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### Biological activities and chemical constituents of *Illicium verum* hook fruits (Chinese star anise)

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#### ABSTRACT

Chinese star anise (*Illicium verum* Hook) is widely used as culinary and medicinal fruit and is most popular in indigenous system of medicine. The fruit is an important source of essential and volatile oil. Traditionally the fruit has been used as carminative, digestive, dyspepsia, antispasmodic, and stimulant, antirheumatic and diuretic. Preclinical studies indicate the therapeutic potential of oil of *I. verum* fruit in the treatment of microbial diseases, as antifungal and antioxidant. This review presents a detailed compilation of the literature on phytochemistry, traditional and biologically evaluated medicinal uses of *Illicium verum*.

**Keywords:** *Illicium verum*, Antibacterial, Antifungal, Antioxidant, Shikimic acid, Tami flu.

#### INTRODUCTION

Ayurveda is the most ancient health care system and is practiced widely in India, Srilanka and other countries [1]. There is a great demand for herbal medicines in developed as well developing countries because of their wide biological activities, safety margin than synthetic drugs and lesser cost [2]. The current market potential of herbal medicines is estimated about \$8-250 billion in Europe and USA. The Indian herbal drug market size is about \$1 billion and export of plant-based crude is around \$100 million [3]. Ayurveda and modern medicines technique should coupled to bring out highly quality herbal products with rapid onset of action and good bioavailability.

*Illicium verum* hook is herbal drug with wide range of medicinal properties and investigation still remains in relatively newer areas of its application. *Illicium verum* hook. also named star anise is

the fruit of a medium sized tree that grows in Asia is native to China and Vietnam. The genus name *illicera* (allure) probably because of sweet and attractive fragrance [4].

The oil produced by the process of steam distillation is having wide range of culinary usage and medicinal properties. The oil is used as substitute for European aniseed in commercial drinks. Chinese star anise is one of the flavors used in “china five spices”. It is a spice frequently used in meat and Chinese cooking. It is stronger than aniseed and is used in baked goods, confections and liquors. It has insecticidal properties and is effective against Japanese termites and adult German cockroaches, there does not see any contraindication for herb or drug interaction. The Japanese star anise, *illicium anisatum* has poisonous properties the active principle responsible anisatin is elucidate and should not be mixed with Chinese star anise [5]. The herb is reported to be antifungal, antibacterial and antioxidant. It can increase production of milk new mother. Some folk remedies recommended the use to facilitate birth and to increase the libido, as well as to relieve menopausal discomforts; oil is used in rheumatism [6]. The attributed medicinal properties are carminative, stomachic, stimulant, expectorant and diuretic. In east it is used to combat colic and rheumatism. It is a common flavoring for medicinal tea, cough mixture and pastilles. *Illicium verum* fruit is used in traditional system of medicines having both culinary and medicinal uses. Its seed oil is used worldwide as medicine. The fruits are sweet, aromatic, carminative, digestive, stomachic, stimulant, diuretic, expectorant, deodorant, constipation and insomnia. It relieves colic and is a common ingredient of cough lozenges and cattle sprays. They are also useful in dyspepsia, flatulence, spasmodic pain, facial paralysis, asthma, bronchitis, halitoris [7, 8].

The aim of the present review is to highlight the traditional use, phytochemical and pharmacological investigation carried out on *Illicium verum* and to explain the multifaceted role of this medicinal plant.

### **Botanical Description**

The *Illicium verum* is a medium sized tree is about 8-15 (-20m) tall and 30 cm depth with a straight rounded trunks and green, glabrous branch lets. The bark is white to bright grey. Leaves 6-12 cm long, alternate, simple, leathery, entire, shining, glabrous, usually crowded in bundles at the end of the branches. Flower large, bisexual, 1-1.5 cm in diameter, white pink to red or greenish yellow, axillary and solitary. Fruit is capsule like, aggregate is star shaped, radiating five to ten pointed boat shaped sections about eight on average. Each arm is seed pod. Tough skinned and rust colored they measure up to 3 cm (1-1/4”) long. Fruits are picked before it ripens and dried. Seed are shiny brown or reddish with high oil content [9, 10].

