

## An investigation on conformation of antimicrobial and superfluous ecological role of *Acacia nilotica indica*

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### Abstract

The plant species *Acacia nilotica indica* belongs to the leguminosae family and subfamily mimoseae. It is widely cultivated in the Indian subcontinent. It is also an imperative multipurpose plant that has been used broadly for the treatment of various diseases. The present study intended to elucidate the cumulative potential of *A. nilotica indica*. The study revealed that *A. nilotica indica* can play a crucial buffering role on the populations of dominant indigenous bacterial groups of the lake water. In addition, chemical composition and their other constituents clearly indicate the phramocological and nutritional values of *Acacia nilotica indica*.

**Keywords:** *Acacia nilotica*, antimicrobial activity, cumulative potential.

### 1. Introduction

The plant species *Acacia nilotica indica* (Linn.) wild. Ex. Del. belongs to the leguminosae family and subfamily mimoseae. It consists of dried mature stem bark having moderate sized spiny, evergreen tree found throughout India. It is estimated that there are roughly 1380 species of *Acacia* worldwide. Taxonomy of the *Acacia nilotica indica* is,

Kingdom: Plantae

Phylum: Magnoliophyta

Division: Magnoliatae

Family: Leguminosae

Subfamily: Mimoseae

Genus: *Acacia*

Species: *nilotica*

It withstands extremes of temperature (-1 to 50 °C). Trees are generally deciduous during the dry season, through riverine species can be almost evergreen [1]. *A. nilotica* is a plant 5 to 20 m high with a thick spherical crown, stems and branches usually sinister to black coloured, grey-pinkish slash, fissured bark, exuding a reddish low quality gum. The plant has straight, light, thin grey spines in axillary pairs, usually in 3 to 12 pairs, 5 to 7.5 cm long in young trees, mature trees commonly without thorns. The leaves are bipinnate, with 3 to 6 pairs of

pinnulae and 10 to 30 pairs of leaflets each, rachis with a gland at the bottom of the last pair of pinnulae. Flowers are globulous heads, with 1.2 - 1.5 cm in diameter of bright golden colour set-up either axillary or whorly on peduncles. Pods are strong constricted, white grey hairy thick.

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 [3].

*A. nilotica indica* occurs naturally and it is imperative in traditional, rural and agro pastoral systems. It is also an imperative multipurpose plant that has been used broadly for the treatment of various diseases. The phytochemicals contribute chemically to a number of groups among which are alkaloids, volatile essential oils, phenols and phenolic glycosides, resins, oleosins, steroids, tannins and terpenes. Bargali and Bargali (2009) [2] reported about the role of *A. nilotica* in the recovery of waste lands on degraded lands. Because of the presence of variety of bioactive compounds in the plant can play a versatile role [4].

**Fig. 1: *Acacia nilotica indica* plant**



**Fig. 2: *Acacia* leaves, barks and pods**



**Fig. 3: General growth pattern of *Acacia nilotica indica* as presented by Bargali and Bargali, 2009 [2]**

Features	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Flowering			■	■	■	■						
Pod formation							■	■	■	■	■	■
Seed drop	■											
Germination	■	■										
Leaf fall						■	■	■	■	■	■	■

Almahy and Nasir (2011) have conducted a study to find phyto-chemical and mineral content of the *Acacia sp.* including *A. nilotica*[5]. Their investigation revealed about high medicinal value of *A. nilotica* due to their phyto-chemical content and mineral content. Ali et al., (2012) done their review on multipurpose medicinal uses of *A. nilotica* and explained about phyto-chemistry, medicinal uses and pharmacological effects of *A. nilotica*[6]. The various potentials including pharmacological, nutritional, ecological of the plant were explored by wide range of studies. While, the present study intended to elucidate the cumulative potential of *A. nilotica indica*.

**2. Materials and methods**

Experimental site was conducted in the experimental unit of the dry deciduous forest of Vellode Lake, Erode District, South India. Vellode Lake is lies between 11°8'04.04" N and 77°37'52.42" E with the elevation of 764 ft. The climatic condition of Vellode Lake is very hot in summer (March to June). The yearly average maximum temperature is about 30°C and the minimum temperature is about 19°C. During the peak summer the maximum temperature often reaches 38°C. This area receives rainfall mainly from north-east monsoon between September and December, whereas the period between February and June it generally remains parched. The average number of rainy days in a year is around 55 and the average annual rainfall is around 760mm.

