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A CRITICAL REVIEW ON OCIMUM TENUFLORUM, CARICA PAPAYA AND SYZYGIUM CUMINI: THE MEDICINAL FLORA OF GUYANA

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The total land area of Guyana is 21 million hectares, of which 18.3 million hectares are forested. Therefore, 87% of the country's land resource is covered by forest. These forests are classified as swamp forests and the coast and rain forest, seasonal and dry evergreen forest in the interior. Guyana is low-lying coastal state is vulnerable to climate change. The Government of Guyana believes that we can protect and maintain our forests and at the same time attract resources for our country to grow and develop. The forest of Guyana are valuable reservoirs of biodiversity and provide home to approximately 8,000 plant species and in excess of 1,000 species of terrestrial vertebrates. The total biodiversity in the Guyana shield is not at the level as found in the forests of Amazon basin. The map in Figure 1 shows forests allocation of Guyana.

In addition to the range of ecological services that the forests provide, the timber which the forests yield for housing and industry, and the non-timber forest products assist in the country's social and economic growth. The forests are also used for agriculture, research, ecotourism and biodiversity reserves. Forests are also a source of food, building materials, fibres for textiles and weaving, medicine, tannis and dyes. The present review presents a summary of current research findings on the following three common medicinally important Guyanese flora – (i) Ocimum Sanctum (Tulsi), (ii) Carica papaya (Papaya), (iii) Syzygium cumini (Jamun)

1. OCIMUM TENUIFLORUM (TULSI)

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Lamiales
Family	:	Lamiaceae
Genus	:	Ocimum
Species	:	O. tenuiflorum

Ociumum tenuiflorum also known as Ocimum sanctum, Holy basil or Tulsi is an aromatic plant. It is native throughout the Eastern world tropics and wide spread as cultivated plant. The variety of Ocimum tenuiflorum used in Thai cuisine is referred to as Thai Holy Basil [1]. Ocimum is a genus of about 35 species of aromatic annual and perennial herbs and shrubs. Some species includes Ocimum basilicum or Thai basil; O. Campechianum or Amazonian basil; O. Gratissimum or African Basil; O. Tenuiflorum or O. Sanctum or Tulsi or Holy Basil; O. Citriodorum or Lemon Basil, O. Sanctum grow up to 60 cm high with red or purple subquadrangular branches.

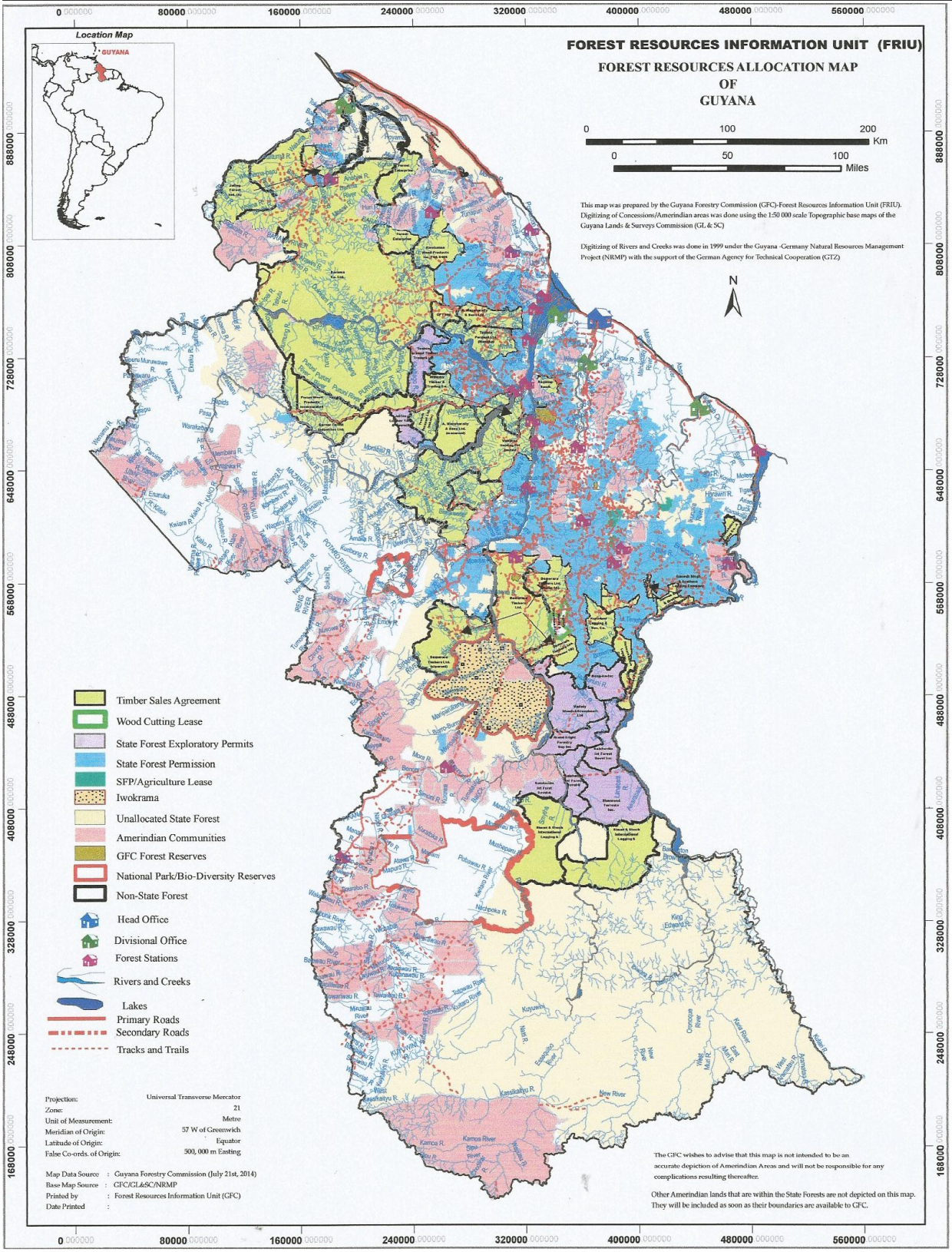

Figure 1. *Forest resources allocation map of Guyana*

Leaves are simple, serrate and hairy. Flowers are purple in colour. Fruits are smooth and not mucilaginous when wetted. It is propagated by means of seeds. Seeds are planted directly in the ground. Young plants are transplanted when they attain 8-10 cm height [2]. Krishna Tulsi has purple leaves while Shri Tulsi has green leaves. Tulsi is used to reduce skin disorders, pain, swelling, headache and disease of head and neck. Tulsi leaves are very useful for lung intestinal and cardiovascular diseases. It is also effective in reduce stress, blood sugar and blood cholesterol.