### **Taxonomic Classification [11]**

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Austrobaileyales

Family: illiciaceae

Genus: *illicium*

Species: *I. Verum*

Bionomical name: *Illicium verum* hook .f.

**Vernacular Names [12]**

English: - True star Anise (Chinese star anise)

Hindi : - Anasphal, Badiyan Khatala

Kanada: - Kankola

Malayalam:-Takkolappultil, Takkolappottil

Sanskrit:-Takkolakum

Tamil:-Anusappu, Anusuppu

Telgu:-Kuppi, Anasapuveru

Danish: Stjerne anis

Dutch: adas china, Steranijs

French: anis delachine

German: Sternanis

Italian: Anice stellato

Spanish: Anis estrillado

Indonesian: - Bunga lawang

Malaysia:-bunga lawang

Arab: Raziyanje khatai

Persian: Badian – i- khatai

In ayurvedic system used as rasa: katu, Guna: Lakhu, Teekshna, Virya: Ushra, Vipaka: Katu

**Chemical Constituents**

The fruit contain higher bitter principle, tannins and essential oil (9-10%), consisting of anethole (85-90%),  $\alpha$ -pinene, limone,  $\beta$ -phellandrene,  $\alpha$ -terpineol, farnesol and safrol [13, 14]. They are 14 hydrocarbons components and 22 oxygenated hydrocarbon derivatives and small amount of nitrogenous compounds *p*-allyl anisole, *p*-cumicaldehyde, *p*-allylpen, anisylacetone, anisaldehyde linoleic acid (1-4 methoxyphenyl)-prop-2-one, foeniculin and palmitic acid[15,16,17].The new phenylpropanoid glucosides, known phenylpropanoid, alkylglucosides and Seco-Cycloartane;3,4seco(242)cycloartane4(28),24(diene)3,26-dioic acid.26, methyl ester of nigranoic acid from the dichloromethane extract from leaves of *illicium verum* was identified [18,19].