**2.1. Phyto-Chemical Analysis**

Phyto-chemical analysis of plant samples is extremely valuable in giving information about the nature

of constituents found in each plant. It is necessary to found to correlate the nature of chemical constituents and its role on the ecosystem. In the present study area, *Acacia nilotica indica* is the most dominated plant species; therefore it has been necessary to conduct phyto-chemical analysis of the plant species to find its chemical constitution and its impact on the ecosystem.

**2.1.1. Collection of plant materials**

The plant parts like bark, leaves, flowers and fruits of *Acacia nilotica indica* were collected from study area and authenticated by Botanical Survey of India, Coimbatore (certificate number No.: BSI/SRC/ 5/23 /2013-14/tech/287).

**2.1.2. Preparation of samples for analysis**

The collected leaves and fruits were shadow dried and the barks were cut into small pieces and then shadow dried. After proper drying all the plant portions were powdered individually. All the powdered plant portions were stored at room temperature in separate air tight glass bottles.

**2.1.3. Extraction of *Acacia nilotica indica* plant materials**

The basic principle is to grind the plant materials finer to increase the surface area for extraction there by increasing the rate of extraction.

**2.1.4. Choice of solvents**

Successful determination of biologically active compounds from plant material is largely dependent on the type of solvent used in the extraction procedure. Properties of a good solvent in plant extractions includes, low toxicity, ease of evaporation at low heat, promotion of rapid physiologic absorption of the extract, preservative action,

inability to cause the extract to complex or dissociate. In the present analysis, water, acetone, alcohol and chloroform were used for the extraction of phyto-chemicals from *A. nilotica indica*.

### 2.1.5. Methods of extractions

During the present phyto-chemical analysis the following methods were followed for the extractions of bioactive compounds from the plant portions of *A. nilotica indica*.

#### a. Plant tissue homogenization

Dried or wet fresh plant parts were grounded in a blender to fine particles. Then certain quantity of solvents were added, shaken vigorously for 5-10 minutes and after 24 hours stand, the extraction was collected and used for further analysis.

#### b. Maceration

In maceration, whole or coarsely powdered plant materials were kept in contact with a solvent in stoppered containers for a defined period with frequent agitation until soluble matter was dissolved.

#### c. Decoction

This method was used for the extraction of the water soluble and heat soluble constituents. By boiling the plant materials in water for 15 minutes, cooling and passing sufficient cold water through the filters required volume of sample was produced.

d. Serial exhaustive extraction: In this method, successive extractions were done with solvents of increasing polarity from a non-polar to a more polar solvent to ensure that wide polarity range of compound could be extracted.

### 2.1.6. Qualitative analysis

Qualitative analysis was conducted to find the presence of phyto-chemical compounds like phenols by Ferric chloride test (Mace, 1963) [7], alkaloids by Mayer's test [8], Wagner's test [8] and Hagner's test [8], tannins by Horbone method [8], saponins by Evans Mehtod and flavonoids by Alkaline reagent test [8] and Lead acetate test [8] in extracts of *A. nilotica indica*.

### 2.1.7. Quantitative analysis

The quantity of alkaloids by Phosphate buffer-Spectrophotometer method [9], saponins by Spectrophotometer method [9], flavonoids by Evaporation method, phenols by Ammonium hydroxide - Amyl alcohol method [9], calcium by EDTA - Titrimetric method, phosphates by Vando-Molybdate method [10], chlorides by Argentometric method and sulphates by Spectrophotometer [10] were estimated.

### 2.1.8. HPLC analysis

High performance liquid chromatography analysis was done for the conformation of the presence of the phyto-chemical compounds including alkaloids and flavonoids.

## 2.2. Antimicrobial analysis

### 2.2.1. Collection of samples

For the isolation of dominant indigenous bacterial species water, sediment and droppings were separately collected in well sterilized glass bottles. With proper labeling they transported to the laboratory and stored refrigerator at 4 °C until further process.

