Review Article

A Phytopharmacological Review of *Litchi chinensis.*

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ABSTRACT

Litchi chinensis is an evergreen plant member of Sapindaceae family is famous fruit in south east asia. The tree is semitropical, harvest in Southeast Asia, especially in China. Litchi belongs to Soapberry genuses which incorporate 150 subfamily and 2000 species. The flower, fruits and leaves is being used in unani and Ayurvedic medicines. Litchi is one of the principal major fruit possessing various pharmaceutical or pharmacological activities. Various activities has been reported on *Litchi chinensis* – Analgesic, Anti- oxidant and effective against inflammation, diabetes, cancer ,microbial infection, platelet, Hepatoprotective, chest irritability, flatulence, epigastric pain, cardiovascular activity, neurological pain, testicular swelling, cough etc. Seeds, flowers, leaves, pericarp, pulp and fruits are a source of bioactived components. The present review is an effort to consolidate information available on *Litchi chinensis* in the last one decade.

Keywords: *Litchi chinensis*, Anti- oxidant, Anti-inflammatory, Flatulence, epigastric pain.

INTRODUCTION

Litchi (*litchi chinensis sonn.)* is an evergreen plant and a non-climatic subtropical fruit arise from Southeast Asia, belonging to family – Sapindaceae. Ayurveda has acknowledged the opportunity of the medicinal plants to heal different diseases and to foster immunity. There is a need to evaluated herbal drugs technically for their mechanism of action, therapeutic efficacy and side effects. Litchi is one among the principal fruit plants which holds various bioactive compounds. Litchi fruits have sweet taste and rich nutritious value. Litchi fruit is widely recognized by consumers over the world as other subtropical fruit [1]. In conventional Chinese medicine litchi plant leaf has been used for the therapy of heart stroke, flatulence and detoxification. Litchi pericarp tissue contains notable quantity of flavonoids [2]. Flavonoids engaged in vital pharmacological role in treating disease, such as cardiovascular disease, malignancy, inflammation, hypersensitivity, analgesic and anti-pyretic activities, petroleum extract of litchi leaf could inhibit the cyclo-oxygenase pathway of arachidonic acid metabolism rather than inhibiting arachidonic acid include inflammation [3]. The principal source of toxic hepatitis is an oxidative stress which may produce chronic liver disease. Polyphenolic compounds, like anthocyanin, tannins and numerous other ortho-diphenolic compounds, have been recognize recently in Litchi. The investigation of the distinctive polyphenolic contents of litchi for medicinal cause and efficacy in hepatoprotection has been done. Litchi chinensis is a natural source for the development of antiplatelet, anticoagulant and thrombolytic therapeutics for thrombotic and cardiovascular diseases and more research will be encouraged to develop herbal products in the market as the conventional drugs may lead to serious side effects and are costly. [4].

Taxonomical Classification

Kingdom	: Plantae
Order	: Sapindales
Family	: Sapindaceae
Subfamily	: Sapindaceae
Genus	: Litchi
Species	: Chinensis

Morphological Description

Litchi is an evergreen plant having small stout trunk and its height is up to less than 15m tall, sometimes reaching 28m (92ft). Leaves are 10-25cm alternate with 2-4 pair leaflets. Flower are small, yellowish white, bark is grey-black, fruits depends upon variety are ovoid, round and heart shaped up to 5cm long and 4cm wide. Litchi is fresh fruit, fully grown in 80-112 days depending on location, climate and cultivation. Fruits weigh approximately 20g, thin, tough skin is green when immature and on ripening becomes red or pink-red and is smooth or covered with small sharp protuberances roughly surface, freshly aril, and sweet flavor. Fruit is an aril, enclose one dark brown inedible seed, seed is 1-3 .3cm long and 0.6-1.2cm wide. Litchi needs a tropical climate which could be ice free not below -4°C. Presently litchi is cultivated as trade fruit crop in the Central and South America, few parts of Africa, throughout Asia, South Africa (Mauritius, Mclean sRed), Australia (Tai So,

Kwai May Pink, Fay Zee Siu,Souey Tung, Salathiel, Wai Chee),Mauritius, Thailand, Madagascar are now the major litchi originating countries of the world. India is second massive producer of Litchi in the world, after China [5-9].