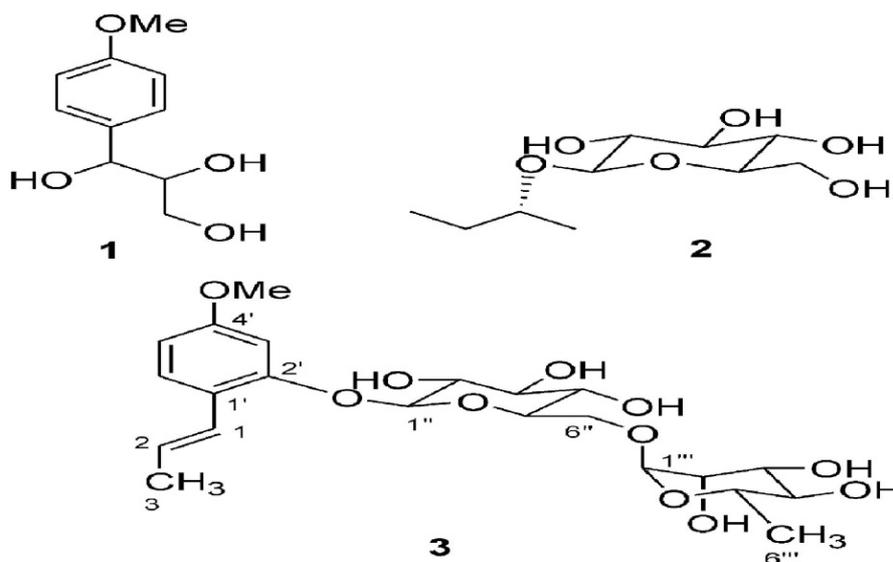
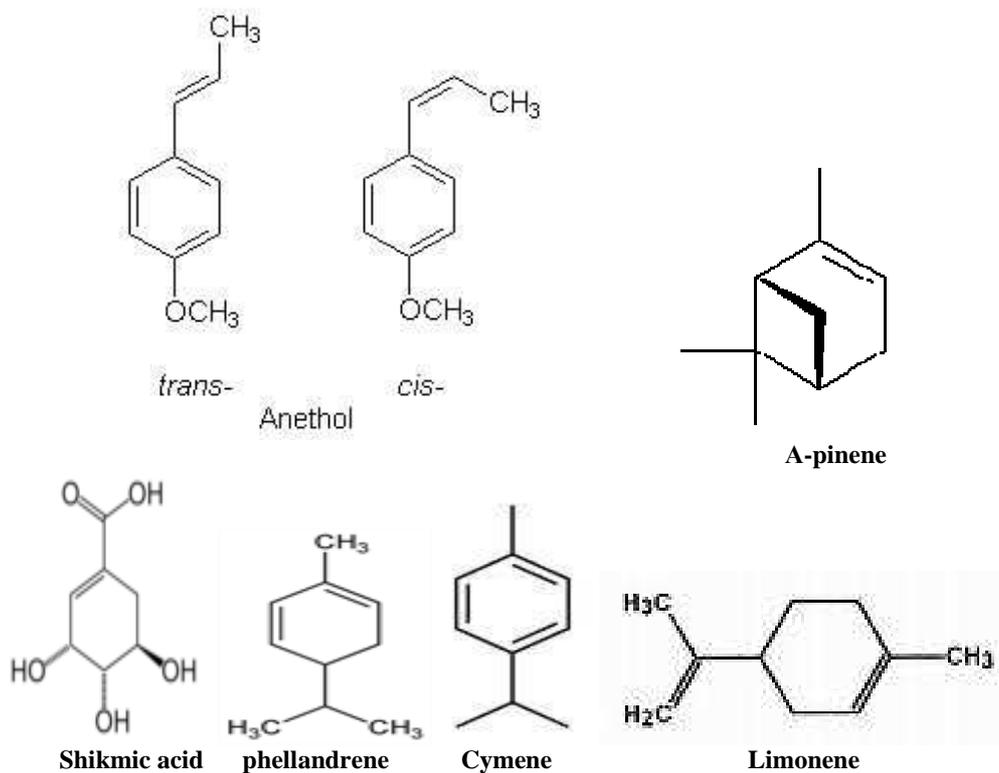
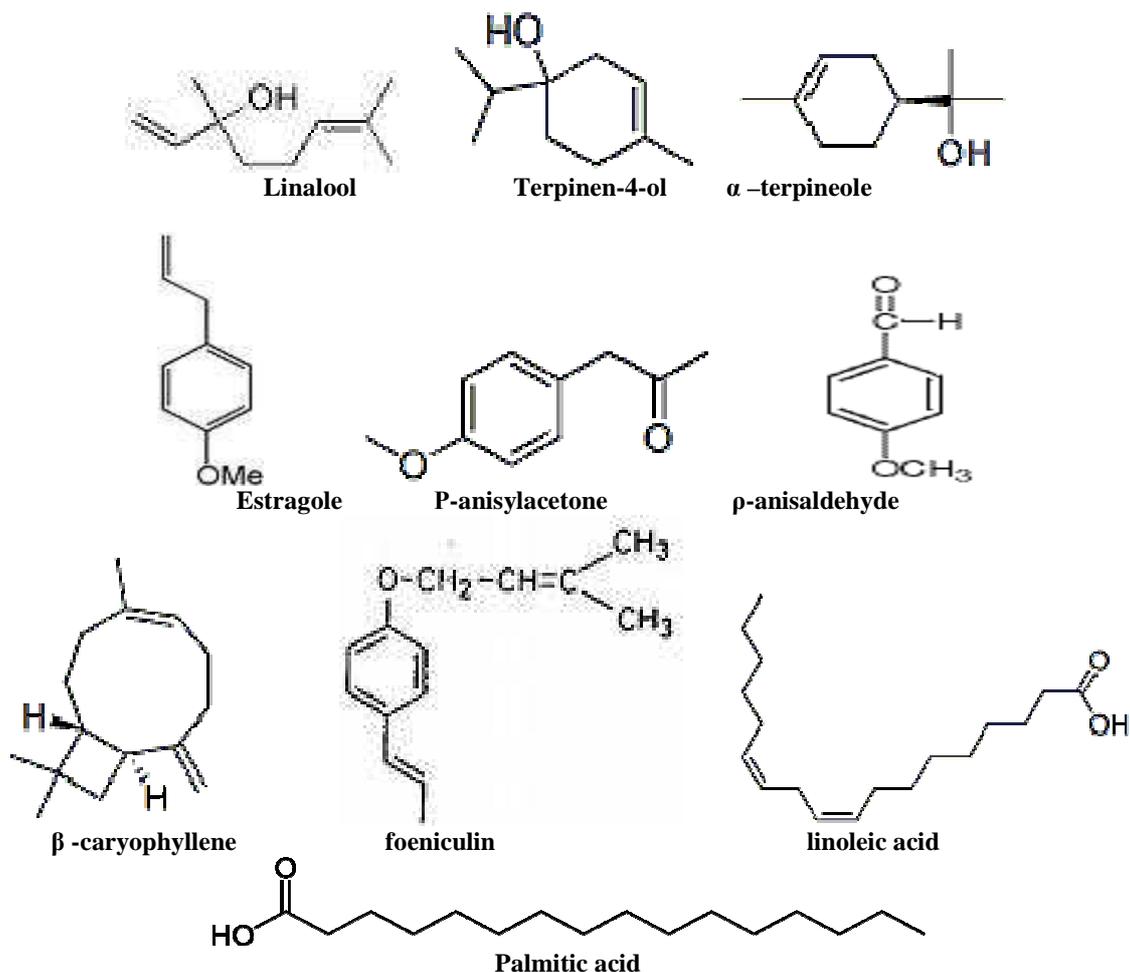


