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A REVIEW ON HEPATOPROTECTIVE ACTION OF ACACIA NILOTICA (GUM)

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Abstract

The potential biological function of *Acacia nilotica* have long been described in traditional system of medicine. Acacia nilotica gum is an exudate obtained from stems and branches of Acacia nilotica tree. It is a natural, water soluble hydrocolloid which has been claimed to possess several physiological, nutritional and therapeutic beneficial properties with special emphasis on hepatoprotective action due to the presence of various bioactive phytochemicals.The hepatoprotective action of Acacia nilotica gum can prove to be a pathbreaking discovery in the world of traditional medicine and can significantly relieve the overburdened modern medicine of its huge disease load.The present study undoubtedly provides a proof that heptoprotective action of A.nilotica gum is a reality.

Keywords: Acacia nilotica, Phytochemicals, Hepatoprotective action

INTRODUCTION

Liver disease is one of the major health problems worldwide because liver is a vital organ and has a wide range of functions in the body, including biotransformation and detoxification of endogenous and exogenous harmful substances, plasma protein synthesis, and glycogen storage.

Hepatic injury is associated with distortion of various metabolic functions. It is well known that reactive oxygen and nitrogen species play a crucial role in initiation and progression of liver-associated diseases such as alcoholic and viral hepatitis, non-alcoholic fatty liver disease, and hepatocellular carcinoma.

The progression of liver fibrosis may develop into cirrhosis and is associated with liver cancer. Steroids, vaccines, and antiviral drugs have been employed for treatment of liver diseases which have adverse side effects if administrated for long term. Extensive studies reported that natural products with antioxidant activity are effective to prevent the oxidative stress-related liver pathologies due to particular interactions and synergisms.

Toxicity is the ability of a substance to cause harmful effects on a single cell, a group of cells, an organ system, or the entire body [1]. Many chemicals found in the environment are toxic and necessitate accurate identification of their potential hazards to both human and animal health.

Herbal products and traditional medicines with better effectiveness and fewer side effects in therapeutics have replaced the synthetically derived drugs in modern allopathic medication system [2]. Many bioactive compounds and extracts from plants such as Rosa damascena, Boerhaavia diffusa, Moringa oleifera, curcumin from Curcuma longa, meso-zeaxanthin, and Salidroside from Rhodiola sachalinensis have thus been investigated for hepatoprotective and antioxidant effects against hepatotoxin-induced liver damage [3–8]. Therefore, there is a great demand for development of an effective hepatoprotective drug from the natural products. Traditional healers of different regions in India used Acacia species for treatment of various ailments [9].

Acacia species is one of the richest resources of bioactive flavonoids, alkaloids, phenolics, saponins, polysaccharides, tannins, and terpenoids [10]. The published reports of various biological activities of Acacia species include hypoglycemic, anti-inflammatory, antitumor [11], antifungal [12], antiplatelet aggregation, spasmogenic and vasoconstrictor, antihypertensive, antihepatitis C virus [13], antioxidant potential [14], wound healing [15], chemopreventive and antimutagenic [16], and anthelmintic activity [17].



Pic.1 : *Acacia nilotica* tree

Among the acacia species, A. nilotica is widely distributed in tropical and subtropical countries belonging to family Mimosoideae. Several bioactive agents have been identified from A. nilotica which includes androstene steroid, gallic acid, ellagic acid, kaempferol, naringenin, rutin, lupane, niloticane, umbelliferone catechin, and γ-sitosterol [13, 18-20].

Origin and distribution

★ Acacia is multipurpose nitrogen fixing tree legume. It occurs from sea level to over 2000m and withstand at extreme temperature (>50°C) and air dryness but sensitive to frost when it is young [21]. It is widely spread in subtropical and tropical Africa from Egypt to Mauritania southwards to South Africa, and in Asia eastwards to Pakistan and India [22, 23].