Prakash and Gupta [3] has described a short review on therapeutic uses of Ocimum Sanctum with a note on eugenol and its pharmacological actions. A critical review on phytochemical, antibacterial and immunomodulatory properties of O. Sanctum is reported by Kumar et al [4]. Joshi et al [5] has investigated phytochemical and antimicrobian properties of aqueous ethanolic extracts of Tulsi, Cloves, Datiwan, Neem medicinal plants. Prasad et al [6] has explained antibacterial, phytochemical and antioxidant potential of some Ocimum species. The qualitative phytochemical screening and GC-MS analysis of Ocimum sanctum leaves extracts is discussed by Devendran and Balasubramanian [7]. A comparative study of antimicrobial activity and phytochemical screening of aqueous and alcoholic leaf extract of Tulsi on E. Coli is presented by Sadul Rama et al [8]. Choudhury et al [9] studied pharmacognostical and phytochemical screening of various Tulsi plants available in South Eastern Odisha State of India. Comparative analysis of Tulsi stem and leaves for phytochemicals and inorganic constituents has been described by Shafquatullah et al [10]. Invitro antioxidant potential of Ocimum sanctum and Ocimum basilicum is reported by Ramesh and Satakopan [11]. Devi [12] has presented reviews on antioxidant properties of the Indian Holy Basic, Osciumum sanctum (Tulsi). Joshi et al [13] studied antibacterial property of different medicinal plants viz: Tulsi, Ram Tulasi, Dalchini, and Timur for potential antibacterial activity against 10 medically important bacterial strains e.g. S. Aureus, E. Coli, B. Subtilis, S. Typhi, Shigella, K. Pneumnial etc. Mishra and Mishra [14] has observed antibacterial activity of aqueous and chloroform extract of leaves of Tulsi against the bacteria i.e. E. Coli, S. Aureus, P. Aeruginosa, S. Typhimurium present investigation reveals that Oscimum Sanctum may be used as a preservative in food industries since it is equally effective against pathogenic gram positive and gram negative bacteria. Jeba and Rameshkumar [15], studied antimicrobial activity of leave extracts of Ocimum gratissiumum was tested against Salmonella, Typhimurium, S. Aureus, and E. Coli, pathogenic bacteria that cause diarrhea. Rathod et al [16] has reported antimicrobial activity of aqueous and ethanolic extract of Neem (leaves and bark) and Tulsi (leaves) against two gram positive bacteria (B. Subtilis and E. Coli) and two gram negative bacteria (K. pheumaniae and E. Coli).

Neem bark was found to have significant antibacterial activity than Neem and Tulsi leaves. Rabeta and Lai [17] have determined antioxidant capacity of freeze drying, vacuum drying, fermented and unfermented leaves of Ocimum Sanctum. The vacuum drying method seem to produce a product which a higher quality of antioxidant property than freeze drying. Khan et al [18] observed anti fungal activities of aqueous extracts and oils of five (5) Indian medicinal plants against two Candida species causing Candiasis, C. Albicans and C. Tropicalis. Tulsi essential oil was found to be most effective. Sanguri et al [19] has investigated and compared antibacterial and anti fungal activity of leaves extracts taken from plants viz Q. indica, C. procera, A. aspera, O. sanctum against ten microorganism comprising five bacteria and five fungi. Ocimum sanctum extract was found to be more effective on bacterial species. Singh et al [20] has evaluated the qualitative estimation of phytochemicals and antimicrobial activity of aqueous and methanol extracts of root and leaves of Ocimum sanctum against pathogenic bacteria E. coli, P. mirabilis, S. aureus. Study has shown the presence of steroid, alkaloids and tannins. Significant antimicrobial activity of plant extract has been observed. Chemical composition, antifungal and anti aflatoxigenic activities of oils of Ocimum species are investigated by some workers [21, 22]. Osciumum sanctum essential oil and its major component, eugenol against the fungi causing bio deterioration of food stuff during storage. Essential oil of Ociumum gratissimum used as preservative, antimicrobial, antioxidant.

Review on therapeutic potential of O. sanctum in prevention and treatment of cancer is investigated by Singh et al [23]. Pingale et al [24] reported that extract of O. tenuiflorum is potent in radio protective, antimicrobial, antioxidant, anti-helmertic, antiviral, cardioprotective, anticancer, anti-distress, renal damage recovery and wound healing activity of Ocimum sanctum in albino rats observed by Asha et al [25]. Tropical O. santum found to promote better ranulation tissue, complete epithelisation and better tensil strength. Antibacterial, antifungal, antioxidant, anticancer, anti-ulcer pharmacological properties of Ocimum species viz: O. sanctum / tenuiflorum, O. gratissiumum, O. basilicum, O. americanum, O. kilimandcharicum discussed by Verma and Kothiyal [26]. A review on use of Ocimum kilimand for the treatment of disease like cold, cough, abdominal pain, anti-cancer, anorexia, memory disorder, anti-ulcer, memory disorder, diarrhea explained by Narwal et al [27]. Joseph and Nair [28] presented comprehensive study on anti-cancerous effect of O. sanctum in numerous cancers such as lung, skin, oral, cervical, gastric, breast and prostate. Joshi et al [29] presented review of the plant Tulsi from Ayurvedic texts and

macroscopic and microscopic sections were taken to identify the species. Mondal et al [30] presented review on scientific studies of Oscimum species for its antimicrobial, anti-diabetic anti inflammatory, mosquito repellant properties.

2. CARICA PAPAYA (PAPAYA)

Kingdom	:	Plantae
Order	:	Brassicales
Family	:	Caricaceae
Genus	:	Carica
Species	:	Carica Papaya

It is native to the tropics of the Americas. The papaya is a tree like plant of 5 to 10 M tall. Leaves are 50-70 cm in diameter with seven lobes. Fruit is 15-45 cm long and 10-30 cm in diameter. Papaya fruit contains high percentage of vitamins C, A, E, magnesium, potassium, calcium and carbohydrates. Vitamins B, C and E, carotenoid and phenolic compounds are the most abundant antioxidants present in the plant foods. Papaya leaves are used to cook in some tropical countries which contain high calories than papaya fruit. The leaves also have high levels of protein (7.0 g), phosphorus (142 mg), vitamin B and E (136 mg), calcium (334 mg) and sodium (16 mg).