### 2.2.2. Isolation of indigenous bacterial species

By serial dilution method, water, sediment and droppings were diluted to  $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$ ,  $10^{-4}$  and  $10^{-5}$ . All diluted samples were poured in separate petri-discs containing enough amount of nutrient agar medium (peptone: 5.0g, beef extract: 3.0g, NaCl: 5.0g, Agar: 15.0g and distilled water: 1000ml).

All poured plates were inverted and kept in incubator for 24 hours at 35°C - 37°C. Based on the color and morphology grown colonies were counted with the assistance of colony counter. The top three dominant bacterial isolates from water, sediment and droppings were selected for the further identification tests. The isolates of water samples were named as WB1, WB2 and WB3. Similarly, isolates of sediment as named SM1, SM2 and SM3 and isolates of droppings as DM1, DM2 and DM3. By continuous streaking method, the dominant three bacterial species of water, sediment and droppings were sub-cultured to obtain pure isolates for further identification tests.

### 2.2.3. Identification of bacterial isolates

Identification of the bacterial isolates up to genus level was done on the basis of morphological and biochemical tests of Bergey's manual [11].

### 2.2.4. Antibacterial activity

Isolated indigenous bacterial species were properly inoculated and used for the antimicrobial activity. The antibacterial tests were done by following the disc diffusion method. 10 µl of test microorganisms were seeded into respective petri plates with agar medium. The paper discs (5mm in diameter) were impregnated in solidified medium after dipping in extracts of *Acacia nilotica indica*. After 24 hours of incubation period, the inhibition zones of the discs were measured. By comparing with inhibition zone of control the inhibition zones of extracts were calculated.

## 2.3. Soil analysis

To find the effect of *Acacia nilotica indica* over the characters of the soil in its ecosystem, physico-chemical analysis of soil samples from the zones like mid canopy (MC), canopy edge (CE) and canopy gap (CG) were collected at different depth i.e. 0 - 10 cm, 11 - 20 cm, 21 - 30 cm, 31 - 40 cm and 41-50 cm. Collected soil samples were transported and physico-chemical parameters including pH, total phosphorus total potassium, calcium, magnesium, chloride and sulphates were determined.

### 3. Results

#### 3.1. Phytochemical analysis

Phyto-chemicals including alkaloids, glycosides, saponins, steroids, flavonoids, protein, terpenoids, tannins and phenols were present. By their positive results in qualitative analysis, extracts were undergone for the further

quantitative analysis. The quantitative analysis for phyto-chemicals of the extracts from leaves, bark and fruits of *Acacia nilotica indica* revealed their phyto-chemical composition (Table 1). Results of High Performance Liquid Chromatography (HPLC) analysis of the extracts for alkaloids and flavanoids are presented in table 2.

**Table 1: Chemical composition of leaves, bark and fruits of *Acacia nilotica indica***

S. N.	Parameters	Units	Composition		
			Leaves	Bark	Fruit
1	pH	-	5.86 ± 0.87	6.6 ± 0.53	6.35 ± 0.7
2	Total phenols	mg/g	12.2 ± 0.2	13.5 ± 1.1	7.5 ± 0.34
3	Alkaloids	mg/g	4.2 ± 1.2	8.7 ± 0.8	4.9 ± 0.83
4	Saponins	%	0.156 ± 0.08	0.183 ± 0.1	0.026 ± 0.01
5	Total flavonoids	mg/g	9.7 ± 1.32	5.6 ± 2.1	3.8 ± 0.87
6	Total nitrogen	%	0.98 ± 0.61	2.1 ± 0.55	1.4 ± 0.92
7	Total phosphates	%	0.65 ± 0.04	0.59 ± 0.19	0.12 ± 0.01
8	Total potassium	%	0.96 ± 0.32	0.9 ± 0.4	0.74 ± 0.15
9	Calcium	%	0.63 ± 0.28	1.31 ± 0.71	0.48 ± 0.2
10	Magnesium	%	0.45 ± 0.09	0.63 ± 0.3	0.38 ± 0.14
11	Sodium	%	0.31 ± 0.08	0.3 ± 0.05	0.52 ± 0.2