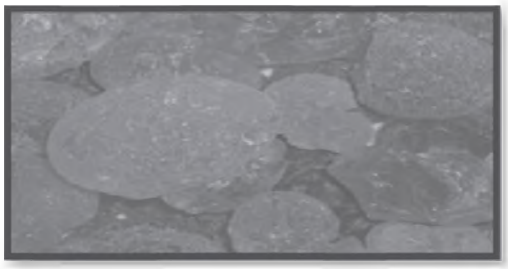
Table 1. Taxonomical classification [25]

Kingdom	*Plantae*
Subkingdom	*Tracheobionta*
Super division	*Spermatophyta*
Division	*Magnoliophyta*
Class	*Magnoliopsida*
Subclass	*Rosidae*
Order	*Fabales*
Family	*Fabaceae*
Subfamily	*Mimosoideae*
Genus	*Acacia*
Species	*Nilotica*

Table 2. Subspecies of Acacia nilotica [25]

- *subsp. nilotica*
- *subsp. indica*
- *subsp. Cupressiformis*
- *subsp. tomentosa*

- *subsp. adstringens*
- *subsp. subalta*
- *subsp. leiocarpa*
- *subsp. hemispherica*
- *subsp. Kraussiana*



Pic.2 : *Acacia nilotica* gum

The species is widespread in Africa and Asia, and occurs in Australia and Kenya. Indian gum Arabic tree is found in well watered Sahelian and Sudanian savannas to the southern Arabian Peninsula, East Africa and in the Gambia, the Sudan, Togo, Ghana, and Nigeria. It is widely cultivated in the Indian subcontinent, and also found on lateritic soil in the Himalayan foothills in India [24].

A. Physical characteristic of Acacia nilotica gum

Acacia nilotica gum exudates collected from Batagarawa, Katsina State were in form of tasteless and odourless nodules or lumps, with their colour varying from off-white to orange brown. The Acacia nilotica gum samples were found to be water soluble at 30°C to form viscous solutions, indicating that they are natural gums of the hydrophilic colloid group. Samples were however found to be insoluble in common organic solvents (ethanol, acetone, ether, chloroform, benzene etc) and in oils, with which they form emulsions in aqueous suspension [34]. The solubility of the gum is indicative of the absence of cross linking between polymeric chains. This is because gums having cross linked polymeric chains only swell in water, without dissolving [35]. Cationic composition of gum samples was also determined and results showed that calcium has the highest value followed by magnesium, sodium, potassium, iron and zinc.

PLANT DESCRIPTION

PARTS OF THE PLANT	GENERAL DESCRIPTION
Acacia nilotica (Whole plant)	single stemmed plant, grows to 15-18 m in height and 2-3 m in diameter
Pods	7-15 cm long, green and tomentose (when immature) or greenish black (when mature), indehiscent, deeply constricted between the seed giving a necklace appearance
Seeds	8-12 per pod, compressed, ovoid, dark brown shining with hard testa [24]
Leaves	bipinnate, pinnate 3-10 pairs, 1.33.8 cm long, leaflets 10-20 pairs, and 2-5mm long [26]
Flowers	globular heads, 1.2-1.5 cm in diameter of a bright golden yellow colour, develop either in axillary or whorled pattern on peduncles 2-3 cm long located at the end of branches [21]
Stems	usually dark to black coloured, deep longitudinal fissured, grey-pinkish slash, exuding a reddish low quality gum [27]
Bark	tinge of orange and/or green (young tree), but older trees have dark, rough bark and tend to lose their thorns [28]
Thorns	thin, straight, light grey exist in axillary pairs (usually 3-12), 5-7.5 cm long in young trees
Root	generally of brown colour in older and whitish in younger regions
Gum	varies in colour from very pale yellowish brown to dark reddish brown depending on the quantity of tannins in the sample. The lighter, more highly valued gums are soluble in water and very viscous; the tannins in the darker gum reduces the solubility [29]

A.Major Chemical Constituents in Acacia nilotica Linn

PARTS OF THE PLANT	CHEMICAL CONSTITUENTS PRESENT
Seeds	high percentage of phenolic constituents consisting of m-digallic acid, gallic acid, protocatechuic and ellagic acids, leucocyanidin, m-digallic dimer, 3,4,5,7-tetrahydroxy flavan3-ol, oligomer 3,4,7- trihydroxyflavan 3,4-diol and 3,4,5,7tetrahydroxy flavan-3-ol and (-) epicatechol
Mature seed	crude protein, crude fibre, crude fat, carbohydrates, potassium, phosphorus, magnesium, iron and manganese occurred in high concentrations and it is richer source of cystine, methionine, threonine, lysine and tryptophan
Fruit	mucilage and saponins [30]
Pods	gallic acid, digallic acid and condensed tannins
Leaves	apigenin, 6-8-bis-Dglucoside, rutin, 8% digestive protein (12.4% crude protein)
Bark	tannin (12-20%), terpenoids, saponins and glycosides, Phlobetannin, gallic acid, protocatechuic acid pyrocatechol, catechin, epigallocatechin-5,7-digallate [31]. Its extract contains total phenolic content ranging from 9.2 to 16.5 g/100 g [32]
Root	octaconsanol, betulin, β-amyrin and β-sitosterol
Gum	composed of galactoaraban which gives on hydrolysis Larabinose, D-galactose, L-rhamnose, D-glucuronic acid and 4O-methyl- D-glucuronic acid [33]