Nutritional composition

Litchi fruits are characterized as a big seeded fruit, having semi-transparent pulp which is digestible and thin corky pericarp. Litchi fruits are used fresh. Furthermore, many commodities like squash, canned lychee, syrup, cordial, jam, jelly, juice etc. are also accessible in the market. It is also used as dried or dehydrated (lychee nuts) or used in ice-creams. Fruits contain 60% juice, 8% rag, 19% seed and 13% skin on the basis of variety and climate. The fruits contains proteins (0.83g), fats (0.44g), carbohydrates (sugars-15.23g, dietaryfiber-1.3g), minerals (Calcium-5 mg, Iron-0.13 mg, Magnesium-10 g, Manganese- 0.055 mg, Phosphorus-31 mg, Potassium-171 mg, Sodium-1 mg, Zinc-0.07 mg),fibrous matter and carotene. The fruits are also enriched with vitamin (Thiamine (B10 -0.011 mg, Riboflavin (B20- 0.065 mg, Vitamin B6-0.1 mg, Niacin (B3)-0.603 mg, Vitamin C-71.5 mg), Folate (B9)-14 µg. Litchi contains less quantity of lipid and sodium [10, 11].

Traditional uses

Medicinal properties of different parts of *Litchi chinensis for* combating various diseases have its history way back from traditional system of medicine. The Litchi tree is being used for its fruits, leaves and flowers in Ayurvedic and Unani system. The leaves are green, 2-4 leaflets pair and finds its application in reducing inflammations and anti-oxidant activity [12]. Litchi is commercially used for the treatment of hepatoprotective, cardiovascular, cyto-toxicity, anti-cancer, anti-viral, anti-hyperglycemic. There is a regular desire for natural drugs in Pharmaceutical sector. Fruits are used in food industries in various forms like juice or health drink, honey, lipbalm, wine, jam. Locals in China, India, Nepal, Bihar utilize the tree as health drinkas well as an edible fruit in their food.

Phytochemistry

Leaf, root, seed, fruit and pericarp extracts of litchi fruits have been dealt with HPLC and HPTLC followed by the pharmacological investigation. Literature reviews declare various bioactive components studied in different parts of the litchi plants. These compounds have been classified as flavonoids, glycosides, amino acid, phenolic compounds, fatty acids, phenolic aldehyde, monoterpenes and anthocyanin.

Leaves

Leaves are reported for various phytoconstituents such as alkaloids, flavonoids, tannins, terpenoids, saponin, and steroids etc. like flavonoids - Epicatechin, procyanidin A2, and procyanidin B2 which are probably responsible for the anti-diabetic, anti-cancer, anti-oxidant, free radical scavenging activity and reduce blood sugar level [14-22].

Fruits

Flavanol (flavanol -3-ol) rich litchi fruit extract is a mixture of oligomerized polyphenols and also prosperous in Flavanol monomers, dimers and trimmers which are shown suppress inflammation, 5-hydroxymethyl-2-furfurolaldehyde (5- HMF), benzyl alcohol, hydro benzoin, and (+) – catechin [23].

Seeds

Seeds contain various flavonoid, saponin, glycoside like eucocyanidin, cyanidin glycoside and malvidin glycoside[24].