**Table 2: Detected alkaloids and flavonoids of extracts of *A. nilotica indica***

Phyto-chemical	Extracts	Rf values	Time (Minutes)	Name of the detected Chemical compound
Alkaloids	Leaves	10.2	16.9	Dimethyl tryptamine
		6.1	26.85	N- Methyl tryptamine
	Fruit	1.2	4.83	5- Methoxy dimethyl tryptamine
		6.1	13.8	Dimethyl tryptamine
Flavonoids	Leaves	0.34	24.9	6,8 -bis C,B,D gliuopyranoside
		0.71	38.2	(+) Catechin- 4,5 digallate
		0.27	48.1	Melacacidin
	Bark	0.69	27.3	(+) Catechin- 5,7 digallate
		0.17	42.3	Quercetin 3-O-rutinoside
	Fruit	0.26	8.4	Melacacidin
		0.76	34	1,2 - Dimethyl benzaantracene

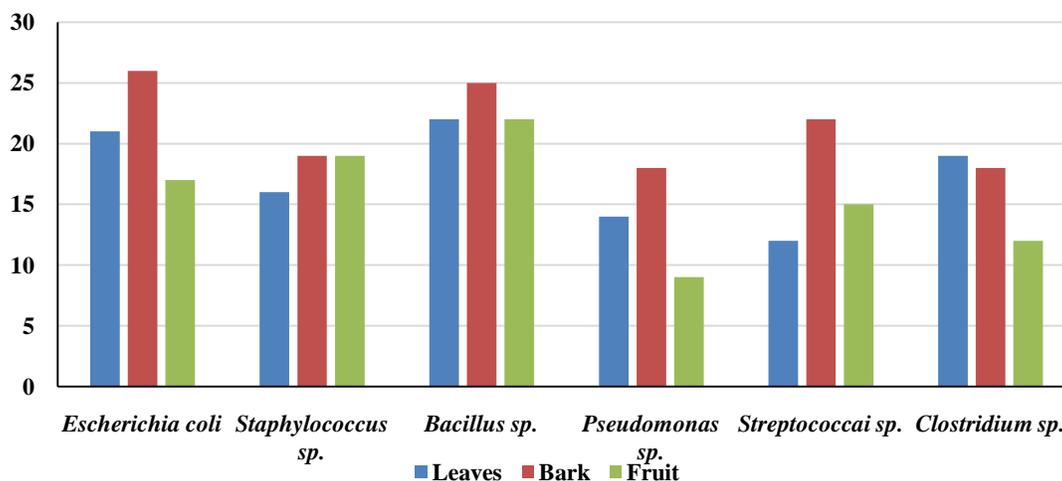
#### 3.2. Antibacterial analysis

By counting the numbers of colonies of dominant three bacterial isolates in serial dilutions of the water and soil samples suitable dilutions were selected for the further streaking. Bacterial colonies of dominant three bacterial isolates counted in serial dilutions of water and sediment samples were selected. By continuous streaking, pure cultures were obtained for further identification tests. The present study revealed that based on the morphological

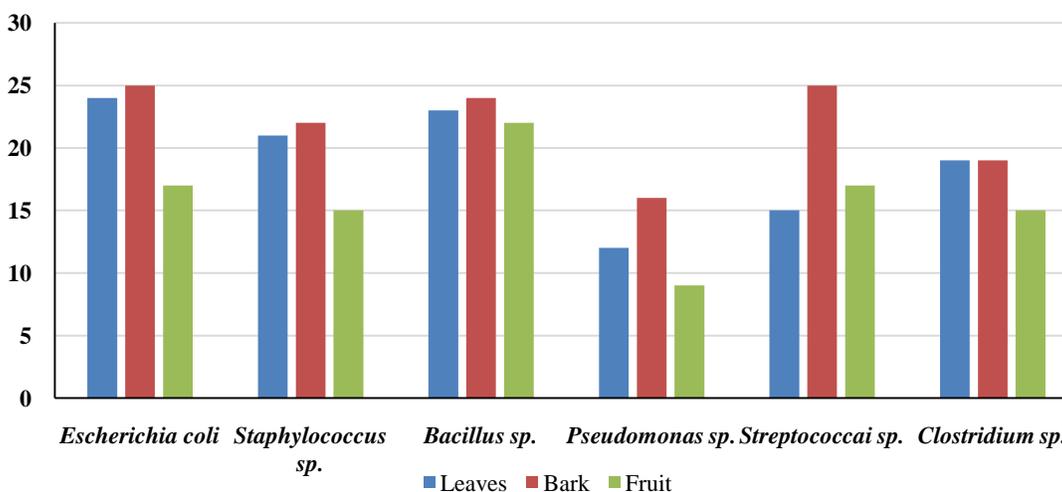
and biochemical tests, three dominant bacterial species were isolated from water *Escherichia coli*, *Staphylococcus sp.* and *Bacillus sp.* and from soil *Pseudomonas sp.*, *Bacillus sp.* and *Streptococci sp.*

