Pharmacogn. Commn. 2021;11(1):31-35.
A multifaceted peer reviewed journal in the field of Pharmacognosy and Natural Products
www.phcogcommn.org

Review Article

Survey on Chemical Constituent, Traditional and Modern Pharmaceutical and Health Benefits of Chinese Star Anise, a Treasure from the East

Mohamad Hesam Shahrajabian[1], Wenli Sun[1], Qi Cheng[1,2,*]
[1]Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, Beijing, CHINA.
[2]College of Life Sciences, Hebei Agricultural University, Global Alliance of HeBAU-CLS & HeQiS for BioAl-Manufacturing, Baoding, Hebei, CHINA.

ABSTRACT

Introduction: Star anise has traditional usages and multiple applications in botany, chemistry, pharmacology and therapy. Chinese star anise has antioxidant, antibacterial, fungicidal, anti-inflammatory, anesthetic and anti-nociceptive effects. **Methods:** A literature search was conducted in Medline, PubMed, Science direct and Google scholar databases. **Results:** The seeds are good source of the minerals calcium, iron, copper, potassium, manganese, zinc and magnesium. The seeds are also a good source of the essential B-complex vitamins pyridoxine, niacin, riboflavin and thiamin. Chinese star anise is also a good source of anti-oxidant vitamins including Vitamin-C and Vitamin-A. The essential oil of Chinese star anise contains anethole which has shown several functional properties including antimicrobial, antioxidant, hypoglycemic, hypolipidemic and oestrogenic properties. Chinese star anise also contains shikimic acid, which has become a major weapon against global influenza. Moreover, it contains bioactive compounds possessing insecticidal properties which can be used as natural grain protectants. The most important compounds of Chinese star anise are α-pinene, β-pinene, myrcene, α-phellandrene, 3-carene, α-terpinene, p-cymene, limonene, trans-ocimene, cis-β-ocimene, γ-terpinene, terpinolene, linalool, γ-terpineol, 4-terpineol, α-terpineol, estragole, cis-anethole, trans-anethole, α-cubebene, β-clemene, caryophyllene, bergamotene, Δ-cardinene and α-cadinol. **Conclusion:** The most important properties which have been reported for star anise is carminative, antifungal, antibacterial, analgesic, sedative, anticarcinogenic and antioxidant. Usage of Chinese star anise can provide industrial sustainability and could be considered as both organic food and medicine in both East and West.

Key words: Traditional Health Benefits, Modern Pharmaceutical Benefits, Antioxidant, Estragole.

Correspondence:
Dr. Qi Cheng
[1]Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, Beijing-100081, CHINA.
[2]College of Life Sciences, Hebei Agricultural University, Global Alliance of HeBAU-CLS&HeQiS for BioAl-Manufacturing, Baoding, Hebei-071000, CHINA.
Phone no: +86-13051039294
E-mail: chengqi@caas.cn
DOI: 10.5530/pc.2021.1.7

