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Review Article

A Collective Overview of the Phytoconstituents and Pharmacological Actions of *Satureja Hortensis* L.

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ABSTRACT

Satureja hortensis L. belongs to the annual herbaceous crop, native to Mediterranean and Europe region. Its uses as traditional culinary and medicinal herbs trace back to ancient times on the basis of scientific research and documents. The chemical constituents of summer savory (extracts and essential oils) which was extracted by various methods were found to be dominated by polyphenols, flavonoids and volatile oils consisting of main components (Carvacrol, α -Terpinene, p-Cymene, Thymol). Other biomolecules found in summer savory extracts were found to be tannins, gums, phenolic compounds, pyrocatechols, steroids, triterpenic acids, mucilage, resins, sugars and mineral salts. The various research study of summer savory extract based on the above-mentioned chemical constituents showed various pharmacological actions namely anti-inflammatory, antidiabetic, antihyperlipidemia, cytotoxic, antidiarrhoeal, anti-spasmodic, antileishmanial, antinociceptive, hepatoprotective, antimicrobial, cardioprotective, fertility aiding, diuretic, immunomodulatory and genotoxic. This review article provides a comprehensive review of the biochemical constituents and pharmacological activity of the plant *Satureja hortensis* L.

INTRODUCTION

Satureja hortensis L. belongs to the “annual herbaceous” crop species and belong to the “*Lamiaceae*” family. Its aerial part especially its flowers and leaves were used for traditional culinary purposes and also as a medicinal herb due

to its health benefits [1]. There are almost 7,000 species and 230 genera belonging to the family *Lamiaceae* from which *Satureja hortensis* (savory) consists of over 200 different varieties of herbs and shrubs species which are often aromatic and indigenously distributed to the Europe and

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Mediterranean area [2]. The main biomolecules and chemical constituents found in *Satureja hortensis* L. extract are volatile oils/essential oils, flavonoids, tannins, mucilage, phenolic compounds, gums, pyrocatechols, steroids, triterpenic acids, resins, sugars, mineral salts etc [3]. From among all the bio constituents some main bio constituents in the volatile oil were found to be “monoterpenoids, carvacrol, thymol and p-cymene”. Due to which *Satureja hortensis* showed properties such as hepatoprotective, antioxidant, antiparasitic, antiinflammatory, antinociceptive, antiviral, antialzheimer and antimicrobial [4]. *Satureja hortensis* L. has been used as a traditional medicine in the treatment of several disorders and diseases such as spasm, stomach, intestinal, cramps, muscle pain etc. And from modern studies it has been revealed it possess various beneficial action like antimicrobial, anti-inflammatory, cytotoxic, anti-diarrheal, anti-spasmodic, antileishmanial, anti-aggregation etc [5]. This review aims to provide a comprehensive review of various biochemical constituents and established pharmacological activity of the plant *Satureja hortensis* L.



Figure - 1: *Satureja hortensis* L.

Table – 1: Taxonomic Classification of *Satureja hortensis* L.

Kingdom	Plantae
Phylum	Streptophyta
Class	Equisetopsida
Order	Lamiales
Family	Lamiaceae
Genus	<i>Satureja</i> (savory)
Species	<i>Hortensis</i>

2. An Overview of The Chemical Constituents of *Satureja Hortensis* L. (Summer Savory) Extracts

The biochemical composition of the fresh *S. hortensis* L. leaves were found to contain protein, fibre, fat, moisture, ash and sugar. Whereas the biochemical composition of the dried mass was found to include volatile oil, triterpenic acids, tannins, mucilage, resins, minerals salts, sugars etc [6]. Various research has shown the following constituent's tannins, sterols, phenols, volatile oils, mucilage, gums, pyrocatechol and acids as the main bioactive molecule of *Satureja hortensis* L. The volatile oil isolated from the *Satureja hortensis* L. has major constituents like carvacrol (11-67%), thymol (0.3-28.2%), p-cymene (3.5-19.6%), γ -terpinene (15.30-39%), phenols and flavonoids. The study also states that due to the different climatic factors, geographical variation, seasonal variation, agronomy procedures,

extraction technique, drying method, harvest period, distillation technique the chemical constituents may vary but the main bioactive constituents are commonly present [7][8]. Also, the methanol extract which was extracted by maceration process was found to majorly contain isoferulic acid, caffeic acid, rosmarinic acid, naringenin, apigenin and also in minor content contained flavones, flavonol, flavones glycosides, coumarins and flavonol glycosides [6][9]. So, from all these studies major constituents of *Satureja hortensis* L. was found to be thymol (0.3-28.2%) carvacrol (67.00%), p-cymene (6.73%) and γ -terpinene (15.30%) and the other residual oil constituents was found to be less than 1% [8].