Antibacterial activity of leaves, bark and fruits extracts of *Acacia nilotica indica* against isolated dominant three bacterial groups from water and soil were done by disc diffusion method. The inhibition zones were measured and presented in Fig. 4 and 5.

**Fig. 4: Inhibition zone of bacteria species with water extract of *Acacia nilotica***



**Fig. 5: Inhibition zone of bacteria species with ethanol extract of *Acacia nilotica***



**3.3. Soil analysis**

Chemical analysis of the soil samples from the mid canopy (MC), canopy gap (CG) and canopy edge (CE) of

the *Acacia nilotica indica* dominated areas were done and the results are presented in table 3.

**Table 3: Chemical composition of soil of *Acacia nilotica indica* dominated area**

S. N.	Parameters	Zone	Soil depth (cm)				
			0 - 10	10 - 20	20 - 30	30 - 40	40 - 50
1	pH	MC	6.52	6.61	6.63	6.61	6.56
		CE	6.75	6.89	7.02	7.07	6.94
		CG	7.12	7.11	7.31	7.42	7.36
2	Total organic carbon (%)	MC	1.3	1.39	1.19	0.84	1.2
		CE	1.1	1.1	1.21	1.08	0.09
		CG	0.96	1.03	0.92	0.72	0.81
3	Total nitrogen (%)	MC	0.191	0.206	0.201	0.168	0.113
		CE	0.136	0.138	0.142	0.116	0.092
		CG	0.069	0.073	0.072	0.043	0.032
4	Total phosphates (%)	MC	0.092	0.082	0.073	0.081	0.068
		CE	0.089	0.081	0.071	0.076	0.072
		CG	0.069	0.067	0.062	0.057	0.061
5	Total potassium (%)	MC	8.1	7.3	7.2	6.8	6.7
		CE	7.2	7.1	6.9	6.7	6.7
		CG	6.8	6.8	6.7	6.7	6.5

#### 4. Discussion

Phyto-chemical investigation on *A. nilotica* and observed various phyto-chemical qualities of extracts of *A. nilotica* plant portions, similar results were obtained by Malviyo *et al.*, (2011) [3]. A study of Ceema *et al.*, (2011) reported that the chemical composition, mineral, profile and *in-situ* digestion kinetics of leaves of *A. Nilotica* and estimated the amount of organic matter, fiber, lignin, ash, mineral and secondary metabolites in the leaf extracts of *A. nilotica* [12]. Akinsulire *et al.*, (2007) demonstrated the efficacy of *A. nilotica* extracts in treatment of gonorrhoea, leucorrhoea, diarrhea, dysentery and wounds [13]. Manesh and Sathish (2008) reported that the antibacterial activity of *A. nilotica* against *Xanthomonas* sp. has ascertained the value of *A. nilotica* plant in Ayurved [14]. Banso (2009) conducted an investigation on phyto-chemical and antibacterial nature of bark extracts of *A. Nilotica* and observed that the antimicrobial activity of ethanolic stem bark extract against *Salmonella viridis*, *Bacillus subtilis*, *Salmonella aureus*, *Eschericia coli* and *Salmonella sonnei*. Sumathiand Parvathi (2010) explained that antimicrobials destroy or inhibit the growth of microbes such as bacteria, viruses, fungi or protozoa and more than 50% of the reported antimicrobial substances are derived from plants [15].