INTRODUCTION

Botany and Plant Description of Chinese Star Anise

Traditional Chinese medicines consider as both medicine and food item, because most of Chinese medicine are used as pigments and flavors in the preparation of Chinese food items.[1-16] Star anise is a medium-sized evergreen tree which is native to southwest of China. It is widely cultivated in subtropical and tropical areas of Asia.[17] Its common name has many synonyms in different areas: Chinese star anise or Bajiaohuixiang in China; Anis de la Chine, Anise etoile or Badiane in France; Dai-uikyo or Hakkaku-uikyo in Japan; Sternanis in Germany; Anicestellato in Italy; Sonf or Anasphal in India; Anis estrellado in Spain; Bunga lawing in Indonesia and Malaysia.[18] Chinese star anise is one of the flavors used in China five spices.[19] In traditional Chinese medicine, it is known as warming yang for dispelling cold, as well as regulating the flow of Qi to relieve pain or common cold.[18] The crude fruits and its powders were used in traditional teas to treat nervousness and sleeplessness and also as a sedative.[18] Dried ripe, star anise fruit and seed are used as important spice in Asian cooking especially in Chinese, Vietnamese and Indian cuisines. Vietnam produces more than 5000 tonne of star anise seeds per annum and it is estimated that the combined production of China and Vietnam is more than 25,000 tonne per annum. Moreover, 200-250 tonne of essential oil is shipped to France and the Czech Republic annually. Wang *et al.*[18] found that star anise has long been used in traditional Chinese medicine and the food industry with the effects of dispelling cold, regulating the flow of Qi and relieving pain. Chinese star anise, together with the morphological similar Japanese star anise (*Illicium anisatum*), is also used for decoration purposes.[20,21] This plant also has been reported to possess anti-bacterial, anti-cancer and of course anti-inflammatory characteristics.[22] Kang *et al.*[23] noted that Chinese anise star can alleviate inflammatory responses and is a common flavor in medicinal tea, cough mixtures and pastilles. Star anise is classified in the division Magnoliohpyta, class Magnoliopsida, sub-class Magnoliidae, order Austrobaileyales, family Illiciaceae. Chinese star anise is used as a remedy to treat infant colic. Japanese star anise, *Illicium anisatum* (Schisandraceae) is an evergreen broad-leaved tree or shrub that exhibits ballochory. The plant is widely distributed in the central and southern parts of the Japanese archipelago.[24] Japanese star anise looks very similar to Chinese star anise in its dried form but that is where the similarity ends. The Japanese star anise is extremely toxic and is not edible in any form. Recently, concern has been raised regarding adulteration of Chinese star anise with Japanese star anise.[25] Howes *et al.*[26] explained that the volatiles desorbed from the pericarps of the toxic Japanese star anise were characterized by the presence of asaricin, methoxyeugenol and two other eugenol derivatives, none of which were detected in any other species examined. Star anise is a medium sized tree, 8-15 m tall and 30 cm depth, with the bark which is white to bright grey. Furthermore, its leaves are 6-12 cm long, alternate, simple, leathery, entire, glabrous, shining, usually crowded in bundles at the end of the branches. It has large bisexual flowers, 1-1.5 cm in diameter, white pink to red or greenish yellow in colour, axillary and solitary. The fruit is capsule like, aggregate andstar shaped; each arm of which is a seed pod. In China, star anise is frequently used as spice in Chinese cuisine. Guangxi followed by Guangdong, Yunnan and Fujian are the original and main production

regions of star anise in China, accounting for more than 85% of the total average of star anise in China.[27] Estragole (4-allyl anisole, 1-methoxy-4-enylbenzene) is a naturally occuring compound which can be extracted from anise and Chinese star anise; flavors and fradrances containing estragole are used in food products, perfumes, soaps and detergents.[28] (E)-anethole, limonene, linalook and α-pinene are major components of the essential oil of *I. verum*. Star anise is socially accepted in occasions and is traditionally being used in high altitude regions of Arunachal Pradesh where dried seedless fruits are used as incense, flavouring tea, preparation of butter salted tea or sugar tea for sweet fragrance and to increase and improve the potency and strength of alcohol.[29] It is also used as a medicine to cure cough, toothache and sinusitis, used as an anti-fungal agent and food preservative.[30,31] Gholivand *et al*.[32] reported that the dried star anise fruit contains 49 compounds including trans-anethole (81.40%), limoene (6.50%), chavicol (2.10%) and also anisaldehyde (1.81%). It is primarily located in the woody shell and to a lesser extent in the seed. Anethole is only slightly soluble in water but exhibits high solubility in ethanol. It is 13 times sweeter than sugar. Parsa *et al*.[33] reported that Chinese star anise is used extensively in both the Indian diet and medicine because it does not have any adverse influence and is also readily absorbed. They have also found that the oil of star anise is a stimulant, stomachic, carminative and is mildy expectorant and diuretic. The fruit of the plant has been used in traditional medicine for treatment of stomach aches, vomiting, rheumatic pain, insomnia and skin inflammation.[34] Its fruit is an important traditional Chinese medicine as well as a commonly used spice.[35,36] Zhang *et al*.[37] showed that trans-anethole, p-anisaldeyde, farnesol and estragole are main aroma compounds of Chinese star anise. They have also shown that 47 compounds accounted for more than 90% in total Chinese star anise aroma molecules, including trans-anethole (75.76%), p-anisaldehyde (8.65%), estragole (4.70%), farnesol (3.26%), limonene (1.01%), linalool (1.44%), caryophyllene (1.03%) and 4′-methoxypropiophenone (0.72%). The crude extract of Chinese star anise can be applied as an optional control of house fly at breeding sites. Classification of Chinese star anise is shown in Table 1. Vernacular and common English names of Chinese star anise are presented in Table 2.

