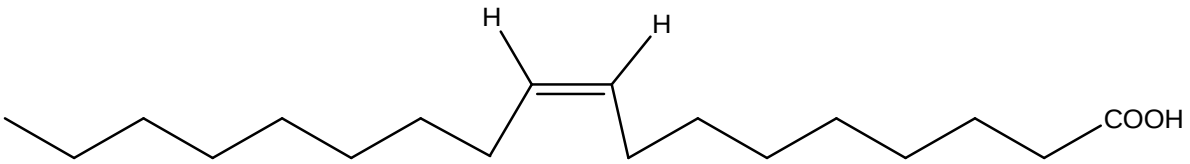

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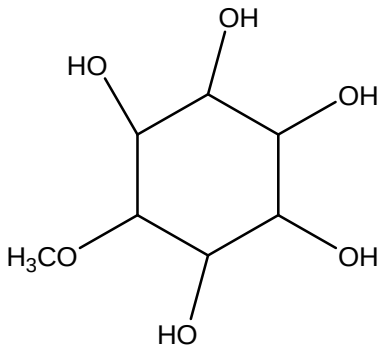

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CONCLUSION

This review is the collection of the studies on *A. modesta* conducted by different scholars and traditional healers which can be further investigated to achieve lead compounds.

Conflict of interest

None.

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