Papain and specific enzymes found in both papaya fruits and latex, which has been utilized for meat tenderization. Papaya lipase which is a component of papaya latex used as biocatalyst for fat and oils modification, esterification and inter – esterification reactions in organic media. Papaya use for prevent oxidization of cholesterol, treating of gastrointestinal tract disease, nausea and morning sickness, weight loss, looting of body immunity, recovery of kidney, effect liver cancer cells, dengue fever treatment and menstrual irregularities in women. Papaya root, seed and leaf extracts used for pest control [31]. Sherwani et al [32] investigated the presence of phytochemical constituents including carbohydrates, proteins, anthraquinones, flavonoids, saponins, cardiac glycosides and alkaloids in the leave extract of C. Papaya. Crushed and boiled leaves extracts of C. Papaya tested for their antifungal activity against 6 yeasts. The crushed leaves extract was found to be more effective. The nutritional and medicinal applications of C. Papaya reported by Milind and Gurditta [33]. The whole papaya plant including its leaves, seeds, fruits and their juice is used as a traditional medicine. The prominent medicinal properties of papaya include anti-fungal, antibacterial, antitumor, wound – healing, etc. Baskaran et al [34] has described antimicrobial activity and phytochemical screening of ethyl acetate, acetone, chloroform, petroleum ether, hexane, hot water, ethanol and methanol extract of C. Papaya. The antimicrobial activities of different solvent extracts of C. Papaya were tested against the Gram – positive and Gram – negative bacterial strains and fungus.

Ifesan et al [35] has prepared ethanol, hexane and water extracts from leaves of Anacardium occidentale (cashew), Cocosnucifera (coconut), Citrus sinesis (sweet orange) Citrus limon (lemon) and Carica papaya (pawpaw) and screened for their anti oxidant and antimicrobial properties. Ocloo et al [36] observed the presence of alkaloids, flavonoids, reducing sugars, phenols, saponins, tannins, and terpenoids in organic and aqueous extract of dried seed of papaya and also tested for antibacterial activity against S. Aureus (gram positive), E. Coli (gram positive) and Shigella flexneri (gram negative) using the disc diffusion method. Okoye (37) has tested antibacterial and antifungal activity of crude ethanolic and aqueous extracts of seeds of carica papaya against four different test bacteria and fungi. The four test bacteria are S. aureus, P. aeruginosa, S. typhi and E. coli. The four test fungi are Aspergillus Niger, Penicillium notatum, fusarium solani and candida albicans.

Alibi et al [38] has done comparative studies an antimicrobial and anti fungal properties of extracts of fresh and dried leaves of Carica papaya. Study repeated by various concentration of extract using the disc diffusion method. C. papaya leaves showed better antibacterial activity than antifungal activity. Antifungal and antibacterial activities of aqueous and methanolic root extracts of Carica papaya linn. Tested against eleven microorganism species seven bacteria and four fungi by Adeiuwon et al [39]. Ambicillin and tetracycline were used as standard drugs for investigating the bacterial species, while griseofulvin was selected for fungi. TLC confirmed the presence of anthraquinones, cardiac glycosides and alkaloids.

Maisarah et al [40] conducted study to compare the total antioxidant activity, total phenolic content, and total flavanoid content from the different part of papaya tree including their seed, fruit and leaves. The two methods namely DPPH radical scavenging activity and carotene bleaching assay were used to determine total antioxidant capacity. Anti oxidant potential follow the sequence, young leaves > unripe fruit > ripe fruit > seed.

Anti-oxidant activities of the ethanol, petroleum ether, ethyl acetate, n-butanol and aqueous extract of seed of papaya tested by Zhou et al [41]. It is observed that high amount of total phenolics and total flavanoids in the ethylacetate and n-butanol fractions contribute their antioxidant potential.

Irondi et al [42] determined comparative potential for antioxidant properties of Carica papaya and Azadarichta leaves, which are popularly used as medicinal plants. The antioxidant potential measure were the levels of total phenol, tannin, total flavonoids, total caroteniod, vitamin C, 1, 1 – diphenyl – 2 – picrylhydrayl free – radical scavenging ability, trolox equivalent antioxidant capacity and ferric reducing antioxidant power. This study conclude that mixture of papaya and neem leaf extract has more antioxidant property in comparison to single neem leaf extract has more antioxidant property in comparison to single neem or papaya leaf extract. Tiwari et al [43] tested antimicrobial activity of carica papaya root extract against P. vesicularirs, S. faecalis, A. hydrophilia, S. typhae, S. Cohni, S. Ficarioa, and E. coli by well diffusion method. Ethanol extract of powdered leaves of carica papaya partitioned in chloroform and water and used for testing of antibacterial activity against clinical isolates of E. coli, K. pheumoniae, P. Mirabilis by Yusha'u et al [44]. Phytochemical screening indicated the presence of alkaloids, flavonoids, steroids and tannins.

Imaga et al [45] has described phytochemical and antioxidant constituents of Carica papaya and Parquetina nigresceus leaves extracts. Phytochemical screeing indicate the presence of folic acid, vitamin B_{12}, alkaloids, sapoinins, glycosides, tannins and anthraquinons. Both plant leaves extract use as herbal remedy for the management of sickle cell anemia. Comparative study of the phytochemical composition of the leaves of five Nigerial plants investigated of Eleazu et al [46]. The percentage phytochemical composition of the leaves of pawpaw, bitter cola, tetrapleura, neem and gender was investigated using the methods of Harbone and the alkaline picrate methods. Presence of tennin indicated its use in treatment of burns and wounds. Antimicrobial activity of Carrica papaya leaf extract a Pseudomonas aeruginosa was reported by Anibijuwon and Udeze [47]. The extract demonstrates higher activities against all gram positive bacteria than the gram negative bacteria. Phytochemical analysis indicated presence of alkaloids, tannins, saponoins, glycosides and phenols in the leaf extract. C. Papaya extract may be used for the treatment of gastro enteritis, uretritits, would infection and otitis media. Zuhair et al [48] explained antioxidant capacities of extract of papaya fruit at their ripening stages. The antioxidant capacity of C. Papaya as determined by total phenol content (TPC), ferric reducing anti oxidant powder (FRAP), 2, 2- diphenyl – 1 – picryl hydrazyl (DPPH) and scavenging systemand (ABTS). The results showed the important role of the ripening stage in increasing the antioxidant content of papaya fruit. Antibacterial activity of root extract of Carica papaya tested against some pathogenic bacteria using the cup plate agar diffusion method. Phytochemical analysis showed the presence of alkaloids, tannins, saponins, glycosides and phenols C. papaya may be used for the treatment of gastroenteritis, typhoid fever, and wound infection.