Riaz *et al.*, (2011) done a work on antibacterial and cytotoxic activities of *A. Nilotica* extracts against *E. coli* and *Klebsiella* species and observed that killing capacity of the extracts against these bacterial species [16]. Sakthivel *et al.*, (2012) demonstrated that the effective tumor inhibition nature of extracts of *A. nilotica* in *in-vivo* models [17]. Vikrant (2012) reviewed about ethanobotany, phytochemical and pharmacological profile of *A. Nilotica* and concluded that *A. nilotica* is an important source of many therapeutically and pharmacologically active constituents [18]. Deshpande and Kadam(2013) estimated the phyto-chemical components of *A. nilotica* and observed marked antibacterial activity against *Sterptococcus mutans* [19]. Deshpande (2013) observed the antibacterial activity of *A. nilotica* against clinical isolates and reported that it is rich in phyto-chemicals and have potent antibacterial activity [20]. Kavitha *et al.*, (2013) have done a study on antibacterial activity of methanolic extracts of *A. Nilotica* against hospital isolates of Bangalore [21].

Phyto-chemicals are present in variety of plants utilized as important components of both human and animal diets. These include spices, fruits, herbs and vegetables. The usefulness of these plant materials medicinally is due to the presence of bioactive constituents such as alkaloids, tannins, flavonoids and phenolic compounds [22]. The role of plants in maintaining health of human, animals and ecosystems are well documented. Many of the indigenous

species and their extracts are used in traditional medicine. Bioactive compounds from the plants exhibit physiological activity against bacteria and other microorganisms [23]. Alkaloids play some metabolic role and control development in living systems. They are also protective function in animals and are used as medicine especially the steroidal alkaloids. Tannins are known to inhibit pathogenic fungi. Saponin prevents disease invasion of plants by parasitic fungi, hence have some antifungal properties, they also have anti-fertility effects. Studies revealed that flavanoids apart from their antioxidant protective effects, inhibits the initiation, promotion and progression of tumors [24,25].

In total of 96 hectares of the lake, the plant *Acacia nilotica indica* rules almost 55 hectares. A fully grown plant can cover an area of 230 square feet. It can develop moderate level of canopy by their irregular branches. They can tolerate high level of water and withstands high levels of turbidity. By their annual cycle, they shed high volume of leaves, barks, flowers and fruits on water/soil. Old and dead plant portions also falls as a whole and decomposes. When compare to canopy edge, the mid canopy of *A. nilotica indica* have high level of the dominance over other floral species. However, it has a limited dominance over grasses. The invasive *Prosopis juliflora* is a heavy competitor for this plant. In particular, the vigorous competition from *Prosopis juliflora* was observed over young growing *Acacia nilotica indica* for water and sunlight [26]. The lake ecosystem supports numerous microorganisms in water as well as in sediment. The droppings from the birds also deposit sufficient amount of microbial populations into the lake ecosystem. The bacterial and fungal species play an important role in the dynamics of the lake ecosystem. The processes like nitrification, denitrification, nitrogen fixation and phosphates release, etc are the main events facilitated by the microbes. However, the microbial populations of an ecosystem vary from time to time, temperature, availability of light, oxygen, nutrients and organic matter. In the present study, three dominant bacterial species were isolated from water *Escherichia coli*, *Staphylococcus* sp. and *Bacillus* sp. and from sediment *Pseudomonas* sp., *Bacillus* sp. and *Streptococci* sp.

The present study revealed that plant portions like leaves, bark and fruits of *Acacia nilotica indica* constitute phyto-chemicals such as alkaloids, saponins, flavonoids, terpenoids, tannins and phenols. These phyto-chemicals are known to have antimicrobial activity [27]. The presence of phenolic compounds indicated that they can act as efficient antimicrobial agents. Thus, the presence of phenolic compounds in the plant may be the reason for therapeutic, antiseptic and anti-bactericidal properties [28]. Alkaloids can play crucial role on metabolic rate and regulated

development in living systems [22]. Pure form of alkaloids used as medicinal agents [24]. Tannins are known to inhibit pathogenic fungi [25]. They can control the growth of parasitic fungi [23,29]. Saponins are useful in pharmaceutical and food industry due to its foaming ability produces frothy effects and they also used in manufacture of shampoos, insecticides and synthesis of steroidal hormones [30,31]. Presence of flavanoids in plant portions of *A. nilotica indica* elucidates the medicinal values. Flavanoids are antioxidants and free radical scavengers which prevent oxidative cell damage, have strong anticancer activity and protect the cell against all stages of carcinogenesis [32, 33].