Evidence indicate that anethole is natural bioactive compound with multiple beneficial effects in human health such as anti-inflammatory, anticancer, chemo preventive, neuroprotective, spasmolytic, hypotensive, antithrombotic, immunomodulatory and antidiabetic. Domiciano *et al*.[38] found that the anethole may be effective in controlling some non-immune acute inflammation-related disease, probably by an inhibitory action on production or release of PGE2 and NO. Wei *et al*.[39] suggested that *I. verum* fruit extracts and trans-anethole can potentially be developed as a grain protectant to control stored-product insect pests. Zhou *et al*.[40] Suggested that *I. verum* extracts have potential as an eco-friendly biopesticide in integrated pest management against *M. persicae*.

Table 1: Classification of Chinese star anise.

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Austrobaileyales
Family	*Illiciaceae*
Genus	Illicium
Species	Verum

Table 2: Vernacular and common English names of Chinese star anise.

Common English names	Badian Star Anise, Chinese Aniseed, Chinese Anise, Chinese Star Anise, Indian Anise, Star Anise, Star Aniseed, True Star Anise
Chinese	Ba Jiao, Ba Jiao Hui Xiang, Da Hui Xiang (Mandarin); Bat Gok, Bart Gok, Pa-Chiao, Pak Kok (Cantonese), PehKah (Hokien)
Hindi	Anasphal, BadiyanKhatala
Kannada	Kankola
Malayalam	Takkolappultil, Takkolappottil
Sanskrit	Takkolakum
Tamil	Anusappu, Anusuppu
Telugu	Kuppi, Anasapuveru
Danish	Stjerne anis
Dutch	Adas China, Sternijs
French	Anis delachine
German	Sternanis
Italian	Anicestellato
Spanish	Anis estrallado
Indonesian	Bunga lawang
Malaysia	Bunga Lawang
Arab	Raziyanjekhatai
Persian	Badian-i-khatai

Table 3: Economic and medicinal importance of Chinese star anise.

1.	The anti-bacterial and anti-fungal properties of Chinese star anise are useful in the treatment of diseases like asthma, bronchitis and dry cough.
2.	Chinese star anise can also be used as for its sedating properties to secure a good sleep.
3.	Its oils are appropriate in providing relief from rheumatism and lower back pain.
4.	It can also be used as a natural breath freshener.
5.	There is a compound present in Chinese star anise which is called Shikimic acid and it is used for preparing drug for curing influenza or the flu virus.
6.	Another important compound present in Chinese star anise which contains anti-oxidants properties is Linalool and it is good for overall health.
7.	The chemical compounds which derived from this important herb also have anti-oxidant, disease preventing and health promoting properties.
8.	Anethole is the most important compounds in this herb, but other important compounds found in the seeds include extragol, p-anisaldehyde, anise alcohol, acetophenone, pinene and limonene.
9.	In traditional Chinese and Asian medicine, it mainly uses as stomachic, anti-septic, anti-spasmodic, carminative, digestive, expectorant, stimulant and tonic.
10.	The seeds are excellent source of many essential B-complex vitamins such as pyridoxine, niacin, riboflavin and thiamin.
11.	Seeds are also great source of minerals like calcium, iron, copper, potassium, manganese, zinc and magnesium.
12.	This important spice is also contain good amounts of anti-oxidant vitamins such as vitamin-C and Vitamin-A.

