A STUDY OF THERAPEUTIC APPLICATIONS OF THE
EXTRACTS OF SEEDS OF Syzygium cumini

A SYNOPSIS OF THESIS

Submitted by

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in partial fulfillment for the award of the degree
of

DOCTOR OF PHILOSOPHY

DEPARTMENT OF CHEMICAL ENGINEERING
Dr. M.G.R.
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Prof. & Head  
Dept. of Chemical Engineering  

Date: 20.10.2008  

BONAFIDE CERTIFICATE  

I certify that the thesis entitled "A STUDY OF THERAPEUTIC APPLICATIONS OF THE EXTRACTS OF SEEDS OF Syzygium cumini" submitted for the degree of Doctor of Philosophy by Mr. A. Kumar is the record of research work carried out in the Department of Chemical Engineering under my guidance and supervision during the period from February 2005 to October 2008 and that this work has not formed the basis for the award of any degree, diploma, associate ship, fellowship or other titles in this University or any other University or other Institution of higher learning.  

Signature of the Supervisor  
(Dr. N. Padmanabhan)
DECLARATION

I declare that the thesis entitled "A STUDY OF THERAPEUTIC APPLICATIONS OF THE EXTRACTS OF SEEDS OF Syzygium cumini" submitted by me for the degree of Doctor of Philosophy is the record of research work carried out by me in the Department of Chemical Engineering under the guidance and supervision of Prof. Dr. N. Padmanabhan during the period from February 2005 to October 2008 and that any part of the thesis has not formed the basis for the award of any degree, diploma, associateship, fellowship or other titles in this University or any other University or other Institution of higher learning.

Signature of the Candidate
A. Kumar
Research Scholar
Department of Chemical Engineering
1. INTRODUCTION

Therapeutic potentials of natural plants have left indelible mark on human welfare since the dawn of civilization. Herbal medicines have been used to maintain health and to treat the diseases. Herbal medicines referred to as herbalism or botanical medicine is the use of herbs for therapeutic or medicinal value. The antiquity of herbal medicine can be understood from the earliest recorded evidence of their use in Indian, Chinese, Roman and Syrian texts which dates back to about 5000 years. India has an ancient heritage of traditional medicine. Ayurveda, Siddha and Unani systems of medicines are widely used in India. Pharmacoepidemiological survey carried out in adults over 60 years of age revealed that about 47% of the elderly populations use herbal drugs (Karandikar et al., 1997). Indian material medica consists of about 2000 drugs of natural origin almost all of which are derived from different traditional systems and folklore practices (Narayana et al., 1998).

Plants have been the major source of drugs in Indian system of medicine and other systems in the world. Earliest description of curative properties of medicinal plants was found in Rigveda (2500 – 1800 DC). Charaka Samhita and Sushruta Samhita give extensive description on various medicinal herbs (Kirtikar and Basu, 1975). Information on medicinal plants in India has been systematically organized (Satyavati et al., 1976; Satyavati and Gupta, 1987).

Even in this modern world people realize the therapeutic value of plants as drug as serious side effects of modern medicine are increasingly felt by them. The World Health Organisation (WHO) estimates that about three quarters of the world’s population currently use herbs and other forms of traditional medicines to treat the diseases. Even as we commence the new century its exciting prospect of gene therapy, herbal medicine remains one of the common forms of therapy available. Drugs derived from natural plants have special significance of having been tested on long time scale.
1.1 DIABETES

Diabetes mellitus is a major endocrine disorder and growing health problem in most countries. Approximately 4% population worldwide and is expected to increase by 5.4% in 2025 (Kim et al., 2006). The number of adults suffering from diabetes in India is expected to increase threefold, from 19.4 million in 1995 and 57.2 million in 2025. Recent studies on geographical and ethical influences have shown that people of Indian origin are highly prone to diabetes. Diabetes is characterized by hyperglycemia due to an absolute or relative deficiency of insulin (WHO, 1994). Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. The ethnobotanical information reports about 800 plants that may possess anti-diabetic potential (Alarcon-Aguilara et al., 1998).