The mineral composition of the leaves and fruits showed that they can be a good fodder for cattle. Especially, the low percentage of sodium indicates that these plant portions can be used to treat the human diseases also [5]. Antibacterial tests of *A. nilotica indica* extracts were showed that bark and leaves have high efficacy against isolated dominant indigenous bacterial species from water and sediment. The study revealed that *A. nilotica indica* can play a crucial buffering role on the populations of dominant indigenous bacterial groups of the lake water, because of the addition of plant debris into water body by seepage water from LBP canal through the canopy regions of the dry deciduous forest. In addition, chemical composition and their other constituents clearly indicate the pharmacological and nutritional values of *Acacia nilotica indica*.

## References

- [1]. Fagg CW, Greaves A. *Acacia nilotica*. Annotated Bibliography. I. CAB, 199077:F42.
- [2]. Bargali K, Bargali SS. *Acacia nilotica*: A multipurpose leguminous plant. *Nature Sci* 2009; 7(4): 11-19.
- [3]. Malviyo Sapna, Swati Rawat, Anil Kharia, Meena Verma. Medicinal attributes of *Acacia nilotica* Linn. - A comprehensive review on ethno-pharmacological claims. *I. J. Pharm. Life Sci.* 2011; 2 (6): 830-837.
- [4]. Bansa A. Phyto-chemical and antimicrobial investigation of bark extracts of *Acacia nilotica*. *J. Medi. Plants Res.* 2011; 3(2): 82-85.
- [5]. Almahy HA Nasir OD. Phyto-chemical and mineral content of the leaves of four Sudanese *Acacia* species. *J. Stored Prod. Postharvest Res.* 2011; 2(1): 221-226.
- [6]. Ali A, Akhtar N, Khan AB, Khan SM, Rasul A, Zaman ZS, Khalid N, Waseem K, Mahmood T, Ali L. *Acacia nilotica*: A plant of multipurpose medicinal uses. *J. Med. Plants*, 2012; 6(9): 1492-1496.
- [7]. Mace ME. Histochemical localization of phenols in healthy and diseased banar roots. *Physiol. Plant.* 1963; 16: 915-925.
- [8]. Evans WC. Pharmacology. Harcourt Brace and Company, Asia, Singapore. 1997226.
- [9]. Harbone SB. Phyto-chemical Methods. Chapman and Hall Ltd., London. 1973.
- [10]. Jackson ML. Soil chemical analysis. Prentice - Hall of India Pvt. Ltd., New Delhi. Indian Reprint. 19731- 41.
- [11]. Bergey DH. Bergey's Manual of Systematic Bacteriology. 1<sup>st</sup> Ed., Williams & Wilkins. 1923.
- [12]. Ceema BV, Sultan IJ, Javaid A, Akntar P, Shami M. Chemical composition, mineral profile and *in-situ* digestion kinetics of fodder leaves of four native trees. *Pak. J. Bot.*, 2011; 43(1): 397-404.
- [13]. Akinsulire O, Aibinu A, Adenipekun T, Adelowotan T. *In-vitro* antimicrobial activity of crude extracts from plants *Bryophyllum pinnatum* and *Kalanchoe crenata*. *Afr. J. Tradi. Comp. Alt. Med.*, 2007; 4: 338-344.
- [14]. Mahesh B, Satish S. Antimicrobial activity of some important medical plant against plant and human pathogens. *World J. of Agri. Sci.*, 2008 4(S): 839-843.
- [15]. Sumathi P, Parvathi A. Antimicrobial activity of some traditional medical plants. *J. Med. Plan. Res.*, 2010; 4:316-321.
- [16]. Riaz S, Faisal M, Hashain S, Ahmedkhan N. Antibacterial and cytotoxic activities of *Acacia nilotica* Lann. (Mimosaceae). Methonal extracts against extended spectrum beta lactamase producing *Escherichia coli* and *Klesiella* species. *Tropical J. Pharmaceutical Res.* 2011; 10(6): 785-791.
- [17]. Sakthivel KM, Kannan N, Angeline A, Guruvayoorappan C. Anticancer activity of *Acacia nilotica* (L) wild, Ex. Delile, sub sp. *indica*. Against Dalton's Ascitic Lymphoma induced. Solid and Ascitic Tumor model. *Asian Pacific J. Cancer Prevention* 2012; 136: 3989-3995.
- [18]. Vikrant V. A review on *Acacia nilotica* (Linn.) and its ethonobotony, phyto-chemical and pharmacological profile. *I. J. Pharmaceutical Res. Devel.*, 2012; 4(3): 252-256.
- [19]. Deshpande SN, Kadam DG. Phyto-chemical analysis and antibacterial activity of *Acacia nilotica* against *Streptococcus mutans*. *Intl. J. Pharm. Pharmal. Sci.*, 2013; 5 (1): 236-238.
- [20]. Deshpande SN. Preliminary phytochemical analysis and *in vitro* investigation of antibacterial activity of *Acacia nilotica* against clinical isolates. *J. Pharmacogony Phytoche.*, 2013; 1(5): 23-27.

