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Review Article

Antimicrobial activity of Caesalpinia sappan: A systematic review

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ABSTRACT:
Background: To assess the efficacy of Caesalpinia. Sappan in the effect of antimicrobial activity. **Methods**: A systematic review of controlled trials was performed. 286 articles were retrieved from electronic and hand searches, and four studies were included in the systematic review. The intervention and outcomes were assessed in the studies included in the systematic review. In addition, a literature review was performed using Pubmed, PMC, Science Direct, Wiley Online Library, and Cochrane Library using the keywords "Caesalpinia. sappan, antimicrobial effect". According to PRISMA guidelines, the MeSH terms were altered in each search engine. **Results**: In this systematic review, Four studies were included, which were controlled trials studies. There were studies performed in different countries. Among the four trials, three were found statistically significant, but further studies should be done to prove the effectiveness of antimicrobial activity in the plant-derived C.sappan. **Conclusion**: The present study revealed the potential use of C.sappan in nutraceutical applications for antioxidant, anti-inflammatory, and antibacterial purposes
Keywords: Caesalpinia. sappan, antimicrobial effect, antibacterial effect, C.sappan

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INTRODUCTION

Caesalpinia sappan L. is an indeciduous tree found in China, India, Burma and Vietnam. The heartwood of Caesalpinia sappan has been used in oriental folk medicines to treat various infectious diseases such as abscess, carbuncles, and tetanus. It is an emmenagogue, analgesic, anti-inflammatory, and treatment for thrombosis or tumours.[1] Brazilin is a chemical constituent found in C. sappan. The concentration of Brazilin in plant tissues changes over the plant's lifetime. [2] The heartwood contains water-soluble flavonoids, namely, Brazilin, protosappanin and haematoxylin. Brazilin is the main homoisoflavonoid constituent in the CS heartwood, known as the natural red colour dye for staining. Brazilin also exhibits different industrial applications. Therefore, Brazilin's extraction and purification are important steps to achieve high extraction yield and purity.[3] The extract also showed antifungal activity against Aspergillus niger and Candida albicans.[4] Caesalpinia sappan is a small thorny tree. It grows to 10 m in height, and the wood spreads 15-30 cm in diameter. It bears 3-4 seeds, is ellipsoid, and brown to black coloured. It is also known as Sappan wood or Brazil wood. Earlier the heartwood of the C. sappan was used in calico printing of cotton, wool and silk.[5] The dried heartwood of the plant C. sappan is used for purifying blood, quenching thirst, treatment of jaundice, cough, respiratory ailments and wounds, and curing blood pressure, heart diseases, amenorrhea, dysmenorrhea, blood stasis after delivery. In addition, C. sappan is used as an ingredient in the preparation of an orally utilized drug named Lukol for treating non-specific leucorrhoea and bleeding following insertions of an intrauterine device (IUD).

Vicco vajradanti, a famous toothpaste and powder in India, also comprises wood. According to Ayurveda, heartwood is bitter, astringent, sweet, acrid refrigerant, vulnerable, depurative, constipating, sedative, and haemostatic. The wood is useful in curing the condition of pitta, burning sensation, wounds, ulcers, leprosy, skin diseases, diarrhoea,

dysentery, epilepsy, convulsions, menorrhagia, diabetes and leucorrhoea.[6]
Modern pharmacological studies have revealed its wide range of antimicrobial, antioxidant, anticarcinogenic, anti-inflammatory and anti-diabetic activity. Studies also indicate the antibacterial activity of Brazilin against MRSA and the anti-influenza viral activity of protosappanin A (PsA). A previous study showed the potential of Sappan Lignum methanol extract to restore the effectiveness of β-lactam antibiotics against MRSA and inhibit the MRSA invasion of human mucosal fibroblasts.[7]
The plant extracts were a good source of secondary metabolites, vitamins and metals. The extracts were further tested against certain human pathogenic microbes. The heartwood's methanol and ethyl acetate extract effectively against certain pathogenic microbes.[8] Brazilin is also shown to exert an antibacterial principle from C. sappan preventing the induction of immunological tolerance caused by high doses of sheep red blood cells (SRBC), which suppresses the elevation of suppressor cell activity and inhibits the decrease in IL-2 production in C57BL/6 female mice.[1] Aqueous extract of Caesalpinia sappan has been reported to have antimicrobial activity against Escherichia coli, S. aureus and Salmonella typhimurium. Hence the water extract is used as a food preservative.[9]Crude leaf extract is prepared using solvents such as methanol, ethanol, acetone, chloroform and petroleum ether which has a negative effect on various microorganisms such as Escherichia coli, Bacillus cereus, Enterococcus faecalis, Bacillus subtilis, and Klebsiella pneumonia.[4]
Cyclic AMP phosphodiesterase is inhibited by hot aqueous extract and chloroform extract of wood. The methanolic section showed sleep time-elongation effect and anti-hypercholesteremia activity in mice. Furthermore, chloroform, n-butanol, methanol and aqueous extracts showed antimicrobial activity against standard methicillin-sensitive staphylococcus aureus and MRSA.[10,11] Hence this present study aims to assess the effect on the antimicrobial activity of Caesalpinia sappan.