B. Physicochemical properties

A. nilotica gum exudates:

Acacia nilotica gum exudates collected from Batagarawa, Katsina State were in form of tasteless and odourless nodules or lumps, with their colour varying from off-white to orange brown. The Acacia nilotica gum samples were found to be water soluble at 30°C to form viscous solutions, indicating that they are natural gums of the hydrophilic colloid group. Samples were however found to be insoluble in common organic solvents (ethanol, acetone, ether, chloroform, benzene etc) and in oils, with which they form emulsions in aqueous suspension [34]. The solubility of the gum is indicative of the absence of cross linking between polymeric chains. This is because gums having cross linked polymeric chains only swell in water, without dissolving [35]. Cationic composition of gum samples was also determined and results showed that calcium has the highest value followed by magnesium, sodium, potassium, iron and zinc.

C.Physicochemical properties

A. nilotica gum exudates:

Table 3. Physicochemical properties A. nilotica gum exudates [34]

Physicochemical parameter	ACACIA NILOTICA GUM
Moisture (%)	15.60
Solubility (30°C) (%)	38
Melting temperature (°C)	300-320
Relative density of 20% solution (35°C)	1.32
Relative viscosity of 1% solution (30°C)	24.80
pH (25% solution)	4.50
Ash (%)	3.54
Tannin	0
Nitrogen (% w/w)	0.40
Protein (% Nx6.6)	2.71
Total soluble fibre (%)	78.15
Calcium (g/100g)	0.70
Magnesium (g/100g)	0.30
Iron (g/100g)	0.004
Sodium (g/100g)	0.016
Potassium (g/100g)	0.78

D. Constituent sugar analysis of acacia gum exudates

Table 4. Protein and Constituent sugar analysis of different samples of acacia gum exudates

		CONSTITUENT SUGAR(%)			
SAMPLE	Protein (%)	Rhamnose	Arabinose	Galactose	Uronic acid
I.	1.8	2.0	53.5	36.6	7.9
II.	2.1	2.4	45.9	30.6	14.1
III.	2.5	3.4	49.4	33.7	12.4
IV.	2.2	Trace	65.7	34.2	8.2
V.	1.6	Trace	62.6	23.1	13.2
VI.	1.3	Trace	53.6	32.7	11.9
VII.	2.0	13.5	33.0	37.0	16.0
VIII.	1.9	2.7	44.5	34.1	14.3

(i) Acacia nilotica gum exudate from Maharashtra;

(ii) A. nilotica gum exudate from Andhra Pradesh;

(iii) A. nilotica gum exudate from Madhya Pradesh;

(iv) A. nilotica gum exudate from Uttar Pradesh I (Banthra Research Station);

(v) A. nilotica gum exudate from Uttar Pradesh II (Kukrail Forest during winter);

(vi) A. nilotica gum exudate from Uttar Pradesh III (Kukrail Forest during summer);

(vii) Gum arabic from Acacia senegal (Sudan);

(viii) Gum arabic from Acacia seyal (Nigeria) [36]

A. Acacia Gum or Gum acacia - a gum similar and closely related to Acacia nilotica gum

Gum Arabic or gum Acacia is a tree gum exudate and has been an important article of commerce since ancient times. It was used by the Egyptians for embalming mummies and also for paints for hieroglyphic inscriptions. Traditionally the gum has been obtained mainly from the Acacia Senegal species. The gum oozes from the stems and branches of trees (usually five years of age or more) when subjected to stress conditions such as drought, poor soil or wounding. Production is stimulated by 'tapping', which involves removing sections of the bark with an axe taking care not to damage the tree. The sticky gummy substance dries on the branches to form hard nodules which are picked by hand and are sorted according to colour and size.