Chadwick et al., (2007) reported the anti-diabetic effects of Sutherlandia frutescens plant extract in wistar rats which was fed a diabetogenic diet showed promise as type 2 anti-diabetes medications because of its ability to normalize insulin levels and glucose uptake in peripheral tissues.

Santhosh et al., (2007) suggested the aqueous extract of Cynodon dactylon have high antidibetic potential along with significant hypoglycemic and hypolipidemic effects in streptozotocin diabetic rats.

1.2 INFLAMMATION

Inflammation or phlogosis in a pathological response of mammalian tissue to a variety of hostile agents including infections organisms, toxic chemical substances, physical injury or humor growth leading to local accumulation of plasmic fluid and blood cells (Sobata et al., 2000). Although inflammation is a defense mechanism, the complex events and mediators involved in the inflammatory reaction can induce maintain and aggravate many disorders. Hence, the employment of anti-inflammatory agents may be helpful in the therapeutic
treatment of those pathologies associated with inflammatory reactions (Sosa et al., 2002). The use of steroidal drugs as anti-inflammatory agents is also becoming highly controversial due to their multiple side effects (Vanderworm et al., 2001). Therefore a need rises for the development of newer anti-inflammatory agents from natural sources with more powerful activities and lesser side effects as substitutes for chemical therapeutics.

Edwige et al., (2007) assessed the anti-inflammatory and mechanism of action of *Allanblackia monticola* by the methylene chloride/methanol extract on carrageenan-induced oedema in rats and showed the anti-inflammatory activity with gastric ulcerative side effects.

Khalil et al., (2006) worked on the leaves of *Dodonaea viscole* of hydroalcoholic extract given by oral route at dose of 300 mg/kg, significantly inhibited the paw edema induced by carrageenin injection and the result supported the use in relieving inflammation.

### 1.3 ANALGESIC

An analgesic (colloquially known as a painkiller) is any member of the diverse group of drugs used to relieve pain (achieve analgesia). This derives from Greek *an-*-, "without", and -*algia*, "pain". Analgesic drugs act in various ways on the peripheral and central nervous system; they include paracetamol (acetaminophen), the nonsteroidal anti-inflammatory drugs (NSAIDs) such as the salicylates, narcotic drugs such as morphine, synthetic drugs with narcotic properties such as tramadol, and various others. Some other classes of drugs not normally considered analgesics are used to treat neuropathic pain syndromes; these include tricyclic antidepressants and anticonvulsants.

Pathak and Argal (2007) demonstrated by the oral administration of the alcoholic extract of flowers of *Calotropis gigantean* the analgesic activity commencing for minimum 30 min and lasting to 90 minutes maximum.
Anindya et al., (2007) identified the *Cleome rutidosperma* ethanolic extract (200 and 400 mg/kg, p.o.) showed significant analgesic activity in acetic acid-induced writhing and tail immersion test. This study also further reported anti-inflammatory effect against carrageenan-induced inflammation.

### 1.4 CENTRAL NERVOUS SYSTEM

The central nervous system (CNS) represents the largest part of the nervous system, including the brain and the spinal cord. Together with the peripheral nervous system, it has a fundamental role in the control of behavior. The CNS is contained within the dorsal cavity, with the brain within the cranial subcavity and the spinal cord in the cavity. Since the strong theoretical influence of cybernetics in the fifties, the CNS is conceived as a system devoted to information processing, where an appropriate motor output is computed as a response to a sensory input. Yet, many threads of research suggest that motor activity exists well before the maturation of the sensory systems and then, that the senses only influence behavior without dictating it. This has brought the conception of the CNS as an autonomous system.

Sanchez et al., (2007) identified the effect of the aqueous, butanol and chloroform fractions obtained from the methanol extract of *Hypericum reflexum* on the CNS in mice and indicated that the butanol and chloroform fractions possess antidepressant in mice.