Pericarp

Pericarp contains Epicatechin, dehydrodiepicatechin A, methyl shikimate, ethyl shikimate, isolariciresinol, kaempferol, proanthocyanidin A1, A2, rutin. [25, 26]

Pharmacological Activities

Flower

Antioxidant activity

Yang DJ, Chang YZ et. al. 2012 - The acetone extract of Litchi chinensis flower extract exhibit DPPH radical scavenging activity and suppressing low-density lipoprotein (LDL) oxidation due to the presence of phenolic components. The acetone extract of the flower with remarkable antioxidant potential was suspended in water and sequentially separated with n-hexane, ethyl acetate (EA), and n-butanol. The highest phenolic levels were found in EA portion and the antioxidant potential were subjected to the silica gel column chromatography. (-)-Epicatechin and proanthocyanidin A2 were two principal compounds that could be isolated by semi preparative high-performance liquid chromatography via mass spectroscopy and nuclear magnetic resonance quantification. The study was the first attempt to disclose the efficacy of antioxidant constituents of lychee flower[27].

Cardiovascular activity

Yang DJ, Chang YY et. al. 2010 - Flavonoids, phenols and tannins are present in flower water extract of Litchi (LFWE) Ten male hamsters were selected randomly to one of the subsequent dietary groups: chow diet and normal distilled water (LFCD/NDW), high-fat/cholesterol diet, and normal distilled water. In the gene expressions of the lipid homeostasis in the high-fat/cholesterol-dietary hamsters, LFWE normalized low-density lipoprotein receptor gene expression, decreased sensitivity of FAS gene expression, and increased sensitivity of peroxisome proliferator-activated receptor alpha gene expression. The trolox equivalent antioxidant capacity of the serum was enhanced by LFWE which consequently decreases serum lipid peroxidation malonaldeyhde (MDA) quantity in the elevated-fat/cholesterol-dietary hamsters [28].

Anti-lipase activity

Hwang JY, Lin JT et. al. 2013 - Cytotoxicity of LFAE (Litchi-flower-alcohol extract) against cadmium (Cd) - and lead (Pb)-induced hepatocytotoxicity and TGF-b1 transmit stimulation of hepatic stellate cells (HSCs) were evaluated. Epicatechin, proanthocyanidin A2 and gentisic acid are the prime flavanoid, proanthocyanidin and phenolic acid respectively. LFAE addition could dose dependently decrease the Cd- and Pb-induced lipid peroxidation and DNA fragmentation, and increase the cell viabilities. LFAE can also suppress TGF- b1-induced activation of HSCs as concluded from the downregulating expression of smooth muscle a-actin (aSMA). These results finally demonstrated the effective antioxidant capacity of the lychee flower [29].

Wu YH, Chiu CH et. al. 2013 - The aqueous extract of Litchi chinenesis flower contains anthocyanins, and proanthocyanidins. The study was performed to investigate the anti-lipase activity of 2.5% and 5% of LFWE in hypercaloric diet-induced rats for 10 weeks. In the results, LFWEs showed inhibitory effect on in-vitro lipase activities and were found to reduce the sizes of livers and perirenal and epididymal adipose tissues in 5% LFWE-treated groups. Hypercaloric-diet-fed rats increased the serum cholesterol and the liver lipid levels. However, drinking LFWEs (Litchi-flower-water extract) also decreased these levels so that they were similar to that of control rats. These results correspond to the liver interleukin-1 beta and tumour necrosis factor alpha values, which were ameliorated in hypercaloric-diet-fed the rats with LFWEs. The study concluded that the LFWE possesses a potential nutraceutical for anti-obesity effects[30].

Leaves

Hepatoprotective activity

Basu S, Haldar N et. al. 2012 – The study conducted on methanolic and chloroform leaf extracts of Litchi chinensis for their defensive action against paracetamol-induced hepatotoxicity. The study evaluates the effect of Litchi chinensis on serum biochemical variables serum glutamate-oxaloacetate transaminase, serum glutamate-pyruvate transaminase, serum alkaline phosphatase, total protein, bilirubin, cholesterol, triglycerides and liver biochemical parameters such as the lipid peroxidation, catalase and reduced glutathione. The methanolic and chloroform extracts of Litchi chinensis leaf attempt potential hepatoprotection against paracetamol-induced hepatic injury, normalizing biochemical parameters in the rats plausibly by augmenting endogenous antioxidant defensive mechanisms [31].

