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Cumulative activity of the *p*-coumaric acid and syringaldehyde for antimicrobial activity of different microbial strains

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ABSTRACT

Phenolic compounds and aldehydes vary in their chemical structure and properties. p-Coumaric acid is a natural phenolic compound which exists in grapes and some medicinal plants. Syringaldehyde, an aldehyde is also available as a phytochemical. These two are the naturally occurring phytochemicals in plants like Phragmites vallatoria and some other plants belonging to poaceae family. These two compounds have antioxidant, antimicrobial and other medicinal properties. Anti-microbial activity of these two compounds was screened by Disk diffusion method. p-Coumaric acid and Syringaldehyde were tested for antimicrobial activity against bacterial pathogens such as Klebsiella pneumonia, Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Proteus vulgaris and Bacillus subtilis. Low concentration of p-Coumaric acid or Syringaldehyde alone did not exert any zone of inhibition on above mentioned microbial strains, but these two compounds in cumulation showed zone of inhibition on various microbial strains. Cumulative action of these two compounds at 50 & 100 µg were exerting little inhibition activity on Pseudomonas aeruginosa and Bacillus subtilis and at 200 µg was very effective against all the microbial strains except for Escherichia coli. Tetracycline showed positive results against all the microbial strains under study. The present study reveals that p-Coumaric acid & Syringaldehyde in cumulation only showed antimicrobial effect.

Key words: *p*-Coumaric acid, Syringaldehyde, Microbial strains, Physico-chemical properties, Cumulative effect.

INTRODUCTION

In plants *p*-Coumaric acid is found as a component of lignins and tannins with many medicinal properties (Barros *et al*., 2009). *p*-Coumaric acid is an antioxidant having antitumor and anti-inflammatory activity. This is an antioxidant which is implicated for the prevention of pathologies such as inflammatory diseases like heart diseases and cancer. On other hand Syringaldehyde is an organic compound that occurs in trace amounts widely in plants. Some insects use Syringaldehyde in their chemical communication systems (Amelung *et al*., 2008). Both Syringaldehyde and Coumaric acid analogues are widely present in *poaceae* family members like *Phragmites vallatoria.*

Phenolic compounds from medicinal plants include phenolic acids, tannins, flavonoids, stilbenes, curcuminoids, coumarins, quinines (Huang *et al*., 2010). Flavonoids are physically occurring phenolic compounds with a extensive

range of biological activities and the valuable effects of flavonoids have been considered in relation to diabetes mellitus. (Goutam Brahmachari *et al*., 2011). Some aldehydes like Syringaldehyde also has medicinal properties like antiallergic. Syringaldehyde showed a weak inhibition of prostaglandin synthetase in a dose-dependent way. Syringaldehyde, syringaresinol, isolated from the MeOH-soluble part of a water extract of the stem bark of Magnolia officinalis. Among these compounds, 2-8b were deliberate for anti-inflammatory and antioxidative activities. The study is mainly focused on new lead compounds associated with antimicrobial activity. Physico-chemical properties of *p*-Coumaric acid and Syringaldehyde reveals the Exact Mass, m/e value, Elemental Analysis, Boiling Point, Melting Point, Critical Temp, Critical Pres, Critical Vol, Gibbs Energy, Log P, MR, Henry's Law, CLogP, CMR, Heat Form and Melting Point.

MATERIALS AND METHODS

Chemicals

p-Coumaric acid and Syringaldehyde were purchased from Sigma-Aldrich and other chemicals used in the study were of analytical grade.

Preparation of microbial inoculums

The young microbial inoculum cultures were arranged and used in the entire research period. The pure microbial cultures were inoculated in the tubes using inoculation needles or loops. The bacterial tubes were incubated at 37°C for 24-72 hours consequently.

Antimicrobial activity

The microorganisms were collected from the IMTECH, Chandigarh. Nutrient agar and Mc Conky prepared plates obtained from Hi Media. For *Klebsiella pneumonia and Proteus vulgaris* Mc Conky plates were used, nutrient agar plates were used for remaining organisms.