Table – 2: Biochemical constituents of *Satureja hortensis* L. volatile oil (VO).

Chemical constituents	Concentration
α -Thujene	3.695
β -Pinene	1.374
β -Myrcene	3.931
(+)-4-Carene	6.086
D-Limonene	0.558
β -Phellandrene	0.361
γ -Terpinene	37.862
o-Cymene	15.113
α -Thujone	0.546
Camphor	0.521
β -Caryophyllene	1.496
Bicyclo[5.1.0]octane, 8-(1-methylethylidene)	0.274
Anethole	0.420
Octanoic acid	0.304
Thymol	13.491
Isothymol	0.645
Carvacrol	13.225
Total	99.902

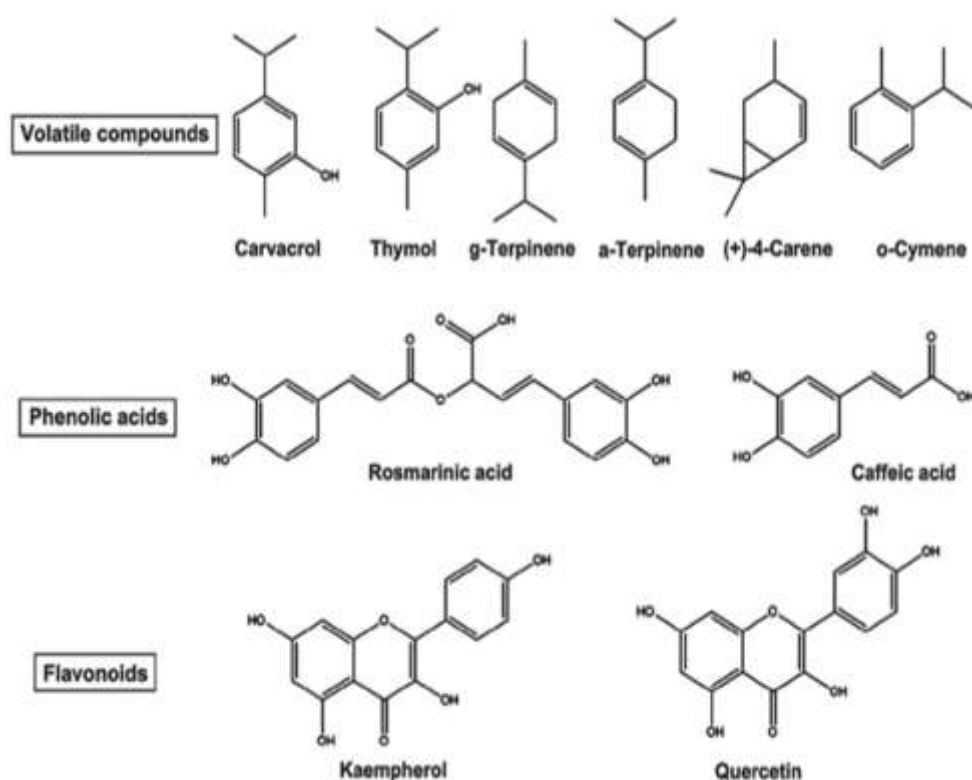


Figure - 2: Main classes of chemical constituents present in *Satureja hortensis* L.