Modern Medicinal Usage of Star Anise

One of the most important character of *I. verum* is a digestive aid which may make the nursing mothers promote breast milk production, has the anti-bacterial and anti-fungal affection of asthma, bronchitis and dry cough, refreshed the breath and ensuresgood sleep.[41] Fagundes *et al.*[42] Concluded that anethole in the essential oil of *I. verum* Hook can be identified and determined by GC-MS, NMR and UV-VIS and a superior HPLC method has been developed for the determination of the compound in rat plasma. The content of trans-anethole was the highest (75.76%), followed by linalool (1.44%), limonene (1.01%) and 4'-methoxypropiophenone (0.72%) were the lowest. Bhatti *et al.*[43] Concluded that the protocatechuic acid [1] residing in *I. verum* most probably underlies its antioxidant action. Star anise volatile oil could be applied in different industries including cosmetic, pharmaceutical or food industries; in the latter it might replace the synthetic antioxidant used nowadays in order to overcome the adverse influence of the synthetic additives on the public health. The economic and medicinal importance of Chinese star anise is summarized in Table 3.

I. verum has been reported to possess antioxidant properties as well as significant anticancer potential. Antioxidant properties may be recommended in enhancing shelf life of products such as spices. Natural antioxidants are known to protect cells from damage induced by oxidative stress, which is generally considered to be a cause of ageing, degenerative disease and cancer.[44] Dinesha *et al.*[45] concluded that the extracts of star anise exhibited effective prevention ability against H_2O_2 induced cell death and DNA protection and these activities of extracts may due to the presence of polyphenols, proteins and flavonoids in star anise extracts. Shu *et al.*[46] discovered that star anise polysaccharides could inhibit the growth of Sarcoma 180 tumor *in vivo*. The tumor inhibition ratio of high dose polysaccharides (720 mg/kg) was 30.92%. Kanatt *et al.*[47] Reported that star anise extract exhibit high reducing power indicating good antioxidant potential and antioxidant potential of star anise extract was better than lemon grass extract and the extracts were able to protect against radiation induced DNA damage in pBR322 plasmid. *I. verum* extract may contribute for development of phytotherapic products that could be more cost effective, safer and more accessible and provide a lower risk of resistance than conventional therapeutic drugs[48]. Ritter *et al.*[49] also found that anethole which has been found in both star anise and anise exerts a peripheral antinociceptive effect without causing sedation. They did propose anethole as an interesting therapeutic alternative in inflammatory and painful diseases. Huang *et al.*[50] Indicated that the cellulase-ultrasonic assisted extraction technology has the potential be used for the industrial production of flavonoids from *I. verum*. They proposed that the combination of chamomile and star anise can be used as an alternative anti-diarrheal treatment. Yadav and Bhatnagar[51] indicate that the treatment with star anise rescues the tumor burden, lowers oxidative stress and increases the level of phase II enzymes, which may contribute to its anti-carcinogenic. Both the essential oil from Chinese star anise fruit and trans-anethole are major constituents and exhibit potent inhibitory effect against all test fungi indicating that most of the observed anti-fungal properties was due to the presence of trans-anethole in the oil, which could be developed as natural fungicides for plant disease control in fruit and vegetable preservation.[52]

CONCLUSION

Aromatic and medicinal plants are gifts of nature which have been used against different diseases since the beginning of the history. Star anise (*Illicium verum* Hook. f.) is one of the most famous evergreen trees, which was originally distributed in tropic and subtropic areas of Asia, especially China and it is famous for its use in traditional Chinese medicine as well as traditional Asian medicine. Its fruit is also commonly used as a spice. The fruit is aromatic and has a strong, pungent and mildly sweet taste. Chinese star anise together with the morphological similar Japanese star anise together with the morphologically similar Japanese star anise (*Illicium anisatum*), is also used for decoration purposes. The Japanese star anise is extremely toxic and is not edible in any form. It has been reported that (E)-Anethole, limonene, linalool and α-pinene are major components of the essential oil of *I. verum*. The most important compounds of Chinese star anise are α-Pinene, β-Pinene, Myrcene, α-Phellandrene, 3-Carene, α-Terpinene, p-Cymene, Limonene, Trans-Ocimene, Cis-β-Ocimene, γ-Terpinene, Terpinolene, Linalool, γ-Terpineol, 4-Terpineol, α-Terpineol, Estragole, Cis-Anethole, Trans-Anethole, α-Cubebene, β-Clemene, Caryophyllene, Bergamotene, Δ-Cardinene and α-Cadinol. Star anise is one of the many species that contain bioactive compounds as well as a number of phenolic and flavonoid compounds, having antioxidant, preservative and antimicrobial properties. Star anise considered as the main source of shikimic acid, which is the most important ingredient of Tamiflu drug. Chinese star anise has anti-bacterial and anti-fungal characters and it is useful in treatment of diseases like asthma, bronchitis and dry cough, it is also good to having a good sleep; it is a natural breath fresher, one of its most compounds is Shikimic which is used as a drug in curing influenza and flu virus; it consists of Linalool which is good for overall health because of its antioxidants characters. Its seeds are good source of minerals like calcium, iron, copper, potassium, manganese, zinc and magnesium. The essential oil of Chinese star anise contains anethole which has shown several functional properties including antimicrobial, antioxidant, hypoglycemic, hypolipidemic and oestrogenic properties. Star anise primarily contains anethole and fatty oil; its essential oil has a sweetish, burning flavor and a highly aromatic odor.