Oloyede et al [50] has described antioxidatiive properties of ethylacetate fraction of unripe pulp of C. papaya in mice. It is concluded that quercetin and β -sitasterol may be responsible for the antioxidant potential of ethyl acetate extract of unripe fruit. Anti HIV – I effect of Carica papaya extract reported by Rashed et al [51]. Present study focus on evaluation of anti HIV – I effect of C. papaya aerial part polar extracts also the investigation of the chemical contents from polar extract of the plant. Result have shown that C. papaya methanol and aqueous extracts have drug ability as anti – HIV – I agents. Romasi et al [52] has investigated anti-bacterials potential of leaf extract of C. Papaya against bacteria Rhizopus stolonifere. The extract inhibited β. Stearothermophilous spore as well. Papaya leaves are potential antibacterial which might be used in certain kind of foods. Boshra and Tajul [53] has discussed nutritional and pharmaceutical value. Papaya has been much studied in pharmaceutical and has wide applications in food industry. National value of fruits and medicinal properties of various part of papaya are discussed in this review. Invitro antimicrobial activity, antihelmentic activity and phytochemical screening for the hydroalcoholic extract of Coriandrum sativum, Cassia occidantalis, Carica papaya and Moringa foetida described by Pavan Kumar et al [54]. The influence of concentration on hydroxyl radical scavenging and antioxidant activities of polyphenol extracts and pawpaw leaves were assessed in vitro by Olabinri et al [55]. A non-significant moderate positive correlation was observed between total phenolic concentration and antioxidant activity of aqueous extract of mango and papaya leaves. Sheri-Ann Tan et al [56] has investigated protective effects of papaya extracts on test – butyl hydroperoxide mediated oxidative injury to human liver cells. This study concluded papaya extract as next therapeutic remedy for liver disease. Amsaveni and Sudha [57] have studied antimicrobial potential of different ethanolic plant extracts against pseudomonas Aeruginosa bacterial species.

Bamisaye et al [58] has described ethnobotanical uses of Carica papaya. The quantitative phytochemical screening of leaves aqueous extract revealed the presence of tannins (0.001 %), flavonoids (0.013 %), saponins (0.022 %), phenolics (0.011 %), steroids (0.004 %) and alkaloids (0.019 %) while that of root gave tannins (0.12 %), flavonoids (0.014 %), saponins (0.026 %), phenolics (0.011 %), steroids (0.006 %), alkaloids (0.021 %) . Melariri et al [59] has investigated antiplasmodial properties and bioassay – guided fractionation of ethyl acetate extracts from Carica papaya leaves. The study demonstrated greater antiplasmodial activity of the crude ethylacetate extracts of Carica papaya leaves. Sharma et al [60] has determined minerals by using Inductively Coupled Plasma Optical Emission Spectrometry (ICE-OES) method in Carica Papaya L. leaf found in northern India. The Mg, Fe, Zn, Mn, Cu, K, Na, Cr, Ca, etc. elements are detected in various samples of C. papaya leaves. Majica – Henshaw et al [61] has demonstrated immunomodulatory and anti-inflammatory actions of carica papaya seed extract. The immunomodulatory activities of crude Carica seed extracts and its bioactive fractions were examined in vitro using lymphocyte proliferation assays and complimentmediated hemolytic assay. Orhue and Momoh [62] has investigated antibacterial activities of different solvent extracts of carica papaya fruit parts on E. Coli and S. aureus. The solvents used were petroleum ether, water, acetone, ethanol, etc. It is suggested that C. papaya may be used as an antibiotic and extracts in petroleum ether seems more potent. A search of literature indicated few or no report on antifungal, antimicrobial, antioxidant properties and phytochemical investigations of Ocimum tenuiflorum (Tulsi) and Carica papaya (Papaya) leaves extracts. In view of t his attempt has been made to investigate above mentioned properties. In addition present work described phytochemicals, antimicrobial, and antifungal and antioxidant properties of Ocimum tenuiflorum and Carica papaya.

3. SYZYGIUM CUMUNI (JAMUN)

Kingdom: *Plantae*

Angiosperms

Eudicots

Rosids

Order: *Myrtales*

Family: *Myrtaceae*

Genus: *Syzygium*

Species: *Syzygium cumuni*

Syzigium cumini or Jamun is an evergreen tropical tree in the flowering plant family Myrtaceae. Syzigium cumini is native to India, Nepal, Pakistan, Bangladesh, Sri Lanka, Philippines and Indonesia.It is also introduced to Florida, USA, Suriname, Brazil, Trinidad &Tobago and Guyana. Syzigium cumini is also known as black plum, Java plum, Duhat plum and Malabar plum etc. It is a slow growing species, it can reach heights up to 30 meters and live more than 100 years. The wood is water resistant because of this it is used in railway sleepers and to install motors in wells. The leaves are used as food for livestocks. The leaves and bark are used for controlling blood pressure. Vinegar and wine are also made from the fruit. It has a high source of Vitamin A and Vitamin C. seeds are used in various alternative healing systems like Unani, Chinese and Ayurveda medicine for digestive ailments and for controlling diabetes. The nutritional value for Syzygium cumini per 100 g (3.5 Oz) is as follows:

Energy	251 kJ (600 kcal)
Carbohydrates	14 g
Dietary fiber	0.6 g
Fat	0.23 g
Protein	0.995 g
Water	84.75 g
Thiamine (vitamin B_1)	0.019 mg (2%)
Riboflavin (vitamin B_2)	0.009 mg (1%)
Niacin (vitamin B_3)	0.245 mg (2%)
Vitamin B_6	0.038 mg (3%)
Vitamin C	11.85 mg (14%)
Calcium	11.65 mg (1%)
Iron	1.41 mg (11%)
Magnesium	35 mg (10%)
Phosphorus	15.6 mg (2%)
Potassium	55 mg (1%)
Sodium	26.2 mg (2%)