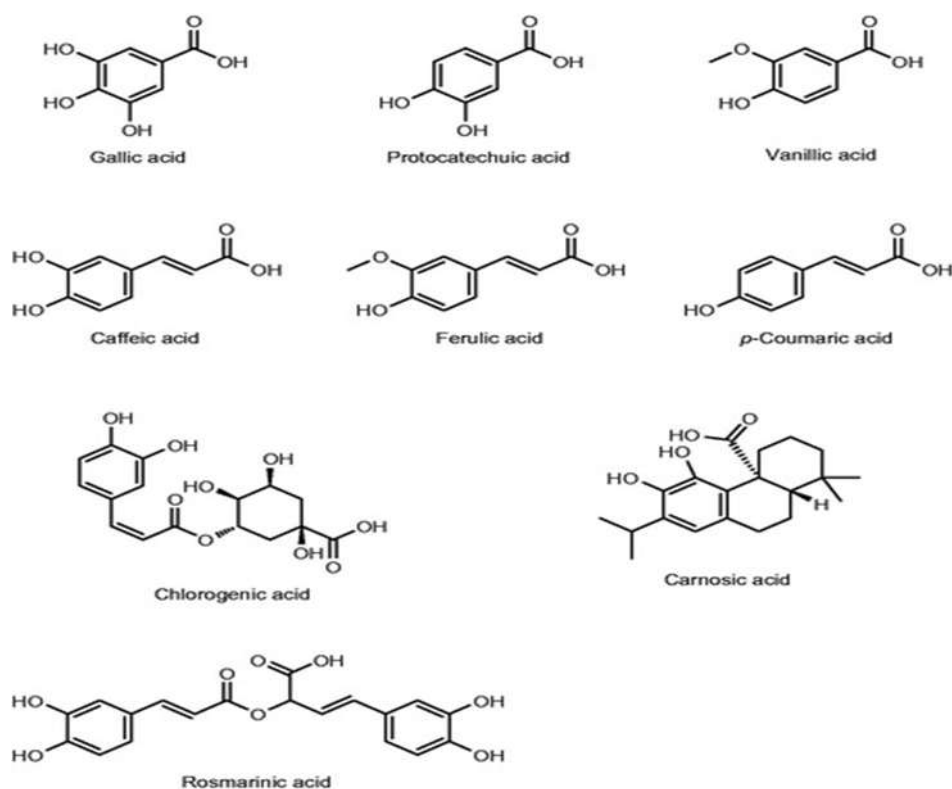


Figure - 3: Terpenoids constituents in *Satureja hortensis* L

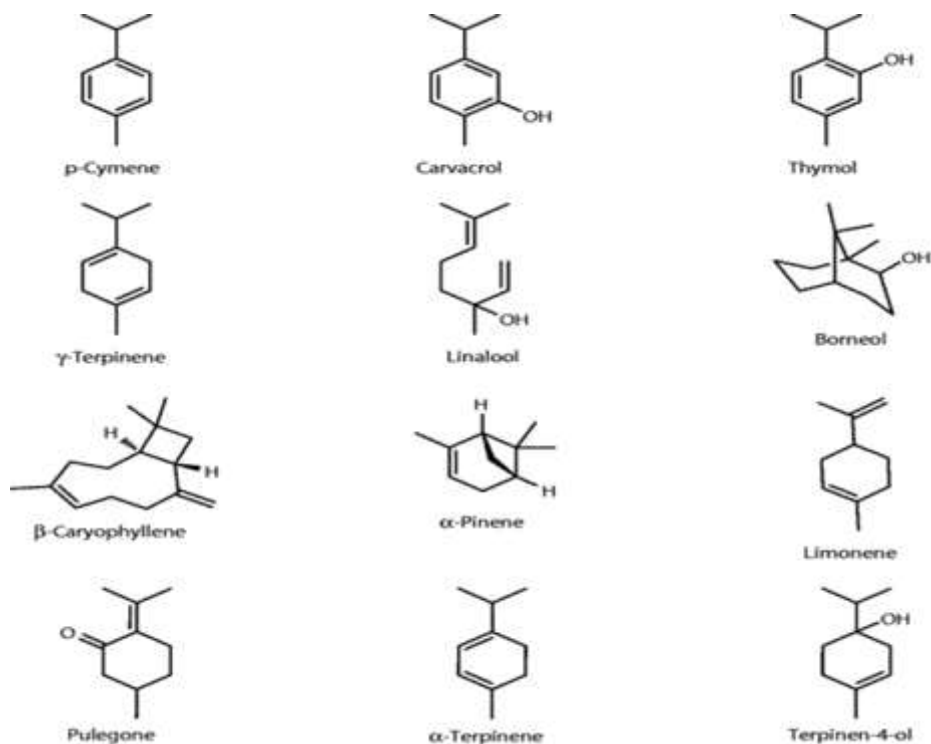


Figure - 4: Phenolic acids in *Satureja hortensis* L

3. An Overview of Biological Activity of *Satureja Hortensis* L.

3.1 Antioxidant activity

Antioxidant means against oxidation or any substance at low concentration that delays or