Cristiana et al., (2006) reported the extract of essential oil from Ocimum gratissimum abd identified the CNS activity in the open-field and rota-rod tests and found the oil increased sleeping duration and protected the animals against tonic seizures by electroshock.

Hence, the present study is designed with an aim to explore and to evaluate the *Syzygium cumini* seed extracts for anti-diabetic, anti-inflammatory, analgesic activities and behavioral changes in the central nervous system of experimental animals.
2. LITERATURE REVIEW

2.1. SYZYGIUM CUMINI

_Syzygium cumini_ Skeels (_Syzynium jambolana_ or _Eugenia jambolana_ or _Eugenia jambola_ or Jamun) belonging to the family Myrtaceae is a large evergreen tree that grows up to 30 m height. It is widely distributed throughout India, Ceylon-Malaya and Australia and known as Jamun, Jam, jambul in India.

2.1.1 TRADITIONAL USES OF THE PLANT PARTS

Most of the _Syzygium cumini_ plant parts are used in traditional system of medicine in India. According to Ayurveda, its bark is good for sore throat, asthma, thirst, biliousness, dysentery, blood impurities and to cure ulcers (Kirtikar and Basu, 1975). The seeds are sweet, good for diabetes, diuretic and astringent (Kirtikar and Basu 1975; Priyavtra and Mehta 1969). In Unani medicine system, the ash of leaves is used to strengthening the teeth and the gums. Juices of leaves _Eugenia jambolana_ and mango are used to cure dysentery (Nadkarani, 1954; Kirtikar and Basu 1975).

2.1.2 PHARMACOLOGICAL USES

Ravi et al., (2005) have observed that _Eugenia jambolana_ seed kernel possesses hypolipidemic effect in rats which might be due to the presence of flavonoids, saponins, glycosides and triterpenoids in the extract.

Kochhar and Nagi (2005) reported that the powdered mixture of traditional medicinal plants (_Jammun, Bittergourd and Fenugreek_ seeds) in either raw or cooked form successfully lowering blood glucose in diabetic patients.

Muruganandan _et al._, (2002) reported the anti-inflammatory activities of _Syzygium cumini_ bark against inflammation induced by individual autacoid insult and its barks exhibits inhibitory role on inflammation.
Antonio et al., (2005) found no evidence of an antidiabetic effect induced by extracts and fractions of *Syzygium cumini* leaves, in different experimental models, including diabetic and non-diabetic animals submitted to a glucose overload.

*Syzygium cumini* is a well known plant and its chemical constituents of *Syzygium cumini* may vary according to humidity, soil and climatic conditions (Evans, 1996). It has been shown that the leaves of Brazilian *Eugenia jambolana* have no effect on diabetes (Teixeira et al., 1997. 200; pepato et al., 2001).

3. SCOPE OF THE STUDY

Medicinal plants continue to provide valuable therapeutic agents in both modern medicine and traditional system. Many herbs have remained as an alternative to conventional therapy. Ayurveda is an Indian form of medicine, which deals with plants and plant extracts. This indigenous form of medicine uses the active principles present in plants for treating various diseases. Plant drugs are comparatively less toxic and free from side effects than synthetic drugs.

A thorough literature survey revealed that no systematic investigation has been elucidated using extract of *Syzygium cumini* seeds. Hence, the present study has given much scope to evaluate the ethyl acetate and methanol crude extracts of *Syzygium cumini* seeds. Hence, the present work was undertaken to validate scientifically the *Syzygium cumini* seed extracts for anti-diabetic, anti-inflammatory, analgesic activities and behavioral changes in the central nervous system in experimental animals.

The following is the design of work;

- Seed extractions.
- Preliminary phytochemical evaluations.
- Inorganic assay.
- Acute toxicity study.
- Isolation and characterization of separated compound.
Pharmacological evaluations of anti-diabetic, anti-inflammatory, analgesic activities and behavioral changes in the central nervous system.