Antioxidant activity

Castellain R.C, Gesser M et. al. 2014 - The antioxidant property of the water and organic extracts of the leaves of Litchi chinensis using 2,2'-azinobis (3-ethylbenzothiazoline-6-sulpohonic acid) decolourization assay, the ferric reducing antioxidant power assay,2.2'-diphenyl-1-picrylhydrazil assay, the total phenolic content assay and the total antioxidant activity assay. Parts of Litchi chinensis - Methanolic, butanolic, aqueous, and ethyl acetate fractions showed strong DPPH and peroxyl radicals scavenging activity. The results obtained in the study demonstrated that all parts studied were potential sources of natural antioxidants [32].

Anti-inflammatory and analgesic activity

Chauhan S, Kaur N et. al. 2014 - Analgesic and anti-inflammatory activities was studied in hydro alcohol extract of Litchi chinensis leaves at three different dose levels.The phytochemical investigation of extracts shows the presence of flavonoids, terpenoids, tannins, phenols and saponins. Carrageenan-induced paw edema model was used to investigate anti-inflammatory activity in the rats and acetic acid-induced writhing test and hot plate method was used to investigate the analgesic activity in the mice.

Oral route administration of extract shows a remarkable anti-inflammatory activity and maximum outcome was observed after 4 hour of carrageenan administration. Hot plate model also shows the significant analgesic activity[33].

Pulp

Antioxidant activity

Kong F, Zhang M et. al. 2010 - Antioxidant activities of four different \polysaccharide fractions of Litchi chinensis were evaluated using various in-vitro assays. These four polysaccharide fractions show a dose- dependent free radical scavenging activity as exhibited by their superoxide anion, DPPH radical and hydroxyl radical inhibition, reducing power and chelating ability. LFP-III showed strongest scavenging activity against DPPH radicals among the different fractions. Superoxide hydroxyl radicals and the chelating ability. This study proves the potential of lychee fruit polysaccharides as a useful antioxidant product [34].

Hepatoprotective activity

Bhoopat L, Srichairatanakool S et. al. 2011 - Hepatoprotective activity, vitamin C, antilipidperoxidation & phenolic contents were evaluated on male Wistar rats using *Litchi chinensis* fruit pulp extract. The CC_{l4} was administered intraperitoneally in rats followed by Silymarin (100mg/kg) and *Litchi chinesis* (100mg/kg). Rats were sacrificed post 10 days and livers were selected for histopathological and immunohistochemical estimation. The SGPT, SGOT, & ALP were investigated on the liver followed by apoptotic activity. Antioxidant properties of *Litchi chinensis* were due to the presence of vitamin C and phenolic contents. The antiapoptotic and antilipid peroxidation activity proves the hepatoprotective property of *Litchi chinensis* [35].

Souza M, Singh R et. al. 2006 - The fruit flesh of *Litchi chinensis* extract (alcoholic and aqueous) exhibit

hepatoprotective action in a dosage of 250 mg/kg b.w and 500 mg/kg b.w orally. Liver toxicity induced by CCl4 which generates free radicals. Defensive activity was exhibited by aqueous extract 500 mg/kg in comparison to the standard drug LIV-52. CCl4- induced liver showed an increase in the liver weight because of inhibition of liver triglyceride discharge into the plasma; the extracts might have arrest this blockade, which might have been one of the reasons behind the reduction in liver weight. The protective activity shown may be due to their antioxidant activity of *Litchi chinensis* [36].