Table 1: Various chemical constituents of *Illicium verum* Hook.fruits

S.No	Chemical constituents	References
1.	Trans -anethole	32
2.	Cis -anethole	32
3.	$\alpha$ -pinene	33
4.	$\alpha$ -phellandrene	34
5.	Limonene	35
6.	Cymene	36
7.	Linalool	37
8.	Terpinen-4-ol	38
9.	$\alpha$ - Terpineole	39
10.	Shikmic acid	40
11.	Estragole	41
12.	Anisylacetone	42
13.	$\rho$ -Anisaldehyde	43
14.	$\beta$ -caryophyllene	44
15.	Foeniculin	45
16.	Linoleic acid	46
17.	Palmitic acid	47
18.	1-(4'-methoxyphenyl)-1,2,3-trihydroxypropane(R)-sec-butyl- $\beta$ -D glucopyranoside	19

Figure 1: Structures of various chemical constituents of *Illicium verum* Hook.fruits



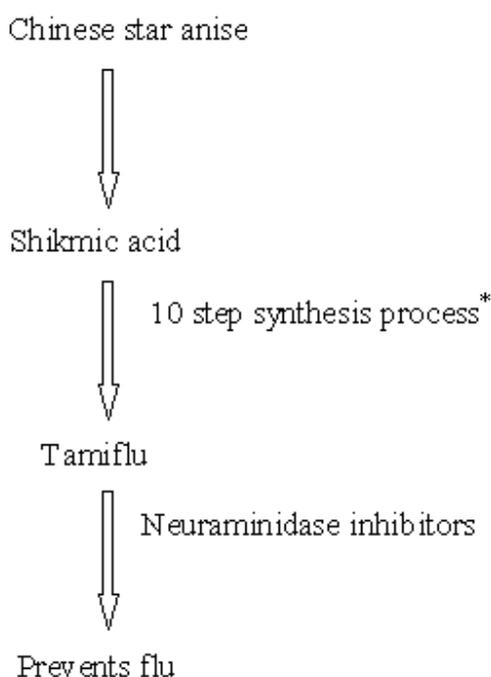
### Chinese Star Anise as Antiflu

Swine flu is a respiratory disease caused by influenza viruses that infects the respiratory tract of pigs, results in nasal secretion, a barking like cough, decreased appetite, and listless behaviour. swine influenza is an infection of any of several types of swine influenza viruses. Shikmic acid is used for synthesis for potent anti flu drug tamiflu.