4. MATERIALS AND METHODS

4.1 PLANT MATERIAL

The fully mature Syzygium cumini seeds were collected in June-July 2006, from Kattuppalayam Village in Erode District of Tamil Nadu, India from a single tree. The seed was identified and authenticated by Dr. S. Amerjothy, Head of the Department of Plant Biology and Plant Biotechnology, Presidency College, Chennai and voucher specimen (No.1586) was deposited in the Herbarium of the Department.

4.2 SEED EXTRACTIONS

The Syzygium cumini seed powdered was extracted with Hexane to remove lipids. It was then filtered, and the filtrate was discarded. The residue was successively extracted with ethyl acetate (EA) and methanol (ME) using the cold percolation method, following the method of Veerappan et al., (2005) with a minor modification. At the end of extraction, each extract was filtered through Whatman No. 1 filter paper. The filtrates so obtained were concentrated in rotary vacuum evaporator at 30-35°C under reduced pressure.

4.3 PHYTOCHEMICAL SCREENING

One gm of ethyl acetate and methanol extracts of Syzygium cumini seed was dissolved in 100 ml of own mother solvent to obtain a stock of concentration 1 % (W/V). The extracts were subjected to preliminary phytochemical screening of various plant constituents (Harborne, 1998; Kokate, 2001).

4.4 INORGANIC ASSAY

Powdered seed sample taken in a vitreosil crucible was placed in an electric muffle furnace and maintained at 450-475°C overnight, which destroy the organic
substances present in the seed powder. The ash was removed from the crucible and
dried in a vacuum desiccator. One gram of ash was digested with a mixture of
hydrochloric acid and nitric acid in the ratio of 1:3 (Rajurkar and Damame, 1998).
The digested sample was dissolved in 50 ml of distilled water and was used for the
assay of trace elements using Atomic Absorption Spectroscopy (AAS-Varion
200AA) using suitable hollow cathode lamps. Sodium and potassium were
estimated by Flame photometer.

4.5 ISOLATION OF THE COMPOUND

ISOLATION OF ACTIVE COMPOUND BY COLUMN
CHROMATOGRAPHY TECHNIQUE (Harbone, 1998)

Five grams of the *Syzygium cumini* seed methanol extract was admixed with 10 gm
of silica gel (60-120 mesh), dried for uniform mixing and the admixture was loaded
in top of the column (5 cm diameter X 50 cm height) packed with silica gel (150
gm) using hexane as the solvent. The column was eluted with increasing order of
polarity of solvents gradually from 100 % hexane, 100 % chloroform and methanol
in ethyl acetate (0-100%). The pure fraction was obtained in 100 % methanol. The
fraction was characterized by spectroscopy techniques like $^1$H NMR, $^{13}$C NMR and
Mass Spectrum.

4.6 PHARMACOLOGICAL EVALUATION

4.6.1 ANIMALS

Wistar rats (160-180 gm) and Albino mice (20-25 gm) of either sex were
purchased from King Institute, Chennai for experimental study. The experimental
protocol was approved by the IAEC (Institutional Animal Ethical Committee) of
CPCSEA (Committee for the Purpose of Control Supervision of Experiments on
Animal).


4.6.2 ACUTE TOXICITY STUDIES
Acute oral toxicity (Ecobichon, 1997), study was performed as per OECD (Organisation of Economic Cooperation and Development) - 423 guidelines (acute toxic class method). The animals (n = 6) of either sex selected by random sampling technique were used for the study. The animals were kept fasting for overnight providing only water, after which the extracts (ethyl acetate and methanol) were administered orally at the dose level of 5 mg/kg body weight by intragastric tube and observed for 14 days. If mortality was observed in 2-3 animals, then the dose administered was assigned as toxic dose. If mortality was observed in one animal, then the same dose was repeated again to confirm the toxic dose. If mortality was not observed, the procedure was repeated for further higher dose such as 50, 300 and 2000 mg/kg body weight.