ACKNOWLEDGEMENT

This research was supported by the National Key R&D Program of China (Research grant 2019YFA0904700).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

TCM: Traditional Chinese medicine.

REFERENCES

1. Shahrajabian MH, Sun W, Cheng Q. A review of goji berry (*Lycium barbarum*) in traditional Chinese medicine as a promising organic super food and super fruit in modern industry. Academia Journal of Medicinal Plants.2018;6(12):437-45.
2. Shahrajabian MH, Sun W, Chen Q. The power of natural Chinese medicine, ginger and ginseng root in an organic life. Middle-East Journal of Scientific Research. 2019;27(1):64-71.
3. Shahrajabian MH, Sun W, Cheng Q. Clinical aspects and health benefits of ginger (*Zingiber officinale*) in both traditional Chinese medicine and modern industry. Acta Agriculturae Scandinavica, Section B- Soil and Plant Science. 2019;1-11.
4. Shahrajabian MH, Sun W, Cheng Q. Traditional Chinese medicine and agriculture; organic life and sustainability for future. GSC Biological and Pharmaceutical Sciences. 2019;7(01):091-5.
5. Shahrajabian MH, Sun W, Cheng Q. A review of ginseng species in different regions as a multipurpose herb in traditional Chinese medicine, modern herbology and pharmacological science. Journal of Medicinal Plants Research. 2019;13(10):213-26.
6. Shahrajabian MH, Sun W, Cheng Q. A short review of goji berry, ginseng and astragalus in traditional Chinese and Asian medicine. Black Sea Journal of Health Science. 2020;3(2).
7. Shahrajabian MH, Sun W, Cheng Q. Rambutan, a tropical plant with ethno-pharmaceutical properties. Agrociencia. 2020;54(1):121-8.
8. Shahrajabian MH, Sun W, Shen H, Cheng Q. Chinese herbal medicine for SARS and SARS-CoV-2 treatment and prevention, encouraging using herbal medicine for COVID-19 outbreak. Acta Agriculturae Scandinavica, Section B- Soil and