Ayyanar and Subash – Babu [63] has described the existing data on botany, phytochemical constituents, traditional uses and pharmacological actions of Syzigium cumini (L.) Skeels (Jambolan). Syzigium cumini plant is rich in compounds viz: anthrocycinins, glucoside, isoquercetin, kaemferol, ellagic acid and myrecetin. The seeds are reported to contain antimellin, alkaloid, glycoside jambolin and jambosine, which halts the diastatic conversion of starch into sugar. Present research work is focused on identification of active compounds inSyzigium cumini, which are useful for producing safer drugs in the treatment of various illness including diabetes. Phytochemical and antimicrobial properties of Syzygium cumini as ethanomedicinal plant of Javadhu hills, India reported by Prabhakaran et al [64]. The study revealed that Syzygium cumini extracts contains high percentage of flavonoids, tannis, carbohydrates and phenols. It is also clear from present study that ethanolic extracts of leaves and aqueous extracts of seeds were found to have very high antimicrobial property for wide range gram positive and gram negative bacterial stains. Modi et al [65] investigated macroscopic, microscopic preliminary phytochemical screening andphysiochemical evaluation of Eugenia Jambolana leaf.

Antibacterial activity, phytochemical analysis of water extract of Syzygium cumini and analytical study by HPLC is explained by Borhade [66]. The water extract of Syzygium cumini shows antibacterial activity at various levels in Escherichia coli, Bacillus cereus and Staphylococcus aureus. Photochemical analysis of Syzygium cumini showed presence of phenol, tannin, flavonoids and saponins. Results justify the use of Syzygium cumini plant in folk medicines.

Sah and Verma [67] presented overview of pharmacological activity of various parts of Syzygium cumini plant including seeds, bark, leaves, and fruits. The phytochemicals like oxalic acid, gallic acid, malieic acid, tannins, oleanolic acid, cyanidin, flavonoids, betunilic acid, essential oils have been reported for significant antinaemic, gingivitis, antipyretic, antidiarrhieal, anti-bacterial, anti-inflammatory, hypoglycemic, gastro protective and hypolipidemic properties. Present investigation for secondary metabolites was carried out in Syzygium cumini stem, bark, collected from Siddarabetta, Tumkur district, Karnataka, India by Gopinath et al [68]. The phytochemicals like alkaloids, tannins, saponins,terpenoids and quinines are confirmed by qualitative analysis. The bioactive compounds from different solvent extracts suspected of anti-diabetic properties. Murti et al [69] studied possible preliminary phytochemical activity of seeds of Syzigium cumini the study include macroscopic, microscopy, phytochemical analysis and physiochemicalevaluation of seeds of Syzigium cumini. This study also provides a scientific rational for the traditional use of seeds of Syzigium cumini in the management of wound. The macroscopic, microscopic, preliminary phytochemical screening and physicochemical evaluation of Syzygium cumini leaves extract is determined by Soni et al [70]. The leaves of Syzygium cumini is considered as an antibacterial and also used to strengthen the teeth and gums in folklore medicine.

Chaudhary and Mukhopadhyay [71] presented review article on Syzygium cumini as a potential source of neutral pharmaceuticals. They have reported a number of research on the medicinal properties of Syzigium cumini extracts in animal model and in vitro animal cell lines but no report on clinical trial experiments to study the in vivo effect of

the phytochemicals on human beings. It is used to control the blood sugar level in the patients suffering from diabetes.

Antimicrobial, antioxidant, and anti-inflammatory properties of Syzygium cumini (Jamun) is described by Mathur et al [72]. The methanol extracts of plant parts were found to be most potent antimicrobial, antioxidant and anti-inflammatory agent in comparison to other solvent extracts. The methanol extracts of the plants were also screened for their hemolytic activity against erythrocytes but the extracts showed negative hemolysis. Siti – Azima etal [73] has determined antioxidant activities in Syzygium cumini and Ardisia elliptica based on ferric reducing antioxidant power, oxygen radical antioxidant capacity 2, 2-diphenyl – 1 – picrylhydrazyl (DPPH) and 2, 2 – azino – bis (3 – ethylbenzo thiazolini – 6 – sulphonic acid (ABTS) radical scavenging assaysin relation to their total phenolic content, total flavonoids content and anthocyanin content. The chromatic properties based on color density, lightness, hue angle and chroma value of the selected plants were determined to evaluate the potential of Syzigium cumini as colorants in food. Antibacterial activity against Escherichia coli,Bacillus subtilis, Pseudomonos aeroginosa and Staphylococcus aureus and inhibitory effect on glucomylase of ethanolic extracts isolated at different temperature from seeds of Syzygium cumini was investigated in vitro by Meshram etal [74]. The ethanolic extract isolated at 20 ºC showed maximum inhibition (50%) of glucoamylase activity. Hence may be hypoglycemic function in diabetes type – II.

Swami et al [75] presented a review on Jamun (Syzigium cumini) as food and its medicinal uses. The present review is focused on existing data on the information on traditional and medicinal use of Syzigium cumini plant is rich in compound containing anthocyanins, glucoside, ellagic acid, kaemferol and myrecetin. The seeds are claimed to contain alkaloid, jamosine, glucoside, jambolin or antimellin which halts the diastatis conversion of starch into sugar. Patel and Rao [76] investigated that fruits of Syzigium cumini possess high medicinal value has been evaluated for its antibacterial activity against some gram positive and gram negative strains. High zone of inhibition was obtained against Bacillus cereus using diethyl ether extract. The minimum inhibitory concentration value of 0.25 mg/mL diethyl ether extract of pre-ripened fruits was effective against Bacillus cereus. The activity of the extracts varied along with the fruit maturity.