Fruit

Aldose reductase activity

Lee SJ, Park WH et. al. 2009 - A powerful inhibition of rat lens aldose reductase was exhibited by *Litchi chinensis* fruit extracts in-vitro in both the methanolic and ethanolic organic fractions. From the active ethanolic fraction, four minor components with multiple structural moieties were isolated and spoted as 2,5 -dihydroxybenzoic acid, D-mannitol, 59-di-O-β-glucopyranoside, delphinidin 3-O-β-galactopyranoside-39 and delphinidin 3-O-β-galactopyranoside-39- O-β-glucopyranoside. Among them, delphinidin 3-O-β-galactopyranoside-39-O-β-glucopyranoside was found to be most powerful RLAR inhibitor and it may be capable in prevention and or treatment of diabetes [37].

Chang YY, Yang DJ et. al. 2013 - Fruits of *Litchi chinensis* bear powerful action to promote the prostaglandin E2 and Nitric oxide growth. The result of effects of hydrobenzoin, benzyl alcohol and 5-hydroxymethyl on PGE2 and NO production were compatible with cyclooxygenase -2 (COX-2) and inducible the nitric oxide synthase (iNOS) messenger RNA expression and the NF-κB was viable molecular mechanism. This study will provide the fundamental constituents details supporting further well-controlled in the in -vivo experiments and mechanisms of action; it also hopes to partly describe the "heating" in traditional Chinese medicine theory [38].

Antiviral activity

Ichinose T, Musyoka TM et. al. 2013 - The study was conducted to find out *Litchi chinensis* phenolic extract Oligonol inhibitory action against Betanodavirus infection in fish cells. Betanodavirus, a member of the family Nodaviridae, is the causative agent of viral nervous necrosis in many species of marine farmed fish. The Oligonol remarkably suppresses the replication of Betanodavirus, as exposed by the depletion of the virus-induced cytopathogenic effect and prevent the cells in the crystal violet staining assay. The study infer that the Oligonol partially suppress the addition of the virion to the cell [39].

Irene PR, Babu DJ et. al. 2012 – Sodium nitrite-induced hypoxia model, passive avoidance model and diazepam-induced amnesia model in mice were used to investigate the Nootropic Activity of the *Litchi chinensis* fruit for both the aqueous and alcoholic extracts. For all the models Piracetam was used as standard drug. Nootropic activity of both extracts were investigated at various dose levels and all the doses showed a notable nootropic result by reduced time spent in the shock area, enlarged step-down latency and a number of mistakes in passive avoidance paradigm. A remarkable rise in inflexion ratio was observed with all doses of extracts in diazepam-induced amnesia model. Both extracts showed a remarkable rise in termination of respiration time in the mice in sodium nitrite intoxication model. Preliminary phytochemical investigation with both the extracts revealed a positive response regarding the exsisting of flavonoids, triterpenes, proteins, carbohydrates, tannins, Vitamin C and amino acids [40].

Anti-inflammatory effect

Yamanishi R, Yoshigai E et. al. 2014 - They have reported that Flavanol rich lychee fruit extract is a combination of oligomerized polyphenols basically obtained from the litchi fruit and is prosperous in Flavanol dimers, monomers and trimers. Adjunct use of Litchi fruit in diet can reduce the tissue damage and inflammation. The effects of Flavanol rich lychee fruit extract and its element on the expression of the interleukin 1b (inflammatory genes) treated the rat hepatocytes were observed. Flavanol rich lychee fruit extract reduce the protein expression and mRNA of the iNOS gene, which cause inhibition of IL- 1b-induced NO production. Flavanol rich lychee fruit extract inhibited the phosphorylation of NF-kB inhibitor and decrease the mRNA extent of NF-kB target gene, TNF-a. The Flavanol may have been accountable for the anti-inflammatory and hepatoprotective action of FRLFE [41].