Science. 2020;1-7. DOI: 10.1080/09064710.2020.1763448
9. Shahrajabian MH, Sun W, Cheng Q. Chinese star anise (*Illicium verum*) and pyrethrum (*Chrysanthemum cinerariifolium*) as natural alternatives for organic farming and health care: A review. Australian Journal of Crop Science. 2020;14(03):517-23.
10. Sun W, Shahrajabian MH, Cheng Q. The insight and survey on medicinal properties and nutritive components of shallot. Journal of Medicinal Plant Research. 2019;13(18):452-7.
11. Sun W, Shahrajabian MH, Cheng Q. Anise (*Pimpinella anisum* l.), a dominant spice and traditional medicinal herb for both food and medicinal purposes. Cogent Biology. 2019;5(1673688):1-25.
12. Sun W, Shahrajabian MH, Cheng Q. Traditional Iranian and Arabic herbal medicines as natural anti-cancer drugs. Agrociencia. 2020;54(1):129-42.
13. Sun W, Shahrajabian MH, Khoshkharam M, Cheng Q. Adaptation of acupuncture and traditional Chinese herbal medicines because of climate change. Journal of Stress Physiology and Biochemistry. 2020;16(1):85-90.
14. Ogbaji PO, Li J, Xue X, Shahrajabian MH, Egrinya E. Impact of bio-fertilizer or nutrient on Spniach (*Spinacea Oleracea*) growth and yield in some province soils of PR. China. Cercetari Agronomics in Moldova. 2018;2(174):43-52.
15. Soleymani A, Shahrajabian MH. Responses of different cultivars of fennel (*Foeniculum vulgare*) to irrigation and planting dates in Isfahan, Iran. Research on Crops. 2012;13(2):656-60.
16. Soleymani A, Shahrajabian MH. Changes in germiantion and seedling growth of different cultivars of cumin to drought stress. Cercetari Agronomics in Moldova. 2018;1(173):91-100.
17. Elmasry TA, Al-Shaalan NH, Tousson E, El-Morshedy K, Al-Ghadeer A. Star anise extracts modulation of reproductive parameters, fertility potential and DNA fragmentation induced by growth promoter Equigan in rat tests. Brazilian Journal of Pharmaceutical Sciences. 2018;54 (1):e17261.
18. Wang GW, Hu WT, Huang BK, Qin LP. *Illicium verum*: A review on its botany, traditional use, chemistry and pharmacology. J. Ethnopharmacol. 2011;136(1):10-20.
19. Acimovic M, Stankovic J, Cvetkovic M, Kiprovski B, Popovic A. Comparative analysis of chemical composition of essential oils from aniseed (*Pimpinella anisum L.*) and star anise (*Illicium verum Hook.*). Annals of Agronomy. 2017;41:9-15.
20. Shen Y, Beek TAV, Claassen FW, Zuilhof H, Chen B, Nielen MWF. Rapid control of Chinese star anise fruits and teas for neurotoxic anisatin by driect analysis in real time high resolution mass spectrometry. Journal of Chromatography. 2012;1259:179-86.
21. Yan JH, Xiao XX, Huang KL. Component analysis of volatile oil from *Illicium Verum Hook*. f. Journal of Central South University of Technology. 2002;9(3):173-6.
22. Yang JF, Yang CH, Chang HW, Yang CS, Wang SM, Hsieh MC, *et al*. Chemical composition and antibacterial activities of *Illicium verum* against antibiotic-resistant pathogens. Journal of Medicianl Food. 2010;13(5):1254-62.
23. Kang P, Kim KY, Lee HS, Min SS, Seol GH. Anit-inflammatory effects of anethole in lipopolysaccharide-induced acute lung injury in mice. Life Science. 2013;93(24):955-61.
24. Yoshikawa T, Masaki T, Motooka M, Hino D, Ueda K. Highly toxic seeds of the Japanese star anise (*Illicium anisatum*) are the dispersed by a seed-caching bird and a rodent. Ecol Res. 2018;33(2):495-504.
25. Scharge M, Shen Y, Claassen FW, Zuilhof H, Nielen MWF, Chen B, *et al*. Rapid and simple neurotoxin-based distinction of Chinese and Japanese star anise by direct plant spray mass spectrometry. Journal of Chromatography. 2013;1317:246-53.
26. Howes MJR, Kite GC, Simmonds MSJ. Distinguishing Chinese star anise from Japanese star anise using thermal desorption-gas chromatography-mass spectrometry. Journal of Agricultural and Food Chemistry. 2009;57(13):5783-9.
27. Ma J, Zeng X, Li K, Deng L, Huang K. Status quo and development strategy of star anise industry in Guangxi. Guangxi for Sci. 2011;40:336-9.
28. Ismaiel OA, Abdelghani E, Mousa H, Eldahmy SI, Bayoumy BE. Determination of estragole in pharmaceutical products, herbal teas and herbal extracts using GC-FID. Journal of Applied Pharmaceutical Science. 2016;6(12):144-50.
29. Mukhia PB. Manageemnt guidelines for *Illicium griffithii* for Community Forests of Bhutan, SFD, Thimphu, Bhutan. 2006.
30. Angami T, Bhagawati R, Khatri N. Star anise (*Illicium Griffithii Hook*. F. and *Thomas*.): A socially important tree species from high altitude region of Arunachal Pradesh. Indian Forester. 2017;143(4):309-91.
31. Dana C, Wej C. Essential oils as potential adulticides against two populations of *Aedes aegypti*, the laboratory and natural field stains, in Chiang Mai province, northern Thailans. Parasitology Research. 2006;99(6):715-21.