Ethanolic leaf extracts of five medicinal plants were studied by Jahan et al [77] for their antimicrobial activity against resistance Staphylococcus aureus stains isolated from different clinical samples. The antimicrobial activity of plant extracts was determined by using agar well diffusion method. The present study suggests the used of these medicinal plants in the treatment of various disease caused by Staphylococcus aureus. Bhargava et al [78] has examined the ulcer – protective and antimicrobial activity of aqueous extract of Syzigium cumini. Gastric ulcer in experimental rat by administration of hard liquor (48% ethanol) and aspirin. Aqueous extract of Syzigium cumini (200 and 400 m /Kg P. O.) leaves showed significant ulcer protective activity ($P < 0.001$). The anti-tumor promotion activity of Syzygium cumini extract in a stomach carcinogenesis model in mice investigated by Goyal et al [79].The Swiss albino mice were used for this experimental trial. Result suggests that the Syzygium cumini extract has anti-tumor and anti-oxidative potential against chemical induced stomach carcinogenesis.

Patel et al [80] evaluated antioxidant and cardioprotective property against doxorubicin induced cardiotoxicity in rats. Daily oral administration of aqueous suspension of Syzygium cumini seeds extract produced normalization in the serum levels of heart marker enzymes. Syzigium cumini seeds were found to be more effective in restoring lipid profile changes in rats and antioxidant enzyme activities in heart tissue. Present study show that Syzigium cumini seeds process both antioxidant and cardio protective effects. The antioxidant activity of Syzygium cumini leaf extracts using 2, 2 – diphenyl – 1 picrylhydrazyl (DPPH) free radical – scavenging and ferric – reducing antioxidant power (FRAP) assays determined by Ruan et al [81]. A significant linear relationship between antioxidant potency free radical – scavenging ability and the content of phenolic compounds of leaf extracts supported this observation. Shyamala Gowri and Vasantha [82] demonstrated presence of phytochemical viz: flavonoids, alkaloids, steroids, phenols, saponins, terpenoids, tannins cardiac glycosides in leaves extractof Syzigium cumini. The extract showed inhibitory activity against clinical isolates of the gram negative bacteria such as salmonella enteritidis, salmonella typhi A, Salmonella paratyphi A, Salmonella paratyphi B, Pseudomonas aeruginosa and Escherichia coli, gram positive bacteria are Bacillus subtilis and Staphylococcus aureus. The result also showed that methanol extracts are more potent than the aqueous extract.

The anti – inflammatory activity of the seed of Syzigium cumini established by Kumar et al [83]. This study was intended to evaluate the anti-flammatory activity of ethyl acetate and methanol extracts of Syzigium cumini seed in carrageenan induced paw edema in wistar rats at the dose level of 200 and 400 mg/Kg administrated orally. Both extract exhibited significant anti-inflammatory activity. Parmar et al [84] described protective efficacy of Syzigium cumini seed extract against perio-oxidative damage contributing to skin carcinogenesis in Swiss albino mice. Results from the present study indicate that the anti-carcinogenic activity of Syzigium cumini seed extract during DMBA –

induced skin papillomagenesis is mediated through alteration of antioxidant status. Syzigium cumini extract can be considered as a readily accessible, promising novel cancer Chemo-preventive agent.

The antibacterial activity of methanolic crude extract and its subsequent fractionation into ethylacetate chloroform, n-butanol and aqueous fraction from wood, bark and leaves of Syzygium cumini and some other plants grown in Egypt was investigated against some pathogenic bacteria discussed by Ally et al [85]. The finding demonstrated that the species. Had great potential to be used as a bio – resource for natural health products and food preservation. Borde et al [86] evaluated antimicrobial activity of methanolic extract of Ocimum americanum, Syzygium cumini, Murraya koenigii, Eucalyptus maculate, Lawsonia intermis, Adhatoda vasica, Tridax procumbens, Prunus amygdalus, Aazardirecta indica, Syzygium aromaticum on Escherichia coli, Staphylococcus aureus by well diffusion method. The information obtained by this study may be used to control the infection associated with Escherichia coli and Staphylococcus aureus.

Phytochemical screening of pollens of Syzygium cumini, Catheranthus rosus, Momordica Gherantia and Butea monospera was reported by Ghoshal and Saoji [87]. The result showed the presence of alkaloids, steroids, flavinoids, tannis, saponins, carbohydrates and anti-diabetic constituents in the pollens of above selected medicinal plants. Present finding also suggest that different important constituents present in the plant parts also present in the pollen. Kothari et al [88] observed antibacterial activity of Syzygium cumini seed extracts prepared in methanol and ethanol by disc diffusion and broth dilution assays. Both extracts exerted a broad spectrum of bacteriostatis action against different gram positive and gram negative bacteria. HPLC analysis indicated presence of galic acid and quercetin in the methanolic extract.

The possible anti – asthma activity of macerated and soxhlet extracts of leaves of Syzigium cumini on tracheal chains of guinea pigs were evaluated by Mahapatra and Pradhan [89]. The isolated guinea – pig trachea pre-contracted with KCl, methacholine and tissue incubated with propranold were used to study the relaxation of macerated and soxhlet extracts of Syzigium cumini leaves. The possible mechanism of anti-asthma activity of Syzigium cumini leaves extract is also presented. Prabhahar et al [90] evaluated antibacterial potential of ethanol and ethyl acetate solvent extracts of mature leaves of Syzygium cumini against nine pathogenic bacteria isolates viz. Staphylococcus aureus, Bacius subtilis, Bacillus cereus, Escherchia coli, Salmonella typhi, Shigella flexneri, Klebsiella pneumniae, Vibrio cholera and Pseudomonas aeruginosa. The ethanol extract of Syzigium cumini (100 mg / mL) showed maximum zone of inhibition (30 mm) against Pseudomonas aeruginosa. Antiepileptic activity of methanolic extract of Syzygium cumini seeds in Albino mice investigated by Pushpa et al [91]. Methanolic extract of Syzigium cumini seeds produced significant anti-epileptic effect shown by reduction in the duration of hind limb exterior phase in electroshock induced seizures model and ability to delay the onset of myoclonic spams and clonic convulsion in Pentylenetetrazole test when compared to control.