4.6.3 PREPARATION OF THE DRUG

Extracts and the standard drugs were administered in the form of suspension with 1% sodium carboxy methyl cellulose (SCMC) solution as suspending agent.

4.6.4 ANTI-DIABETIC ACTIVITY

(Following the methodology adopted by Babu et al., 2002)

The anti-diabetic activity of Syzygium cumini seed (EA and ME at the dose of 200 and 400 mg/kg, p.o) of extracts, isolated compound, micaminose (50 mg/kg) and standard drug, glibenclamide (1.25 mg/kg) against streptozotocin-induced diabetic rats was evaluated.

4.6.5 ANTI-INFLAMMATORY ACTIVITY

(Following the methodology adopted by Winter et al., 1962)

The anti-inflammatory activity of Syzygium cumini seed (EA and ME at the dose of 200 and 400 mg/kg) extracts and standard drug, diclofenac sodium (5 mg/kg) against carrageenan paw oedema in rats was evaluated.

4.6.6 ANALGESIC ACTIVITY

(As per the experimental procedure suggested by Kulkarani, 1999)
(i) Evaluation of analgesic activity of *Syzygium cumini* seed (EA and ME at the dose of 200 and 400 mg/kg.) extracts and standard drug, aspirin (100 mg/kg) in mice by Acetic acid writhing method and (ii) the extracts and standard drugs, pentazocine (5 mg/kg) in mice by Tail immersion method was done.

### 4.6.7 CENTRAL NERVOUS SYSTEM ACTIVITY

(As per the experimental procedure suggested by Kulkarani, 1999)

(i) Evaluation of central nervous systems activity of *Syzygium cumini* seed (EA and ME at the dose of 200 and 400 mg/kg.) extracts and standard drug, diazepam (4 mg/kg) in mice using Rota-rod apparatus and (ii) the extracts and standard drugs, chlorpromazine hydrochloride (5 mg/kg) in mice by Actophotometer was done.

### 5. RESULTS

#### 5.1 SEED EXTRACTIONS

The yield was as follows: ethyl acetate, 01.80 % and methanol, 10.36 %. The final products were stored in screw capped bottles and refrigerated at about 5°C until further use.

#### 5.2 PHYTOCHEMICAL ANALYSIS

The seed contains alkaloids, amino acids, flavonoids, glycosides, phytosterols, saponins, steroids, tannins, triterpenoids and absence of anthraquinones.

#### 5.3. INORGANIC ELEMENTS

Totally 20 trace elements have been estimated in the *Syzygium cumini* seed ash. Among these Se, Hg, Pb, Mo, Cu, Mn, Ni, Cr, Ba, and B are found to be trace level, Fe, Zn, V, Al and Si at minor level and Mg, K, Na and Ca at major level.

#### 5.4. IDENTIFICATION OF COMPOUND
On isolation of the extract, a pale brown semi solid was obtained. Structural determination of the compound was done using spectroscopy techniques and it was identified as ‘MYCAMINOSE’ (4-Dimethylamine-6-methyl-tetrahydro-pyron-2,3,5-triol). Molecular formula is \( \text{C}_8\text{H}_{17}\text{NO}_4 \) and molecular weight is 191.

The structure was confirmed by spectral data (\(^1\text{H}\) NMR, \(^{13}\text{C}\) NMR and mass spectrum) over C\textsubscript{18} ODS reverse phase column.

![Mycaminose Structure](image)

4-Dimethylamino-6-methyl-tetrahydro-pyran-2,3,5-triol
(Mycaminose)

### 5.5. PHARMACOLOGICAL EVALUATION

#### 5.5.1 ACUTE TOXICITY STUDY

Acute toxicity studies showed no mortality upto the dose of 2000 mg/kg body weight. Thus the extracts safe for long term administration.