Pericarp

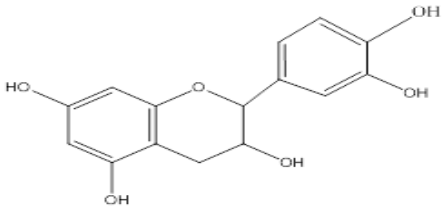
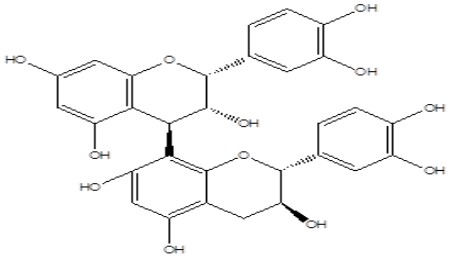
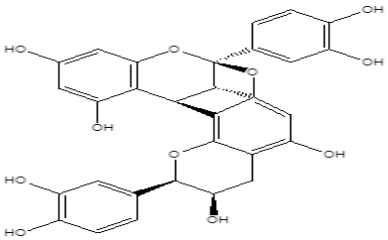
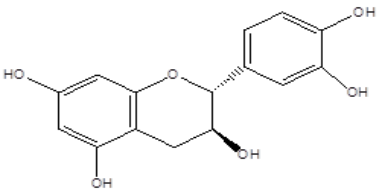
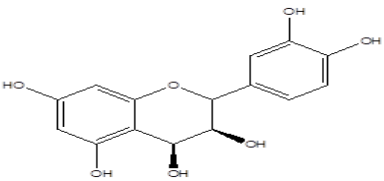
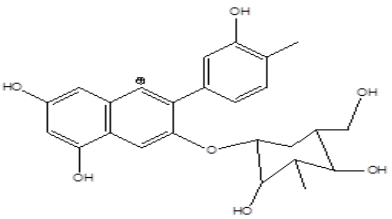
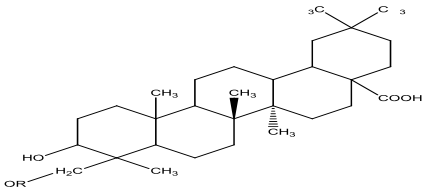
Antimicrobial activity

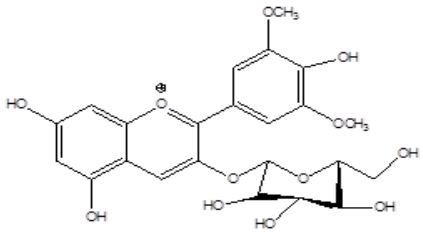
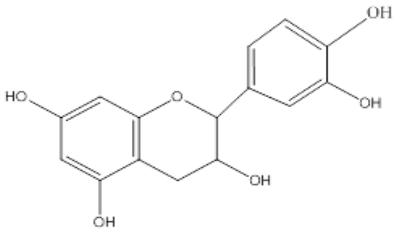
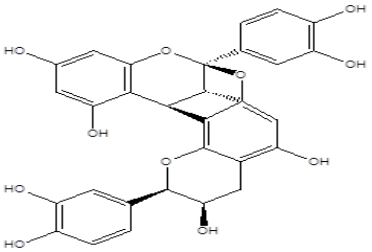
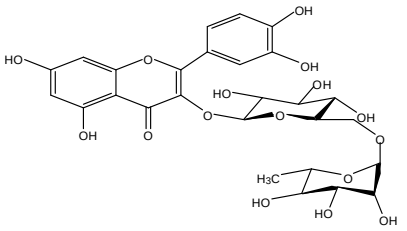
Putta EK, Sastry N et. al. 2014 - Litchi chinensis aqueous extract exhibit the existence of phenolic compounds, except for flavonoids. Antimicrobial study was performed on Litchi chinensis aqueous pericarp extract by agar well diffusion method in-vitro. Antimicrobial potential of the Litchi extract was scrutinized by *Escherichia coli, Salmonella typhi, Vibrio cholerae, Enterococcus faecalis, Shigella dysenteriae, Klebsiella pneumoniae, Staphylococcus aureus,* and *Candida albicans*. The aqueous extract of the fruit pericarp showed constantly remarkable inhibitory activity on the different bacterial species tested and found the importance of antimicrobial activity of Litchi chinensis [42].