prevents oxidation. The oxidation reaction can lead to generation of free radicals which can start a series of chain reaction which can damage the cells or result in cell death. These antioxidants terminate the chain reactions by eliminating free radicals, lipid peroxidation, and also by preventing other oxidative reaction [10]. Antioxidant agents are usually reducing agents like polyphenols, thiols, ascorbic acid [11]. There are various analytical methods and assays options for assessing antioxidant activity namely ABTS, DPPH, FRAP and ORAC assays conducted using methanolic extracts [12]. Quercetin one of the main constituents present in *Satureja hortensis* along with their derivatives was found to possess radical scavenging capacity and therefore, potent antioxidant activity. This activity was determined using DPPH and FRAP assays [13]. *Satureja hortensis* L. was collected at various (three) flowering stages to determine its antioxidant activities. Its anti-oxidant activity as well as its total phenolic content was evaluated using “DPPH assay” and “Folin-Ciocalteu method”. The end result of these study showed that the *Satureja hortensis* collected during the full flowering period demonstrated maximum antioxidant activity and as well as maximum phenolic concentration which was attributed to the presence of γ -terpinene, thymol and carvacrol [14]. A research study was conducted to determine the antioxidant activity of compounds namely carvacrol and thymol. These compounds were administered into polypropylene films. The end result revealed positive results of migration extracts (thymol, carvacrol) showing they are readily released into different food stimulants from PP films. Thymol was found to be more potent of an antioxidant compared to carvacrol. These compounds revealed its likeability to be used in antioxidant food packaging [15]. So, from the above studies it was found that the following chemical constituents γ -terpinene, quercetin, p-cymene, quercetin, thymol,

carvacrol and polyphenolic compounds possess antioxidant effects. And since this are all present in *Satureja hortensis* L. as main constituents it establishes *Satureja hortensis* L. to exhibit potential antioxidant activity.

3.2 Antimicrobial activity

A study was conducted on the *Satureja hortensis* L. essential oil for assessing their antibacterial, antifungal and antioxidant activity. The parameters taken into consideration were zone of inhibition and minimum inhibitory concentration. The end result showed that the *Satureja hortensis* L. from Sabalan Mountain, Ardebil province, Iran exhibits potent antibacterial activity [16]. The hydro-distillation extract of *Satureja hortensis* was used to determine the antimicrobial activity against bacteria and fungi. This activity was assessed by broth microdilution method. The end result validated the antibacterial and antifungal activity of the of *Satureja hortensis* [17]. The antibacterial action of *Satureja hortensis* in various concentration regarding foodborne spoilage and pathogenic microbes was determined. The result suggested possible use of *Satureja hortensis* essential oils in food and other edibles as an potent anti-microbial preservatives [18]. The following studies indicated *Satureja hortensis* L. to exhibit antimicrobial activity.

3.3 Anti-Inflammatory and Anti-Nociceptive activity

Plants belonging to the Lamiaceae family are known to exhibit analgesic, pain-relieving, antispasmodic effects. Also, several species belonging to *Satureja* has known to display anti-inflammatory activity, attributing to the flavonoids content. [19]. A study was performed to determine the anti-nociceptive and anti-inflammatory effects of *Satureja hortensis* seeds. The essential oils which were extracted from its seeds primarily



contained thymol and γ -terpinene. The end result of the study suggested its use as a potential anti-nociceptive and anti-inflammatory agent [20]. A gel was formulated containing *Satureja hortensis* 1% essential oil and was applied as a thin layer in the base of the mucosa. The end result of the study considered it to be an efficient remedy for the denture stomatitis [21]. A study regarding anti-nociceptive activity of carvacrol in mice was conducted. Animal used was male Swiss mice and the antinociceptive and pain model test were used for assessing anti-nociceptive activity. Carvacrol was suggested to be involved centrally in imparting anti-nociceptive effects [22]. The plant *Satureja hortensis* were found to contain the following bioactive compounds such as flavonoids, phenolics, terpenes thymol, cymene, γ -terpinene. These chemical constituents were detected by spectrophotometric method and confirmed the dominance of flavonoids in the extract tincture. The end result of the study suggested that the herbal products obtained from *S. hortensis* have potential anti-inflammatory activity along with other mentioned activities.[23].