#### 5.5.2 PHARMACOLOGY ACTIVITIES

The seed extract of *Syzygium cumini* have,

- Anti-diabetic activity-oral administration of (i) of ethyl acetate and methanol extracts (200 and 400 mg/kg) (ii) the isolated compound, mycaminose (50mg/kg) (iii) the standard drug, glibenclamide (1.25 mg/kg) showed significant decrease in blood sugar level against streptozotocin-induced diabetic rates (Table:1)
Anti-inflammatory activity- the ethyl acetate and methanol extracts (200 and 400 mg/kg) and the standard drug, diclofenac sodium (5mg/kg), decreased oedema significantly at 3rd and 4th hour after administration against carrageenan induced paw oedema in rats, when compared to the control group (Table:2).

Analgesic activity - (i) the ethyl acetate and methanol extracts (200 and 400 mg/kg) and the standard drug, aspirin (100mg/kg), exhibited significant inhibition on the writhing response induced by acetic acid in mice compared with control group (Table:3) and (ii) the same extract and the standard drug, pentazocine (5mg/kg), administrated orally exhibited significant analgesic activity in mice compared with control group in ‘Tail immersion’ method (Table:4)

Effect on Central Nervous System activity - (i) the ethyl acetate and methanol extracts (200 and 400 mg/kg) and the standard drug, diazepam (4mg/kg) administrated orally in mice exhibited significant reduction of activity compared with control group in ‘Rota-rod’ apparatus (Table:5). And (ii) the same extracts and the standard drug, chlorpromazine hydrochloride (5mg/kg), exhibited significant reduction of activity in mice in ‘Actophotometer’ instrument (Table:6).

6. DISCUSSION

Hence, the phytochemical studies performed in the present study of the Syzygium cumini seed extracts of the plant grown in Kattuppalayam Village in Erode District of Tamil Nadu, South India have therapeutic effects of anti-diabetic activity, besides showing anti-inflammatory, analgesic activities and behavioral changes in the central nervous system and also revealed the occurrence of alkaloids, amino acids, flavonoids, glycosides, phytosterals, saponins, steroids, tannins and triterpenoids compounds. A compound namely mycaminose was isolated from methanol extract of Syzygium cumini seed, which has shown anti-diabetic activity.
7. CONCLUSION

In the present investigation, it may be concluded that the presence of biologically active compounds along with trace elements of Syzygium cumini seed extracts may readily account for the observed anti-diabetic, anti-inflammatory, analgesic activities and behavioral changes in the central nervous systems. It is also noted that during isolation, a compound namely, mycaminose is obtained which also has anti-diabetic activity.

Hence, it is suggested that the extracts of seeds of Syzygium cumini have therapeutic potential as a drug which may be taken up for clinical trials as well as drug manufacture in the future.
Table 1: Anti-diabetic activities of *Syzygium cumini* seed extracts and isolated compound against Streptozotocin–induced diabetic rats.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>BLOOD SUGAR LEVEL IN MG/DL (MEAN ± SD)</th>
<th>Initial</th>
<th>Day 1</th>
<th>Day 5</th>
<th>Day 10</th>
<th>Day 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>70.78 ± 7.03</td>
<td>65.05 ± 9.33</td>
<td>66.70 ± 9.85</td>
<td>67.00 ± 7.41</td>
<td>65.48 ± 5.88</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>249.76 ± 8.85</td>
<td>262.28 ± 14.75</td>
<td>285.85 ± 4.78</td>
<td>309.20 ± 8.09</td>
<td>313.28 ± 4.73</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>250.85 ± 8.40</td>
<td>252.49 ± 5.57 NS</td>
<td>239.23 ± 8.42 NS b* (04.63)</td>
<td>204.38 ± 5.84 b* (18.52)</td>
<td>192.03 ± 5.80 b* (23.45)</td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td>249.04 ± 3.89</td>
<td>249.65 ± 7.85 NS</td>
<td>221.24 ± 5.41 b* (11.16)</td>
<td>189.10 ± 8.22 b* (24.07)</td>
<td>178.14 ± 9.30 b* (28.47)</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td>248.70 ± 8.85</td>
<td>256.08 ± 4.98 NS</td>
<td>239.88 ± 8.84 NS b* (03.46)</td>
<td>214.23 ± 3.33 b* (13.86)</td>
<td>182.85 ± 4.58 b* (26.48)</td>
</tr>
<tr>
<td>VI</td>
<td></td>
<td>251.84 ± 4.90</td>
<td>256.57 ± 5.57 NS</td>
<td>233.45 ± 6.30 b* (07.30)</td>
<td>192.77 ± 4.89 b* (23.45)</td>
<td>154.85 ± 10.24 b* (38.51)</td>
</tr>
<tr>
<td>VII</td>
<td></td>
<td>248.38 ± 3.50</td>
<td>251.17 ± 8.14 NS</td>
<td>217.97 ± 4.52 b* (12.24)</td>
<td>190.10 ± 7.91 b* (23.46)</td>
<td>180.21 ± 8.68 b* (27.44)</td>
</tr>
<tr>
<td>VIII</td>
<td></td>
<td>249.62 ± 8.53</td>
<td>247.51 ± 8.11 NS</td>
<td>190.07 ± 11.04 b* (23.86)</td>
<td>167.84 ± 9.37 b* (32.76)</td>
<td>123.93 ± 5.89 b* (50.35)</td>
</tr>
</tbody>
</table>