MATERIALS AND METHODS

SEARCH STRATEGY

This systematic review was reported by the Preferred Reporting Items for Systematic reviews and Meta-Analysis. Original articles were related to the antimicrobial effect of Caesalpinia sappan, and an electronic search was done. The various electronic databases are Pubmed, Science Direct, Prospero, PMC, Cochrane, and Wiley online libraries taken into consideration for this systematic review from 2003 to 2015.
“Caesalpinia sappan, antimicrobial activity, C. sappan" keywords were used. Various MeSH terms were used for retrieving the data, such as C.sappan and microbial activity. Boolean operators were used, such as AND, OR, and NOT.
According to the Prisma guidelines, the MeSH terms were altered in each search engine when the results were too many or too few.

ELIGIBILITY CRITERIA

INCLUSION CRITERIA

- Studies conducted during 2003-2015
- Full-text articles
- Studies with randomized controlled trials

EXCLUSIONS CRITERIA

- Animal studies
- Pilot studies

RESULT

The search yielded 286 articles, and four articles were independently assessed among these eligible articles. Three tables were included. The flow diagram of the reports identified, screened, assessed for eligibility, excluded and fit for the review is shown in figure 1

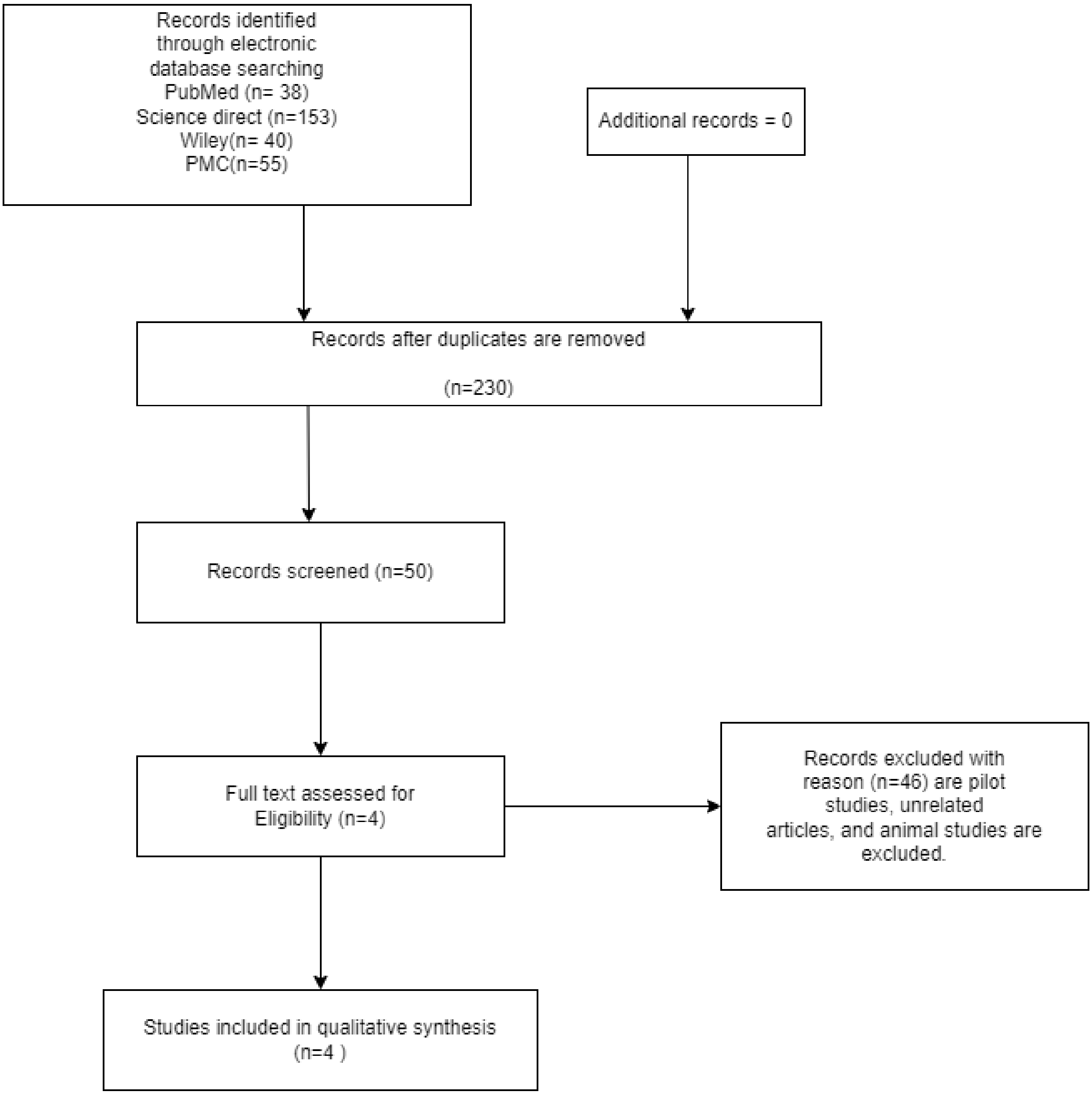

Table I: Characteristics of the various antimicrobial effects on the plants

Author Name	Year	Plants Compound	Antimicrobial Effect
Kang-Ju Kim[11]	2003	Group 1:Caesalpinia sappan L. Group 2: Mimosa pudica L.	Antimicrobial analysis and Phytochemical screening
G.Mohan[12]	2011	Group 1:Caesalpinia sappan L. Group 2:Beta carotene	Antibacterial analysis and anti-inflammatory analysis
Rajendran Srinivasan[15]	2012	Group 1: Caesalpinia sappan Group 2:Control group	Antibacterial analysis
Nilesh Prakash Nirmal[13]	2015	Group 1: Caesalpinia sappan Group 2:Control group	Antibacterial analysis