3.4 Cytotoxic activity

Satureja hortensis was studied to evaluate its cytotoxic potential. Its extract was found to mainly compose of flavonoids and phenols. The cytotoxic effect was assessed by MTT assay on cell lines of lung and kidney. It revealed cytotoxic action on normal cells of lung, kidney [24]. Cell line study was done on *Satureja hortensis* ethanolic extract. The cytotoxic action was assessed by flow cytometry. The end result displayed the potential cytotoxic activity of this plant. [25]. An anti-leukaemia activity of *Satureja hortensis* was conducted. Various fractions of the extracts were used for this study. Assays were conducted on cell lines using coulometric MTT assay and Annexin V assay. These study findings

suggested the dichloromethane and hexane fractions of the extracts of *Satureja hortensis* have therapeutic potential for treatment of leukaemia [26].

3.5 Hepatoprotective activity

Research was done to evaluate the hepatoprotective action of the specific Iranian Medicinal Plants. These study data was collected from different databases and was focused on medicinal plants based on Iranian traditional medicine proven to possess liver protective properties. From the data it was shown *Satureja spp.* (Lamiaceae) along with other activities possess hepatoprotective activity and are commonly employed in the management of liver related disorders in Iranian traditional medicine. The study also showed that chemical constituents like flavonoids, monoterpenoids, terpenes and terpenoids possess hepatoprotective activity [27]. Investigated the action of *Satureja hortensis* L. EO of the toxicity caused by cisplatin. Methanolic extract of the plant was used for this study and displayed protective actions towards cisplatin toxicity. Therefore, all these results proved its hepatoprotective activity [28].

3.6 Antiparasitic activity

The antiparasitic action of the ethanolic extract of *Satureja hortensis* was evaluated on digestive parasites. The ethanolic extract contained four major constituents namely polyphenols, tocopherols, sterols and methoxylated flavones. The end result showed that summer savory extract possessed antiparasitic activity. The data suggested that *Satureja hortensis* L. possess significant anthelmintic and antiprotozoal effect [29]. This study suggested that *Satureja hortensis* extract at 200mg could compete with metronidazole and as an alternative for it as anti-giardia without causing any side effects [30]. An



in vitro anti-leishmanial activity involving three herbal plants *Satureja hortensis*, *Artemisia dracunculus* L. and *Plantago psyllium* extracts on *Leishmania major* promastigotes was examined. Their hydro-alcoholic extract evaluation in different concentration against *Leishmania major* promastigotes cell culture medium was done. The study result showed that out of the three herbal plants *Satureja* and *Artemisia* showed considerable anti-leishmanial activity and may be used in treatment of cutaneous leishmaniasis or as an alternate therapy [31].

3.7 Antidiabetic and Antihyperlipidemic activity

In a study involving Summer savory (*Satureja* L.) plant species the chemical constituents and its novel effects on diabetic complications were studied. The different bioactive constituents were found to be volatile oils, phenols, flavonoids, tannins etc. Of which, polyphenols a natural antioxidant decreased blood sugar level suggesting its use for the treatment of diabetic complications [32]. A study was conducted to evaluate the ameliorating effect of *Satureja hortensis* alcoholic extract on the cadmium induced pancreatic damage in rats. Rats were divided into four groups control, savory-treated control, cadmium-exposed and savory-treated cadmium exposed groups respectively. After the end of the test histopathological analysis was done for the pancreatic tissue as well serum analysis for α -amylase, lipase and insulin respectively. The end result of histopathology study showed the normal maintenance of pancreatic tissue in savory-treated cadmium exposed groups and restoration of serum amylase and lipase in cadmium-exposed rats, suggesting protective effects in pancreatic tissues of rats [33].

3.8 Anti-diarrhoeal and Antispasmodic activity

In this research study antispasmodic activity was performed on the Wistar rats using their isolated ileum. The contraction effect of the isolated ileum was taken into account to assess this activity. The effect of *Satureja hortensis* extract was found to be same as that of the dicyclomine and relaxed the ileum. This study end result suggested the antispasmodic activity in addition to anti-diarrhoeal activity of the SHEO [34].