Values are mean ± SD of respective groups,  NS – Non Significant,   *p<0.05
Values in parenthesis indicate the percentage reduction of blood sugar level.
Comparisons were made a – Initial Vs day 1, day 5, day 10 and day 15 of respective groups.
b – Group II Vs group III, IV, V, VI, VII and VIII.
Table 2 Anti-inflammatory evaluation of *Syzygium cumini* seed extracts against carrageenan induced paw oedema in rats.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PAW OEDEMA VOLUME (ML)</th>
<th>60 min</th>
<th>120 min</th>
<th>180 min</th>
<th>240 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.35 ± 0.14</td>
<td>0.49 ± 0.02</td>
<td>0.65 ± 0.01</td>
<td>0.67 ± 0.01</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>0.28 ± 0.16** (20 %)</td>
<td>0.39 ± 0.02* (20.4 %)</td>
<td>0.39 ± 0.02*** (40 %)</td>
<td>0.31 ± 0.02*** (53.7 %)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>0.25 ± 0.01** (28.6 %)</td>
<td>0.38 ± 0.02* (22.4 %)</td>
<td>0.38 ± 0.02*** (41.5 %)</td>
<td>0.27 ± 0.03*** (59.7 %)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>0.28 ± 0.02** (20 %)</td>
<td>0.38 ± 0.03* (22.4 %)</td>
<td>0.38 ± 0.03*** (41.5 %)</td>
<td>0.30 ± 0.03*** (55.2 %)</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>0.24 ± 0.01 *** (31.4 %)</td>
<td>0.37 ± 0.01** (24.5 %)</td>
<td>0.35 ± 0.02*** (46.1 %)</td>
<td>0.25 ± 0.03*** (62.6 %)</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>0.22 ± 0.01*** (37.1 %)</td>
<td>0.36 ± 0.01** (36.1 %)</td>
<td>0.27 ± 0.02*** (58.4 %)</td>
<td>0.17 ± 0.10*** (74.6 %)</td>
<td></td>
</tr>
</tbody>
</table>

Values are mean ± SEM of 6 animals in each group

Comparisons were made between Group I Vs II, III, IV, V and VI

P-values: *p<0.05, **p<0.01, ***p<0.001
Table 3 Analgesic activities of *Syzygium cumini* seed extracts by acetic acid writhing method