32. Gholivand MBM, Rahimi-Nasrabadi M, Chalabi H. Determination of essential oil components of star anise (*Illicium verum*) using simultaneous hydrodistillation-rice headspace liquid-phase microextraction-gas chromatography mass spectrometry. Anal Lett. 2019;42(10):1382-97.
33. Parasa LS, Tumati SR, Prasad CS, Kumar LCA. *In vitro* antibacterial acitivity of culinary spices aniseed, star anise and cinnamon against bacterial pathogens of fish. International Journal of Pharmacy and Pharmaceutical Sciences. 2012;4(3):667-70.
34. Park SH, Sung YY, Nho KJ, Kim HK. Protective activity ethanol extract of the fruits of *Illicium verum* against atherogenesis in apolipoprotein E knockout mice. BMC Complementary and Alternative Medicine. 2015;15(1):232.
35. Aly SE, Dabry BA, Shaheen MS, Hathout AS. Assessment of antimycotoxigenic and antioxidant activity of star anise (*Illicium verum*) in vitro. Journal of the Saudi Society of Agricultural Sciences. 2014. http://dx.doi.org/10.1016/j.jssas.2014.05.003
36. Mathon C, Bongard B, Duret M, Ortelli D, Christen P, Bieri S. Analysis of the neurotoxin anisatin star anise by LC-MS/MS. Food Additives and Contaminants. 2013;30(9):1598-605.
37. Zhang W, Zhang Y, Yuan X, Sun E. Determination of volatile compounds of *Illicum verum* Hook. f. using simultenous distillation-extraction and solid phase microextraction coupled with gad chromatography-mass spectrometry. Tropical Journal of Pharmaceutical Research. 2015;14(10):1879-84.
38. Domiciano TP, DeOliveria DMM, Silva EL, Ritter AMV, Estevao-Silva CF, Ramos FS, *et al*. Inhibitory effect of anethole in nonimmune acute inflammation. Naunyn-Schmiedeberg·s Arch Pharmacol. 2013;386(4):331-8.
39. Wei L, Hua R, Li M, Huang Y, Li S, He Y, *et al*. Chemical composition and biological activity of star anise *Illicium verum* extracts against maize weevil, *Sitophilus zeamais* adults. Journal of Insect Science. 2014;14(80):1-13.
40. Zhou BG, Wang S, Dou TT, Liu S, Li MY, Hua RM, *et al*. Aphicidal activity of *Illiumverum* fruit extracts and their effects on the acetylcholinesterase and glutathione S-transferases activities in *Myzuspersicae* (Hemiptera: Aphididae). Journal of Insect Science. 2016;16(1):1-7.
41. Ashraf MA, Maah MJ, Yusoff I. Assessment of phytoextraction efficiency of naturally growth plant species in the former tin mining cathcment. Fresenius Environ Bull. 2012;21(3):523-33.
42. Fagundes VHV, Pinho RJ, Wiirzler LAM, Kimura E, Bersani-Amado CA, Cuman RKN. High performance liquid chromatography method for the determination of anethole in rat plasma. Tropical Journal of Pharmaceutical Research. 2014;13(5):793-9.
43. Bhatti HA, Khan S, Faizi S, Abbas G, Ali I, Jawaid S, *et al*. Protocatecheuic acid underlies the antioxidant activity exhibited by *Illicium verum* fruit. Journal of Analytical and Pharmaceutical Research. 2017;6(3):00177.
44. Ringman M, Frautschy A, Cole M, Masterman L, Cummings L. Potential role of the curry spice curcumin in Alzheimer ·s disease. Curr Alzheimers Res. 2005;2(2):131-6.
45. Dinesha R, Thammannagowda SS, Shwetha KL, Prabhu MSL, Leela S. The antioxidant and DNA protectant activities of Star Anise (*Illicium verum*) aqueous extracts. Journal of Pharmacognosy and Phytochemistry. 2014;2(5):98-103.
46. Shu X, Liu XM, Fu CL, Liang QX. Extraction, characterization and antitumor effect of the polysaccharides from star anise *Illicium verum* (Hook f). Journal of Medicinal Plants Research. 2010;4(24):2666-73.
47. Kanatt SR, Chawla SP, Sharma A. Antioxidant and radio-protective activities of lemon grass and star anise extracts. Food Bioscience. 2014;6:24-30.
48. Sri PU, Leelavathi V, Sree NV, Kumar MA. Antihelmenthic and antimicrobial activity of green synthesized silver nanoparticles from *Illicium verum* Hook. F. fruit. IOSR Journal of Pharmacy and Biological Sciences. 2015;10(6):61-5.
49. Ritter AMV, Ames FQ, Otani F, DeOliveria RMW, Cuman RKN, Bersani-Amado CA. Effects of anethole in Nociception experimental models. Hindawi Publishing Corporation, Evidence-Based Complementary and Alternative Medicine. 2014;7. Article ID 345829.
50. Huang D, Zhou X, Si J, Gong X, Wang S. Studies on cellulase-ultrasonic assisted extraction technology for flavonoids from *Illicium verum* residues. Chemistry Central Journal. 2016;10 (56):1-9.Yadav AS, Bhatnagar D. Chemo-preventive effects of star anise in N-nitrosodiethylamine initiated and Phenobarbital promoted hepato-carcinogenesis. Chemico-Biological Interactions. 2007;169(3):207-14.
51. Vecchio MG, Gulati A, Minto C, Lorenzoni G. *Pimpinella Anisum* and *IllicumVerum*: the multifaceted role of anise plants. The Open Agriculture Journal. 2016;10(Suppl 1: M7):81-6.