Table I shows the characteristics of the various antimicrobial effect on the plants chosen for the systematic review. The following factors were studied: Author's name, year of study, plant compound, and development. The trials used plant extraction for the different antimicrobial impacts.

Table II: Outcome data as reported in the included studies

Author Name	Year	Plant Compound Method Of Extraction	Outcome
G.Mohan, S.P.Anand, A.Doss [12]	2011	C.sappan Aqueous extraction-100g of dried plant with distilled water Solvent extraction-100g of dried plant with 200ml of methanol	The presence of bioactive compounds in crude extracts of c.sappan -antibacterial activity against disease-microorganism.C.sappan was found to be most effective than M.pudica
Nilesh Prakash Nirmal & Pharkphoom Panichayupakaranant[13]	2015	C.sappan Aqueous solution -25g of dried plants with 3litre of methanol to the prepared solution Beta-Carotene- 10mg-dissolved in 10 mL of chloroform.-antioxidant activity	Antibacterial activities of Brazillian-rich C.sappan are more effective against both gram-positive and gram-negative bacteria than the control group
Kang-Ju Kim et al [11]	2003	Caesalpinia sappan Preparation of solution of 100g of dried plants with 200ml of methanol An aqueous solution of 100g of dried plants with 1000ml of hot water	Antibacterial activities against Staphylococcus aureus C.sappan are more effective against bacterial agents
Rajendran Srinivasan et al [14]	2012	C. sappan (38 g) with water (1 000 mL) repeatedly for 48 hr.	C.sappan activity against Staphylococcus aureus, Salmonella typhi, Escherichia coli, Streptococcus faecalis, Enterobacter aerogenes and Pseudomonas aeruginosa

Table II shows the characteristics of various plant-derived antimicrobial effects chosen for the systematic review. The following factors were studied: Author's name, year of study, a plant compound, and outcome. C.sappan was more effective against microorganisms.