Shikimic acid can be rapidly separated (*ca.* 5 min) from Chinese star anise with hot water extraction at temperatures of 120 °C or higher to obtain recoveries of 100%. Extraction recoveries of shikimic acid close to 97% were obtained with water at 70 °C using slightly longer extraction times (*ca.* 10 min) than those at 120 °C. For 0.5 g Chinese star anise raw material that contained 8% shikimic acid, 100% recoveries of shikimic acid could be obtained with 60 g water at 150 °C at 15 MPa in 4 min for star anise material having a particle size range from 355 to 600  $\mu\text{m}$  [20].

The synthesis of tamiflu requires shikimic acid. This acid is extracted from the pods of star anise. A 10-step process of complex chemical reactions results in the synthesis of Tamiflu.

Tamiflu is part of a new class of medicines called neuraminidase inhibitors. The surface of an influenza virus contains neuraminidase proteins that enable new virus particles to bud on the surface of the host cell. The neuraminidase enzyme breaks the bonds that hold these new virus particles to the outside of an infected cell, setting them free to infect other cells and spread infection. Neuraminidase inhibitors block the enzyme's activity and prevent new virus particles from being released, thereby limiting the spread of infection [21, 22].



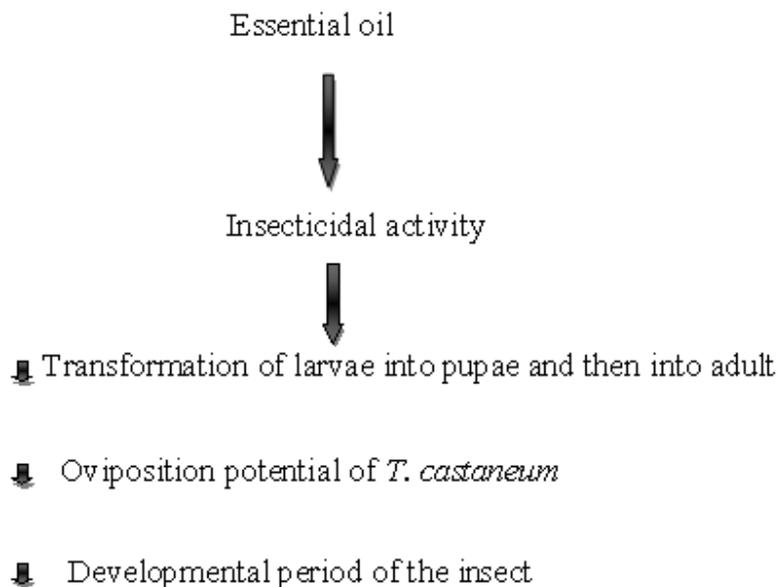
**Scheme 1: *Illicium verum* as Antiflu**

### **Antimicrobial Activity**

Microorganisms are the most versatile pathogens that are transmitted through soil, water, air and food and causes diseases in human being and animals. The crude ethanol extract from the fruits of *Illicium verum* showed antimicrobial activity against *S.aureus* ATCC 25923, *E.coli* ATCC2592, *P.aeruginosa* ATCC27853, *C.albicans* ATCC, *A.Mentagrophyte* which was determined by agar diffusion methods. Crude hexane and crude dichloromethane extracts showed antibacterial activity against *S. aureuse* ATCC25923. The MIC against *C. albicans*, *A. flavus*, and *T .mentagrophytes* was found to be 2500 $\mu$ g/ml, 2500  $\mu$ g/ml, and 625  $\mu$ g/ml. The antimicrobial activity of fruit extract is due to presence of anethole [23].