REVIEW OF LITERATURE

Acacia gum, also called gum Arabic, is a complex arabinogalactan–type polysaccharide exuded by Acacia trees. It is a potent drug having diverse pharmacological effects and wide therapeutic potential. It is used in diarrhoea and dysentery,



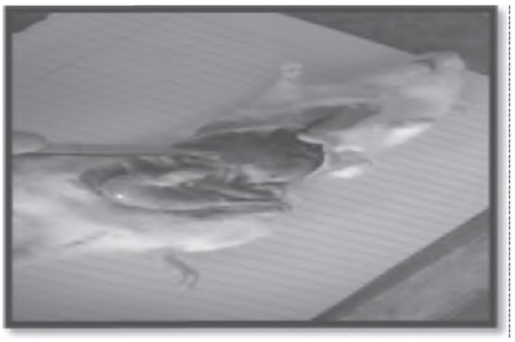
Pic.3 : Collecting gum arabic from Acacia Senegal trees

irritations and ulcers of the stomach and intestine. It I also used in bleeding piles, menorrhagia, spermatorrhoea. It is also known as Babool gum and in Unani System of Medicine it is known as samagh-e-arabi (**Jahan et al.,2008**) [37]. It also acts as galactogogue, antioxidant, prebiotic, also influence lipid profile, gives protection against hepatotoxicity. Gum Acacia also effects on gastrointestinal tract and renal function. Various study suggesting that-

K M Sakthivel et al in 2009 [38] studied the chemopreventive potential of Acacia nilotica bark extract (ANBE) against single intra-peritoneal injection of N-nitrosodiethylamine. The results strongly support that A.nilotica bark prevents lipid peroxidation (LPO) and promote the enzymatic and non-enzymatic antioxidant defence system during NDEA-induced hepatocarcinogenesis which might be due to activities like scavenging of radicals by phytomolecules of ANBE.

Narayanan Kannan in 2013 [39] attempted to investigate the protective effect of A.nilotica against acetaminophen-induced hepatic damage in Wistar rats.The biochemical liver functional tests Alanine transaminase (ALT), Aspartate transaminase (AST), Alkaline phosphatase(ALP), total bilirubin ,total protein, oxidative stress test (Lipid peroxidation), antioxidant parameter glutathione (GSH), and histopathological changes were examined. Results show that the pre **Histology of rat liver treated with *Acacia nilotica* (gum)**[41] treatment with A. nilotica (250mg/kg-bw) orally revealed attenuation of serum activities of ALT, AST, ALP, liver weight, and total bilirubin levels that were enhanced by administration of acetaminophen. Histopathological analysis confirmed the alleviation of liver damage and reduced lesions caused by acetaminophen. The present study undoubtedly provides a proof that hepatoprotective action of A.nilotica extract may rely on its effect on reducing the oxidative stress in acetaminophen-induced hepatic damage in rat model.

Muhammad et al in 2014 [40] explored the effect of methanol crude leaves extract and aqueous fraction of Acacia nilotica on liver enzymes and lipid profiles of alloxan induced diabetic wistar rats. The results obtained showed a statistically significant decrease in the levels of alanine aminotransferase, alanine aspartate aminotranferase and alanine phosphatise in treated groups when compared with control untreated group. The phytochemical screening revealed the presence of tannins, saponins, flavonoids and steroids.



Pic.4. Collection of liver from the rats

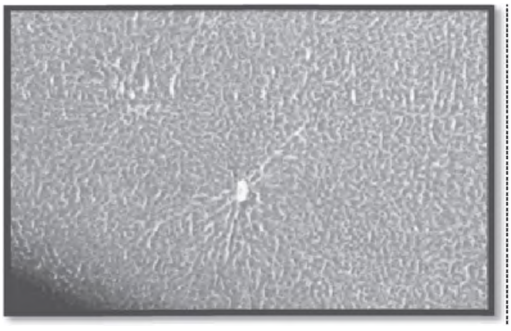


FIGURE- 5A (Liver section of normal rat)