Chowdhury et al [92] reported therapeutic potentials of twenty six plant extracts traditionally used in Bangladesh against human pathogenic bacteria Escherichia coli, Klebsiella pheumoniae, Psudomonas aeuroginosa and Proteus mirabilis by disc diffusion method the maximum antimicrobial activity was found up to 80% in Tamarindus indica. Sensitivity of the bacterial isolates was also evaluated for eight commercial antibiotic discs where most of the isolates found to develop resistance against multiple commercial antibiotics. The screening for total phenolic contents, antioxidant and antibacterial activity of aqueous and ethanol crude extracts from thirteen(13) Thia traditional plants were reported by Chanudom etal [93]. The highest total phenolic contents and antioxidant activity obtained from aqueous crude extracts of Syzygium cumini (L.) Skells wereat 358.250 ± 0.014 mg GAE/ gdw and 358.25 ± 0.21 m MTEAC / g dw, respectively. Thia traditional plant Syzigium cumini and piper betle were demonstrated to be potential sources of natural products for side dishes, dietary supplement product and medicinal uses. Alam et al [94] identified the putative anti-diabetic constituents from the Syzigium cumini leaves from NMR data lupeol, 1, 2 – oleanen – 3 – ol – 3 B – acetate, stigmasterol, B-sitosterol were identified from n-hexane fraction of plant extract. These compounds have potential anti-diabetic activities which support the traditional use of the leaves as being remedy for treating diabetes.

The four compounds were isolated from the Petrolium – ether and carbon tetrachloride soluble fractions of a methanol extract of seeds of Syzygium cumini by Sikder et al [95]. The structure of isolated compounds were elucidated as 7-hydroxycalamenene, methyl – B – orosellinate, B-sitosterol, and oleanolic acid through extensive spectroscopic studies, including high – field NMR analysis. Sonawane and Arya [96] studied Jambhul, wood apple, and vegetables viz. ambadi, ambat chukka for their total phenolic content, total phenolic content, total flavonoid content, ascorbic acid, anthocynin and antioxidant capacity such as ABTS, DPPH and FRAP assay.

Preliminary phytochemical investigation of methanolic extract of Syzygium cumini bark is explained by Jayachandra and Devi [97]. Study indicates the presence of carbohydrates, amino acids, tannins, saponins, phytosterols, terpenoids, phenols, and flavones. The antioxidant activity was determined by DPPH, HP and FRAP

assay. Results of this research work are promising and indicating the utilization of the bark ofSyzigium cumini as a significant source of natural antioxidants. Joseph et al [98] investigated phytochemical analysis of leaves of Syzigium cumini, Cassia occidentalis, Phyllanthus amarus, Clerodendrum vescosum, and Ailanthus excels by using methanol, hexane and aqueous extract. The phytochemicals viz: steroids, saponins, alkaloids, flavonoids, glycosides, tannins, phenolic compounds, terpenoids and lignin are revealed in the extract. These phytochemicals have potent antimicrobial efficiency against selected infectious micro-organisms.

The green synthesis of gold nano particle using various plants extracts (including Syzygium cumini) and spices extracts was reported by Lal and Nayak [99]. The plant extract reduces aqueous $HAuCl_4 \bullet 3H_2O$ to Au° and stabilized by itself at certain crystalline phase. Synthesis of nanoparticle is confirmed by change of color of auric chloride, which is yellow in color. The growth of nanoparticle was monitored by surface Plasmon behavior using UV – VIS spectroscopy. The method is effective for the large scale synthesis of gold nanoparticles.

Kavishankar etal [100 A, B] has described 136 plants around the world with anti-diabetic and hypo-glycemic properties. Jamun is widely used in Indian folk medicine for the treatment of diabetes mellitus. Oral administration of 2.5 and 5.0 g/Kg body weight of the aqueous extract for the seed of 6 weeks resulted in significant reduction in blood glucose and an increase in total hemoglobin. The aqueous extract also decreases free radical formation which clearly shows the antioxidant property. Present study shows that jamun seed extract has hypoglycemic action. An overview of herbal remedies for diabetes described by Shukla et al [101]. The treatment of diabetes mellitus (DM), which includes the use of insulin and oral hypoglycemic agents sulphonylurea, biguanides. The DM one of the major disorder which is growing at faster rate second after cancer. Present review focus to use Ayurvedic formulations for better management of DM instead of using allopathic formulations. Reginold Jebetta et al [102] investigation crude methanol and ethanol extracts of Syzigium cumini pulp powder dried at various temperatures 60ºC, 70ºC, 80ºC and control as raw pulp. Phytochemical studies revealed the presence of amino acids, tannins, flavonoids, alkaloid, steroids and glycosides, tri-terpenoids and the absence of saponin, anthroquinones as the chemical class present in the extract. Most of the biologically active phytochemicals were present during in all the three drying temperatures. This study helpful for production of jamun pulp products and quantifying the active component in the products.

Preliminary pharmacognostical and phytochemical activity of seeds of Syzygium cumini were performed to lay down the standard for future study by Murti etal [103]. The results were discussed in terms of microscopy, macroscopic, phytochemical analysis. The present study provides a scientific rationale for the traditional use of seeds of Syzygium cumini in the management of wounds. Singh and Saxena [104] studied leaves extract of several medicinal plants viz; E. hirta, M. alba, A. indica, S. Cumini, P. emblica, T. Peruvian, and C. Fistula for the presence of secondary metabolites. Presence of phytochemicals like terpenoid, saponin, tannis, steroid, alkaloids, flavonoids and cardiac glycosides confirmed in the leaf extract methanolic leaf extract showed significant antibacterial activity against K. pneumonia, M. luteus, S. aureus, P. flurensis, B. megateriam, P. aeruginosa. Leaf extract was found to be effective against both gram – positive and gram – negative bacteria. Results indicate that S. cumini, P. emblica, and C. fistula plants showed maximum anti-microbial activity. The phytochemical and antimicrobial activity of the leaf and stem bark extracts of Syzigium cumini grown in Abuja, Nigeria reported by Ugbade et al [105]. The phytochemical screening revealed the presence of carbohydrates, saponins, tannins, terpenes, volatile oil, sterols, resins balsam and flavonoids in the leaf and bark extracts. Alkaloids and anthraquinones were absent in all the plant parts studied. P. auriginosa, E. coli, S. aureus, C. albicans, B. subtilis and S. typhii were used for antimicrobial studies. Leaf extract showed activity on all test organisms except P. auriginosa while the stem bark extract showed no activity on any of the test organisms used.