3.9 Diuretic activity

The carbonic anhydrase (CA) enzyme inhibition potential of SHEO was studied using esterase activity assay and molecular docking assay. Of all the major compounds detected by GC-MS analysis SHEO was found to contain thymol, cymene, carvacrol and β -decalol. The following mentioned compounds were found to inhibit carbonic anhydrase and specifically carbonic anhydrous II. These findings suggested the use of SHEO for possible therapy of carbonic anhydrase related diseases [35].

3.10 Immunomodulatory activity

The essential oils of culinary herbs were used in the study of periosteal. The essential oils of summer savory was revealed to possess proinflammatory action by immunomodulating proinflammatory cytokines such as IL-1, TNF, IL-6 and IL-10. [36].

3.11 Cardioprotective activity

A study was conducted using *Satureja hortensis* hydroalcoholic extract to evaluate its cardioprotective activity. Myocardial infarction was produced in rats using isoproterenol (ISO). Various doses of HSAH were used along with the standard drug metoprolol. This study showed that the HASH cardioprotective effects varies according to the level of its dose [37]. A



comparative study between *Satureja hortensis* and other two plants was carried out to check their ability to prevent adhesion, aggregation and secretion on the blood platelets. The methanolic extracts of the mentioned plant were used along with their assays. These study findings provided a scientific basis and suggested the use of these three herbs traditionally for cardiovascular diseases and thrombolytic disorders [38].

3.12 Fertility aiding activity

Doxorubicin (DOX), an anticancer anthracycline antibiotic, has the potential to cause significant dose-dependent damage to tissues that are not intended targets. Studies were conducted with the purpose to determine whether *Satureja hortensis* hydroalcoholic extract might be used to reduce spermatotoxicity caused by DOX. Male rats were administered with DOX and Summer Savory extract over a span of 28 days. According to epididymal sperm tests, whilst *S. hortensis* extract co-administration significantly normalized the quantity as well as the quality of the sperm whereas, DOX was found to produce significant declines in the quantity and quality of the sperm. The study indicated that *S. hortensis* may have contributed to its protective effects against DOX-induced reproductive damage, attributing to its already established antioxidative as well as its anti-inflammatory properties [39]. A research study was conducted on the polycystic ovarian syndrome. POS is characterized by irregular menstrual cycle, insulin resistance, weight gain, hirsutism, lethargy, etc. Biomolecules such as CYP 17 α , CYP 19, leptin receptors and many others have a vital role in disease progression of PCOD. Some chemical components present in summer savory were docked against PCOD targets to check binding affinities of these chemical constituents. The end result indicated extract of *Satureja hortensis* balanced hormonal disturbance

and as well as improved health conditions of POS [40].

3.13 Genotoxic activity

An in vitro antagonistic action of SHEO to assess its anti-genotoxicity activity towards aflatoxin B₁ was evaluated. The different concentrations of SHEO with AFB₁ was found to decrease the frequency of SCE, MN and MDA. Whereas, there was increased activities of SOD and GP_X respectively. The end result of the study showed that SHEO possess anti-genotoxic effects [41]. A study was conducted to assess the genotoxic action of *Satureja hortensis* towards Phaseolus Vulgaris. The seed of Phaseolus Vulgaris was exposed to four different concentrations of SHEO 0.1, 0.2, 0.4, 0.8 μ l/ml. RAPD technique was performed and genomic template stability calculated. The end result of the study showed the essential oil were found to decrease the genomic stability with increasing concentration [42].

CONCLUSION

Satureja hortensis L. has traditionally been used for its medicinal properties and as a culinary. It was concluded that its essential oil extract obtained through various extraction methods contained common bioactive constituents namely p-Cymene, Carvacrol, Thymol, γ -Terpinene, Phenolic acid and Flavonoids. Because of the presence of these mentioned chemical constituents *Satureja hortensis* L. was found to show numerous bio pharmacological activity namely antioxidant, antifungal, antimicrobial, anti-nociceptive, cytotoxic, hepatoprotective, antiparasitic, antidiabetic, anti-inflammatory, antihyperlipidemic, antispasmodic, anti-diarrhoeal, diuretic, immunomodulatory, cardioprotective, fertility aiding and genotoxic activity.



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