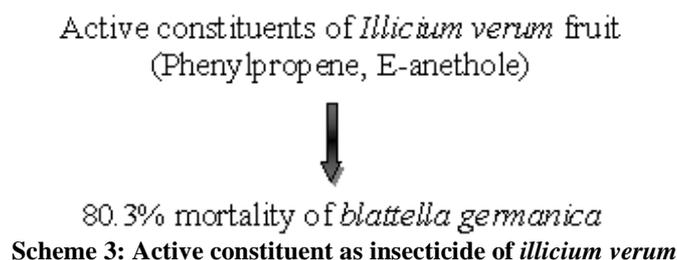
### **Anti insecticidal Activity**

The essential oil of *Illicium verum* was found to be potent insecticidal against wheat flour beetle larvae and adult of *Tribolium castaneum* .The essential oil caused toxicity against larvae and adult of *T.castaneum* when fumigated. Median lethal concentration(LC50)against larvae were 18.43 $\mu$ l and against adult were 19.83 $\mu$ l. Median effective concentration (EC50) that reduced transformation of larvae pupa to half were 11.97 $\mu$ l [24].



**Scheme 2: Mechanism of action of *Illicium verum* as insecticide**

The insecticidal activities of materials derived from the fruit of star anise, *Illicium verum*, against adults of *Blattella germanica* is examined by direct contact application and fumigation methods [25].



### Antioxidant Activity

The antioxygenic activity of star anise and their extracts were evaluated and found to have greater potential as natural oxidant. The phenolic compounds are potent antioxidant [26] and star anise contained higher amount of phenolic (10,025ppm) and flavanoids (5500 ppm) [27,28]. The antioxidant activity (AA) of ethyl acetate extracts of *Illicium verum* were tested in refined peanut oil at  $60 \pm 0.5$  °C. *I. verum* slightly decrease the formation of peroxides in peanut oil as compared with pure oil. Its antioxidant properties was confirmed using other antioxidant properties such as ferric thiocyanate method in linoleic acid system reducing power and scavenging effect (%) on 1,1-diphenyl-2-picryl hydrazyl radical(DPPH) radical [29].

### Antifungal Activity

There are many synthetic drugs that can cure fungal infection, but herbal drugs are needed to be discovered using natural resources. The essential oil of *Illicium verum* strongly inhibited the mycelial growth of both *B. cinerea* and *C. gloeosporioides* by over 90%. Gas chromatography-mass spectrometry and bioassay indicated trans-anethole in *I. verum* and as a major antifungal

constituent [30]. Dermatophyte fungi are the main agents of skin diseases of man, *I. verum* fruit extracts have high antifungal properties. The *I. verum* extract at a concentration of 4mg/ml inhibited the growth of *E. flucosum* and *T. mentagrophytes*. The extracts of *I. verum* at 16 mg/ml controlled dermatophyte fungi. The *I. verum* fruits extract inhibited growth of *A.niger*, one of the most important saprophytic funguses known to be associated with mycotoxin production in agricultural products and foods, at 16 mg/ml [31].