<table>
<thead>
<tr>
<th>GROUP</th>
<th>NO. OF WRITHING (20 MIN)</th>
<th>% ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>50.5 ± 12.19</td>
<td>---</td>
</tr>
<tr>
<td>II</td>
<td>24 ± 5.47*</td>
<td>52.47</td>
</tr>
<tr>
<td>III</td>
<td>08 ± 3.84*</td>
<td>84.15</td>
</tr>
<tr>
<td>IV</td>
<td>28.16 ± 2.85*</td>
<td>44.23</td>
</tr>
<tr>
<td>V</td>
<td>11.16 ± 2.85*</td>
<td>77.90</td>
</tr>
<tr>
<td>VI</td>
<td>14.66 ± 6.47*</td>
<td>70.97</td>
</tr>
</tbody>
</table>

Values are mean ± SD of six animals in each group. Comparisons were made between group I Vs II, III, IV, V and VI. 
p-values: *p<0.001

Table 4 Analgesic activities *Syzygium cumini* seed extracts by tail immersion method

<table>
<thead>
<tr>
<th>GROUP</th>
<th>REACTION TIME IN SEC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 min</td>
</tr>
<tr>
<td>I</td>
<td>3 ± 0.63</td>
</tr>
<tr>
<td>II</td>
<td>6 ± 2.09**</td>
</tr>
<tr>
<td>III</td>
<td>5.83 ± 1.94**</td>
</tr>
<tr>
<td>IV</td>
<td>4± 0.89NS</td>
</tr>
</tbody>
</table>
Values are mean ± SD of six animals in each group.
Comparisons were made between group I Vs II, III, IV, V and VI.
p- values: NS- non significant, *p<0.05, **p<0.01, ***p<0.001

Table 5 Central Nervous Systems evaluation of *Syzygium cumini* seed extracts in mice using by rota rod method.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FALL OFF TIME (SEC)</th>
<th>% DECREASE IN TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before drug</td>
<td>After drug</td>
</tr>
<tr>
<td>I</td>
<td>645 ± 51.67</td>
<td>664.1 ± 46.84</td>
</tr>
<tr>
<td>II</td>
<td>580.16 ± 72.22</td>
<td>89 ± 69.93**</td>
</tr>
<tr>
<td>III</td>
<td>625.66 ± 60.18</td>
<td>58 ± 15.84**</td>
</tr>
<tr>
<td>IV</td>
<td>726.5 ± 81.37</td>
<td>651.83 ± 38.73^NS</td>
</tr>
<tr>
<td>V</td>
<td>648.33 ± 43.08</td>
<td>320 ± 211.33^*</td>
</tr>
<tr>
<td>VI</td>
<td>634.5 ± 66.07</td>
<td>9.8 ± 4.92**</td>
</tr>
</tbody>
</table>

Values are mean ± SD six animals in each.
Comparisons were made between group I Vs II, III, IV, V and VI.
p-values *p<0.01, **p<0.001

Table 6 Central Nervous system evaluation of *Syzygium cumini* seed extracts in mice using actophotometer method.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>LOCOMOTION ACTIVITY 10 MIN</th>
<th>% CHANGE IN ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before treatment</td>
<td>After treatment</td>
</tr>
<tr>
<td>I</td>
<td>207.52 ± 19.50</td>
<td>201.0 ± 9.44</td>
</tr>
<tr>
<td>II</td>
<td>187.50 ± 20.09</td>
<td>90.30 ± 9.77 ^*</td>
</tr>
<tr>
<td>III</td>
<td>230.30 ± 23.59</td>
<td>97.16 ± 16.55 ^*</td>
</tr>
<tr>
<td>IV</td>
<td>217.32 ± 30.80</td>
<td>141.0 ± 33.89 ^*</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>VI</td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>210.33 ± 30.80</td>
<td>214.83 ± 22.48</td>
</tr>
<tr>
<td></td>
<td>65.5 ± 11.80 *</td>
<td>39.67 ± 14.6 *</td>
</tr>
</tbody>
</table>

Values are mean ± SD six animals in each. Comparisons were made between group I Vs II, III, IV, V and VI. p-values *p<0.001.

REFERENCE


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Satyavati GV and Gupta AK (1987). Medicinal Plants of India. Indian Council of India Medical Research, New Delhi, Vol.II.


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