Hajoori and butani [106] discussed antimicrobial activity of Eugenia Jambolana seeds. The aqueous, ethanolic, methanolic, acetic acid, and petroleum ether extracts of the Eugenia jambalana seeds were evaluated for its antibacterial activity against four gram positive (staphylococcus aureus, Bacillus subtilis, Bacillus cereus and Bacillus megaterium) and six gram negative (Escherichia coli, Salmonella typhi, Salmonella paratyphi A, Salmonella paratyphi B, Pseudomonas aeruginosa and Proteus vulgaris) pathogenic strains. Aqueous and ethanolic extract are found to have significant antimicrobial activity as compared to acetic acid and petroleum ether extract. Present study indicates that the seeds of Eugenia jambolana can be used as potential sources of antimicrobial agents. The ethno medicinal uses and anti-diarrheal properties of medicinal plants used by the tribal people, of District Mayurbhanj, Odisha, India explained by Panda etal [107 A,B]. Aqueous and methanol extracts of 72 plants were tested for antibacterial activity using agar well diffusion against eight pathogenic bacteria responsible for diarrheal disease. Nineteen plants are newly reported to have ethno medicinal use to treat diarrheal disease. Among these Bombax ceiba, Butea superb, Ficus racemosa, Flemingia nana, Mesua ferrea, Similax zeylanica etc. experimentally proved toinhibit the diarrhea causing bacteria S. typhi , E. coliand V. cholera, were the most sensitive strain.

Jarald et al [108] presented a review article to discuss correlation between diabetes and herbal medicines. Diabetes Mellitus (DM) is a metabolic disorder in the endocrine system. Several medicinal plants have been investigated for their beneficial use in different types of diabetes. During the past few years many phyto - constituents responsible for anti-diabetic effects have been isolated from hypoglycemic plants. This paper focuses mainly on diabetes, plants used as anti-diabetics in various traditional medicines, constituents isolated from these plants, various mechanisms through which herbs act against diabetes and few examples of anti-diabetic formulations available in the market. Mohanty et al [109] investigated less known uses of 54 plant species in the treatment of various dental and oral diseases like dental carries, gingivitis, and pyrrohea. Maximum number of plants species used as medicine relevance to this phytotheraphy was reported from family Mimosaeae, Euphorbiaceae, Moraceae and Sapotaceae. Besides bark, leaf and rhizome as such or being processed are used as tooth powder. Out of 54 plant species, 28 are exclusively used for tooth stick, 12 for toothache, 9 for gum disease and 24 species for pyorrhea. In few cases the latex, juice or oil extracted from seeds are either directly applied on the affected tooth and gums or gurgled for relief.

The use of dyes for making specific color or color combinations are found to play an important role in the social and religious life of the tribals of Dhar District, Madhya Pradesh, India. The 18 dye yielding plants have been observed in the study area by Alawa et al [110] which are used by tribal. Syzigium cumini seeds also reported to be used for Indigo color production. Oryema etal [111] document (1) the edible wild fruit tree species in Gulu District, Uganda (2) generate a list of preferred fruit trees and (3) establish in indigenous knowledge on seasons of availability, modes of fruit harvest, local preservation methods and other edible products of the fruit trees. Sixty wild indigenous edible fruit (including Syzygium cumini) were identified and they belong to 29 families. Viellaria paradox gartn (37 %), Vitex doniana sweet (34 %), Borassus aethopum mart (17%) Tomarindus indica (4 %) and Annona senegalenis oliv (3%) were the five most preferred fruit tree species. Several edible wild fruit plants and indigenous knowledge existed that could be integrated for conservation of these edible fruit species.

An attempt to rehabilitate sodic waste lands through the establishment to plant cover with diverse plant communities within Banthra Research Station of the National Botanical Research Institute, Lucknow, India reported by Singh and Garg [50]. A rehabilitated forest ecosystem developed in this way consists in a number of herbs, shrubs and trees. Derris indica, Dalbergia sissoo, Azadirchta indica, Cassia siamea, Terminalia arjuna, Syzygium cumini were the dominant species in this rehabilitated forest, whereas Sporobolus, Desmostachya and Dactyloctenium were a common genera of grasses on a barren land. Present studies indicate that Syzygium cumini plant can also be used for bio-reclamation of sodic lands. This experience can be tried out on similar sites of arid and semi-arid regions of the world for the bio-reclamation of sodic lands.

CONCLUDING REMARKS

The following conclusions can be drawn from review on ocimum sanctum, Carica papaya and Syzygium cumini medicinally important flora of Guyana.

1. All parts (leave, root, bark, stem, seed, fruit, etc.) of plant material showed antioxidant, antimicrobial and antifungal activity.
2. Photoconstituents viz carbohydrates, anthraquinones, flavonoids, saponins, glycosides, alkaloids, proteins, amino acids, etc are found in most of the medicinal flora of Guyana.
3. Antioxidant power of plant extracts depend on the nature of solvents used.
4. Oscimum sanctum, carica papaya and Syzygium cumini plant species are found in most geographical regions of the world.
5. Tulsi leaves are very useful for lung, intestinal and cardiovascular disease. It is also effective to reduce stress, blood sugar and blood cholesterol. Tulsi extract is also used to reduce skin disorder, pain, swelling, headache and disease of head and neck.
6. Tulsi leaves extract equally effective against pathogenic gram positive and gram negative bacteria.
7. The whole papaya plant including the leaves, seeds, fruits bark, root are used as traditional medicine. The prominent medicinal properties of papaya include anti-fungal, anti-bacterial, anti-tumor, wound healing, etc.
8. The organic and aqueous extract of dried seed of papaya indicated the presence of alkaloid, flavonoids, reducing sugars, phenols, saponins, tannins, and terpenoids. Phytochemical screening of papaya leaves extract have indicated the presence of folic acid, vitamin B12, alkaloids, saponins, glycosides, tannins and anthraquinones.

9. Syzygium cumini leaves and bark extracts are used for controlling blood pressure. The vinegar and wine made from fruit. It is a high source of vitamins A and C. seeds are used in various alternative healing systems like Unani, Chinese and Ayurveda medicine for digestive ailments and for controlling diabetes.
10. The phytochemicals viz oxalic acid, maleic acid, gallic acid oleanolic acid, tannins, cyaniding, flavonoids, betunilic acid, essential oils, obtained from seed, bark, leave and fruits of Syzygium cumini are found to have significant anti-anemic, gingivitis, anti-pyretic, anti-diarrheal, anti-inflammatory, hypoglycemic, hypolipidemic and gastro protective properties.

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