- [21]. Kavitha PA, Kumar P, Murthy NP, Gopinath SM. Methanolic extract of *Acacia nilotica* and antibacterial activity against hospital isolates of Bengaluru District. *I. J. Latest Res. Sci. Tech.*, 2013; 2(1): 522-524.
- [22]. Edeoga HO, Eriata DO. Alkaloid, tannin and saponins contents of some medicinal plants. *J. Medi. Aromat. Plants Sci.*, 2001; 23: 344-349.
- [23]. Kim SY, Ohandy MJ, Jung MY. Anti-oxidant activities of selected oriental herb extracts. *J. Am. Oil Chem. Soc.*, 2002; 71: 633-640.
- [24]. Okwu DE. Phyto-chemical, vitamins and mineral contents of two Nigerian medicinal plants. *J. Mol. Medi. Adv. Sci.*, 2004; 1: 378 – 391.
- [25]. Burkill IH. The useful plants of west tropical Africa. Royal Bot. *Gardens*, 2005; 3: 522.
- [26]. Richardson DM, Carruthers I, Hui C, Impson FAC, Miller IT, Robertson MP, Rought M, Le Roux IJ, Willson IRU. Human mediated introduction of Australian Acacias – a global experiment in biogeography. *Diver. Dist.*, 2011; 17: 771-787.
- [27]. Ebana RU, Essien A, Ekpa DD. Nutritional and potential medicinal values of the leaves of *Lasianthera Africana* (Beaur.), *Global J. Pure Appl. Sci.*, 2009; 1: 1-7.
- [28]. Gill LS. Medicinal uses of trees and plants in Africa. University of Benin, Nigeria, 1999:24-48.
- [29]. Bidwell RS. Plant physiology. 2<sup>nd</sup> Ed., Macmillan, London, 1999; 225-227.
- [30]. George AG. Legal status and toxicity of saponins in food and cosmetics. *Toxicol.*, 2002; 3: 85-91.
- [31]. Sodiopo OA, Akiniyi JA. Studies on certain characteristics of extracts from bark of *Pansinystallia macruterus*. *Glob. J. Pure Appl. Sci.*, 2000; 6: 83-87.
- [32]. Salah W, Miller NJ, Pagauga G, Tijiburg AP, Bolwel F Evans C. Poly phenolic flavones as scavengers of aqueous phase radicals as chain breaking oxidant. *Res. J. Biochem.*, 2002; 2: 339-346.
- [33]. Okeke CU, Elekwa IZ. Phyto-chemical study of extracts of *Gongronemalati folium* (Asclepiadaceae). *J. Health Visual Stud.*, 2003; 5: 47-55.