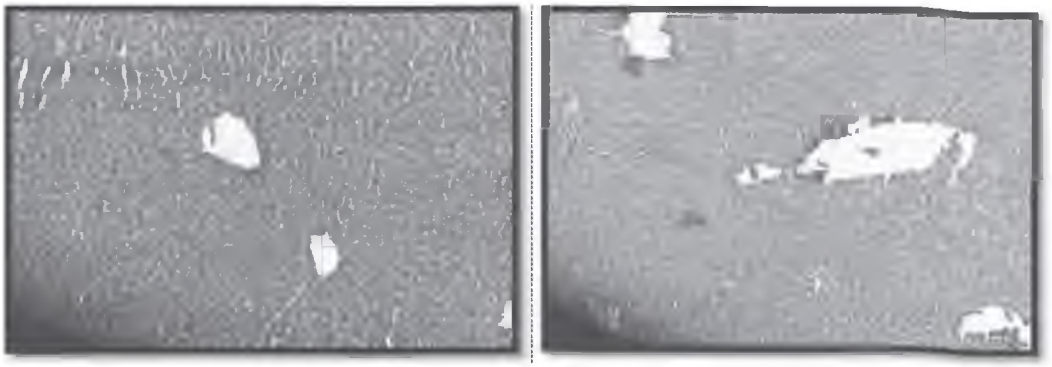


FIGURE- 5B, 5C (Liver sections of hepatotoxin(CCl4) treated Control rats)

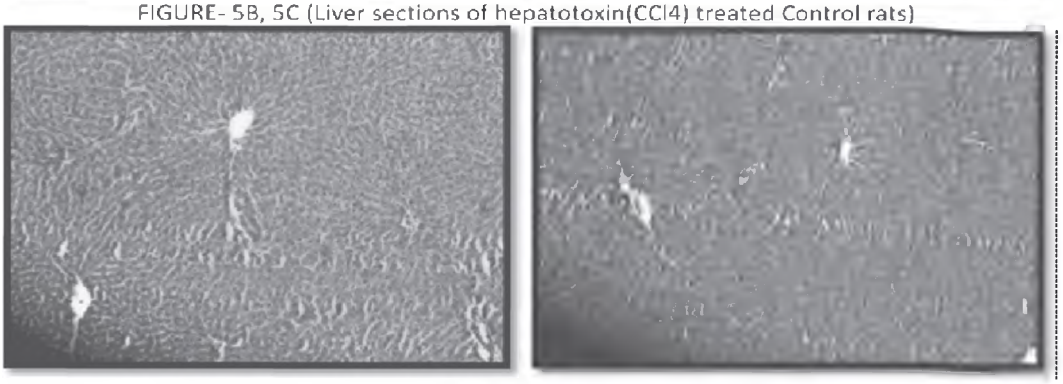


FIGURE- 5D, 5E (Liver sections of Acacia nilotica Gum treated rats)

CONCLUSION

It can be established that hepatoprotective action of Acacia nilotica is a ground reality. It can be useful against several hepatotoxic substances in preserving the normal hepatic histological features and normal hepatic architecture. It is also useful to prevent hepatic damage induced by several free radicals and hepatotoxins.Thus in near future it can prove to be an essential commodity in hepatoprotection.

SCOPE OF FUTURE RESEARCH

Acacia trees of different varieties found in India produce gum exudates that are of potential economic interest. In the present review study, data are collected and compiled to obtain information based on taxonomy, origin, distribution, description, phytoconstituents, traditional and pharmacological claims on Acacia nilotica gum and attempted to investigate the protective effect of A.nilotica gum against hepatic damage in rats. Traditionally the plant used widely for the treatment of various ailments, but scientifically few of them was screened out. Thus the scientific studies should be conducted to investigate the unexploited potential of Acacia nilotica (L.). This gum is very beneficial but is an underutilized food commodity. Awareness should be created about its significance and wide spectrum of medicinal activities. The gum of Acacia nilotica is odourless and tasteless but it enhances the texture, appearance and

stability of the product. So, the gum should also be incorporated in simple recipes which can be prepared at home and its acceptability among people should be assessed. Further studies are needed to identify active moieties and understand the mechanism of action. These studies will be highly beneficial as the demands of natural alternatives are increasing constantly and this is also the primary study, further more human studies require to find out the effective doses and effect of doses. However nutrition education should also be given for management and control of disease.



Pic.6. Acacia gum and its fine powdery texture

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