DNA protection effect of pericarp Antioxidant property was created after fermentation of litchi pericarp extract with *Aspergillus awamori*. Application of DNA cleavage assay further reveal the enhanced protection effect of the fermented phenolic on DNA damage. HPLC analysis showed that some novel compounds like catechin and quercetin appeared after A. awamori fermentation of extract which could account for the

enhancing the antioxidant property and increased DNA protection capacity [43].

Table of Phytoconstituents

Epicatechin	
Procyanidin B2	
Procyanidin A2	
Catechin	
Leucocyanidin	
Cyanidin-3-O-glu	
Saponin	

Malvidin-3-acetyl-Ogluoenin	
Epicatechin	
Procyanidin A2	
Rutin	

Anticancer activity

Wang X, Yuan S et. al. 2014 - Litchi fruit pericarp extract exhibited a strong inhibitory effect on the proliferation of both positive and negative breast cancer cells *in-vitro* and inhibited the growth of estrogen receptor (ER) negative breast cancer *in-vivo* in humans. The effect of the Litchi fruit pericarp extract on proliferating inhibition and apoptosis induction of the cancer cells through upregulation (CYP1A1 and ADPRTL1) and downregulation (BIRC3, ADAM9, and HMMR) of multiple genes, which are involved in the cell cycle regulation and the cell proliferation, apoptosis, signal transduction and transcriptional regulation, motility, and invasiveness of cancer cells [44].

Seed

Singh JP, Chandel R et. al. 2013 - Antimicrobial and antioxidant activities of the seed *Litchi chinensis* seed extract was used for the antimicrobial test against all the selected bacterial strain gram-negative bacteria– *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Proteus vulgaris* while the gram-positive bacteria used were *Staphylococcus aureus* and *Bacillus subtilis*. The extract showed a significant inhibitory effect; moreover, 1% of seed powder solution has shown higher antioxidant property than 1% ascorbic acid solution. So, the seed can be utilized as a therapeutic agent for the treatment of various types of diseases and as an antioxidant for preserving foods and neutralizing free radicals of the body [45].

Clinical trials

Uppal TB et. al. 1985 - *Litchi chinensis* seed Sextract contains lectins. These lectins can agglutinate certain types of the bacteria which has been used for identification of certain antigenic types of the organisms, so it could be made a possible to develop an identification procedure for clinical isolates [46].

Kang SW, Hahn S et. al. 2012 - The oligomerized litchi fruit extract can induce endurance exercise performance more than vitamin C + vitamin E mixture or a placebo. Therefore, the study was designed as double-blind randomized controlled trial, with setting of the change of running time to exhaustion under submaximal treadmill test as the primary endpoint [47].

Acute and short-term consumption of a lychee fruit extract, particularly rich in low molecular weight dietary flavanols, will improve vascular function and reduce

platelet reactivity. So, a study was conducted regarding litchi fruit on vascular function and inflammation in postmenopausal women: A Double-Blind, Crossover Study[48].

CONCLUSION

The investigation of *litchi chinensis* proves that the chemical constituents of almost all parts contain lots of bioactive and pharmacological compounds, the *in-vivo* and *in-vitro* studies have been carried out as well. These results provided us a solid basis for the development and utilization of Litchi chinensis as both pharmaceutical and dietary supplement. Adequate clinical trials are also required for the evaluation and safety of the aforementioned natural compounds. The investigation in this area can lead us to thoroughly understand this plant and provide a foundation for safe and efficient use. More researches are expected so as to produce seed-less varieties, to increase fruit shelf-life, to produce disease-free crop and to reduce the post-harvest loss of the crop.

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