Table III: Characteristics of bias in different studies taken for review

Author name	Random sequence generation	Allocation concealment	Blinding of outcome	Incomplete outcome (?)	Selective bias
G.Mohan, S.P.Anand, A.Doss [12]	-	?	-	+	+
Nilesh Prakash Nirmal & Pharkphoom Panichayupakaranant[13]	+	+	+	+	?
Kang-Ju Kim et al [11]	-	+	?	+	+
Rajendran Srinivasan et al [14]	-	?	-	+	+

+: Low risk of Bias; -: High risk of Bias; ?: Unclear risk of Bias

Table III shows the Bias, including the study, which was categorized as high-risk Bias, low-risk Bias and unclear risk bias. According to Cochrane, the risk of Bias for randomized controlled trials was used for bias assessment.

DISCUSSION

The present study examined the antibacterial effects of plant-derived C.sappan on microbial pathogens and their impact on the host immune/inflammatory response modulation. The collected data revealed the beneficial effect of antibacterial, antiadhesive, and anti-inflammatory characteristics. Positive correlation between exposure and inhibition of bacterial growth, adhesion, and proteolytic activity, as well as reduced host inflammatory response.

C.sappan methanol and aqueous inhibited gram-positive strains S. aureus and B. subtilis, as well as gram-negative strains K. pneumonia, E.coli, and P.vulgaris, with MIC ranging from 0.14 to 0.82 mg/ml and 0.22 to 0.86 mg/ml, respectively. In contrast, methanol and aqueous extracts of M.pudica inhibited gram-positive strains S. aureus, B. subtilis, and gram-negative strains K. pneumonia, P.vulgaris, and P.aeruginosa with MICs ranging from 0.44 to 0.88 mg/ml and 0.71 to 0.83 mg/ml, respectively.[12]

In general, the methanol extract of the tested plants was most effective in inhibiting bacterial growth, indicating that the polar solvent methanol was more successful than aqueous extracts in extracting secondary metabolites responsible for the antibacterial property.[15,16] Tannins and alkaloids were found in C.sappan sections. Several tannin-rich plants have been shown to have antimicrobial activity against various microorganisms. Banso and Adeyemo11, for example, investigated the antibacterial activity of Dichrostachys cinerea leaf extract and found tannins, alkaloids, and glycosides. The extracts demonstrated more susceptibility to Gram-positive bacteria than gram-negative bacteria.[17]

Nilesh et al. stated that the antibacterial activities of BRE, CSE, and Brazilin were found to be antibacterial against both Gram-positive and Gram-negative bacteria.[13] The compound's reducing capacity can also predict its potential antioxidant activity.[18] The presence of reductones, such as ascorbic acid, has lowering properties and can break the free radical chain by donating a hydrogen atom. Reductones are also reported to react with certain peroxide precursors, preventing peroxide formation[19]

The fact that Caesalpinia sappan extracts inhibited the growth of Staphylococcus aureus provides an antimicrobial agent. Although the Caesalpinia sappan extracts inhibited MRSA and standard MSSA, methanol extract inhibited MRSA and standard MSSA more than chloroform, n-butanol, and aqueous extracts.[11] These findings suggest that methanol would be a better solvent for isolating the antibacterial principles. Sappan chalcone, Brazilin, brazilein, protosappanin A, protosappanin B, protosappanin C, protosappanin E, haematein, and hematoxylin have previously been isolated from Caesalpinia sappan methanol extracts were evaluated with the flavonoids in n-butanol, methanol, and aqueous extracts.[20,21,22]

In this systematic review, all four studies recommended that the antimicrobial effect of plant-derived c.sappan should be administered for various anti-inflammatory and immunomodulatory responses with the extraction of plants. More effective against microbial pathogens.

LIMITATION

The present study had some limitations. Despite the low probability, restricted the search for 14 years, excluding in vivo studies. Furthermore, screening links from the Google search engine might omit a tool or guideline.

CONCLUSION

The present study revealed the potential use of C.sappan in nutraceutical applications for antioxidant, anti-inflammatory, and antibacterial purposes. Caesalpinia sappan had antimicrobial activity, reducing the beta-lactam antibiotics against methicillin-resistant Staphylococcus aureus. In addition, the plant-derived solution of C.sappan had effective against microbial pathogens.

CONFLICTS OF INTEREST

Nil

FUNDING

Nil

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