PICTORIAL ABSTRACT

ABOUT AUTHORS

Dr. Wenli Sun: She is an assistant researcher working on related topics of traditional Chinese medicine, allelopathic influence and sustainable agriculture. She is also working on topics which are related to Biotechnology and Molecular Sciences.

Dr. Mohamad Hesam Shahrajabian: He is a senior researcher of Agronomy and Biotechnology. He is interested in crops and herbs which are related to traditional medicine, especially Chinese and Iranian traditional medicine and crops relating to organic farming and sustainable agriculture.

Prof. Dr. Qi Cheng: He is a professor of Biotechnology and his researches have connected with agrobiotechnology. Precently, he is interested to traditional Chinese medicine and molecular researches.

SUMMARY

- Star anise (*Illicium verum* Hook. f.) is one of the most famous evergreen tree which has originally distributed in tropic and subtropic areas of Asia, especially China.
- The fruit is aromatic and has a strong, pungent and mildly sweet taste. In traditional Chinese medicine and the food industry with the effects of dispelling cold, regulating the flow of Qi, and relieving pain.
- The most important compounds of Chinese star anise are α-Pinene, β-Pinene, Myrcene, α-Phellandrene, 3-Carene, α-Terpinene, p-Cymene, Limonene, Trans-Ocimene, Cis-β-Ocimene, γ-Terpinene, Terpinolene, Linalool, γ-Terpineol, 4-Terpineol, α-Terpineol, Estragole, Cis-Anethole, Trans-Anethole, α-Cubebene, β-Clemene, Caryophyllene, Bergamotene, Δ-Cardinene, and α-Cadinol.
- Star anise is one of the many species that contain bioactive compounds as well as a number of phenolic and flavonoid compounds, having antioxidant, preservative and antimicrobial properties.
- Star anise considered as the main source of shikimic acid, which is the most important ingredient of Tamiflu drug.
- Chinese star anise has anti-bacterial and anti-fungal characters, and it is useful in treatment of diseases like asthma, bronchitis and dry cough, it is also good to having a good sleep.
- Its seeds are good source of minerals like calcium, iron, copper, potassium, manganese, zinc, and magnesium.
- The seeds are a great source of essential B-complex vitamins such as pyridoxine, niacin, riboflavin and thiamin.
- Chinese star anise is also a good source of anti-oxidant vitamins such as Vitamin-C and Vitamin-A. The essential oil of Chinese star anise contains anethole which has shown several functional properties including antimicrobial, antioxidant, hypoglycemic, hypolipidemic and oestrogenic properties.