### Claims and Reports

- Elisabeth Fritz, silvesterM.olazan Reinhard Langer (2008), showed anatomical characters and value of differentiation between *Illicium verum* hook.f and *illicium anisatum*.L by means of light microscopy, fluorescence microscopy, SEM and confocal laser scanning microscopy. The presence of hexagonal crystal serves as an indicator for sample of *I.anisatum*. [10]
- Dang Quoc Tuan and Sarath G. Ilangan Tileke (1997) performed liquid Co<sub>2</sub> extract of essential oil from star anise fruits *illicium verum*. The extraction with liquid Co<sub>2</sub> yielded 9.8% more essential oil than steam distillation [13].
- Yan jian Hui and xiao xu-xian, (2002) performed component analysis of volatile oil from *Illicium verum* Hook fruit. The volatile oil extracted by using steam distillation and 41 compounds were separated and analyzed by GC-MS. It was found that it contains 14 hydrocarbon and 22 oxygenated hydrocarbon derivatives and small amount of nitrogenous compounds [16].
- Wang Qin, Jiang Lin and Wen Qibion, (2007), performed extraction on *Illicium verum* by three methods i.e., steam distillation, solvent extraction and supercritical fluids extraction. It is reported that products revealed from SFE and SE are more natural than that obtain from SD [17].
- The structure elucidation of new phenylpropanoid glucosides ,known phenyl propanoid , alkyl glucosides was performed by Sung –won lee, Gaoli,Kyong sun lee(2003) on basis of spectroscopic studies. The MeOH extract of the fruits of *I. verum* was partitioned with n-hexane, EtOAc, n-BuOH and H<sub>2</sub>O, successively, which were then dried. The n-BuOH fraction was chromatographed on Silica-gel column. A major fraction from this column was rechromatographed on a reverse-phase column, which afforded compounds 1-3 [18].
- Lai-King SY and Geoffrey D.Brown (1997) reported the new compound Seco-Cycloartane;3,4-seco(242)-cycloartane-4(28),24(diene)3,26-dioicacid.26,methylester of nigranoic acid from the dichloromethane extract from leaves of *illicium verum* [19].
- Hiroki ohina and Naotatori (2009), separated shikimic acid from Chinese star anise with hot water extraction at temperature of 120°c or higher to obtain 100% recoveries [20].
- Khesorn Manthachit, M.S (2002), reported antimicrobial activity of fruits of *Illicium verum* hook [23].
- Shukla, S.P Tripathi and M.K Chaubey (2009) reported toxicity of *Myristica Frarans* and *Illicium verum* essential oils against flour beetle *Tribolium castaneum* Herbst [24].
- Kyu-sik chang professor young joon ahn, reported fumigant activity of (E)-anethole identified in *Illicium verum* fruit against *blattela Germanica* [25].
- A.Padamshree N.Roopa, A.D semval, G.K.sharma, G.Agathian, A.S.Bawa, reported Star anise & black caraway as natural oxidants [26].
- Pan Ying wing and Liang ying (2004) reported antioxidant activities of several Chinese medicine herbs. The ethyl acetate extract of *Illicium verum* was tested in refined peanut oil at 60± 0.5°c and found slight decrease in the formation of peroxides in peanut oil as compared with pure oil [28].

- Gurdip Singh and Maurya Sumitra (2006) reported chemical constituents, antimicrobial and antioxidant potential of volatile oil and acetone extract of star anise fruits. The volatile oil completely inhibited the growth of *fusarium moniliforme* at 6µl dose using food poison technique, the volatile oil was found to be effective in controlling growth of *f.moniliforme* and *Aspergillus Niger* and its extract against *Aspergillus flavns*. It also shows *staphylococcus aureus* and *bacillus cereus*. Its antioxidant properties was confirmed using other antioxidant properties such as ferric thiocyanate method in linoleic acid system reducing power and scavenging effect (%) on 1,1-diphenyl-2- picryl hydrazyl radical(DPPH) radical [29].
- Lee SO Park IK, Choi GJ, Lim HK, Jang KS, Cho KY, Shin SC, Kim JC (2007) reported fumigant activity of essential oils and components of *Illicium verum* and *Schizonepeta tenuifolia* against *Botrytis cinerea* and *Colletotrichum gloeosporioides* [30].
- Yazdani D, Rezazadeh Sh, Amin Gh, Zainal Abidin, Shahnazi S, Jamalifar H (2009) reported antifungal activity of dried extracts of anise (*Pimpinella anisum* L.) and Star anise (*Illicium verum* Hook. f.) against Dermatophyte and Saprophyte Fungi [31].

### CONCLUSION

In the present article, the relevant literature is revived to congregate the ethno –botanical, phytochemical and pharmacological information on *Illicium verum* hook. A survey of literature revealed that the plant has potent antibacterial, anti fungal, antioxidant activity while literature revealed the presence of shikmic acid as a precursor of Tami flu, anethole, limonene, linoleic acid, anisylacetone, anisaldehyde, foeniculin and palmitic acid and presence of seco-cycloartane in leaves. The medicinal application of this plant for investigation still remains in relatively newer areas of its function. Thus for being successful in ayurvedic medicine, more clinical trial and novel drug delivery system must be developed to improve its therapeutic benefits.

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