Experimental design

Compound 1 - *p- Coumaric* acid with 50, 100 and 200 µg concentrations
Compound 2 - Syringaldehyde with 50, 100 and 200 µg concentrations
Compound 3 - *p-Coumaric* acid + Syringaldehyde (equal amounts) with 50, 100 and 200 µg concentrations
DMSO - Control
Tetracycline - Positive control

Antimicrobial Assay

The nutrient agar and Mac conkey agar media plates were inoculated with test bacterial cultures and were evenly spread over the media by sterile cotton swabs. The standard antibiotic (tetracycline) was used as a positive control and solvent (DMSO) was used as control. The plates were incubated at 37ºC for 72 hours for bacteria. After the incubation the plates were observed for formation of clear inhibition zone around the well indicating the presence of antimicrobial activity. The zone of inhibition was calculated by measuring the diameter of the inhibition zone around the well.

RESULTS

The physico-chemical properties among the two compounds under the study, (Compound-1) *p*-Coumaric acid showed high Boiling Point, Melting Point, Critical Temp and Critical Pressure (Table-1). *p*-Coumaric acid at 50 µg did not show any zone of inhibition on mentioned microbial strains and at 100 µg this compound exerted inhibition only on *Pseudomonas aeruginosa* and at 200 µg exerted inhibition to all the strains studied except for *Escherichia coli*. In case of Compound-2 (Syringaldehyde) at 50 µg concentration did not show any microbial inhibition. At 100 and 200 µg concentration the compound exerted inhibition zone against *Bacillus subtilis* and *Escherichia coli* only (Table 2). On other hand (Compound-3, *p*-Coumaric acid + Syringaldehyde) at 50 µg did not show any zone of inhibition on mentioned microbial strains and at 100 µg this compound exerted inhibition on *Pseudomonas aeruginosa* and *Bacillus subtilis* only and at 200 µg concentration exerted inhibition to all the strains studied. Tetracycline showing positive results against all microbial strains (Table 2).

Table 1: Physico-chemical properties of *p*-Coumaric acid and Syringaldehyde

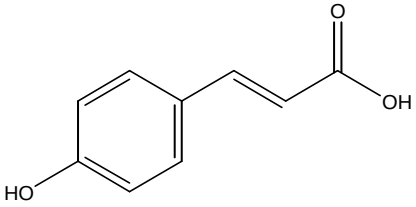
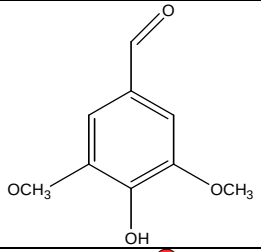
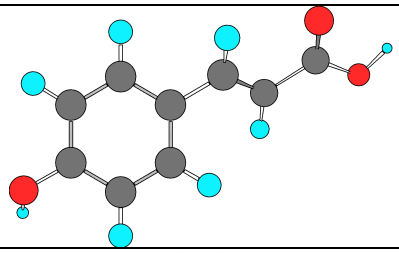
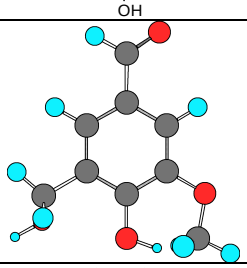
Parameter	*p*-Coumaric acid	Syringaldehyde
Structure		
3D Structure		
Molecular Formula	$C_9H_8O_3$	$C_9H_{10}O_4$
Exact Mass	164.05	182.06
m/e	164.05 (100.0%), 165.05 (10.3%), 166.05 (1.1%)	182.06 (100.0%), 183.06 (10.3%), 184.06 (1.2%)
Elemental Analysis	C, 65.85; H, 4.91; O, 29.24	C, 59.34; H, 5.53; O, 35.13
Boiling Point	662.49 [K]	616.28 [K]
Melting Point	484.35 [K]	440.33 [K]
Critical Temp	824.37 [K]	786.71 [K]
Critical Pres	46.85 [Bar]	39.46 [Bar]
Critical Vol	451.50 [cm3/mol]	500.50 [cm3/mol]
Gibbs Energy	281.00 [kJ/mol]	-346.09 [kJ/mol]
Log P	1.54	1.14
MR	44.67 [cm3/mol]	48.74 [cm3/mol]
Henry's Law	10.26	9.70
CLogP	1.572	1.00598
CMR	4.7005	4.575
Heat Form	-402.92 [kJ/mol]	-542.83[kJ/mol]
Melting Point	210–213 °C	110–113 °C

Table 2: Zone of inhibition in microbial strains against three compounds

Compounds	Concentrations (diameter in mm)	*Escherichia coli*	*Pseudomonas aeruginosa*	*Bacillus subtilis*	*Staphylococcus aureus*	*Proteus vulgaris*	*Klebsiella pneumonia*
Compound-1 (*p*-Coumaric acid)	**50 µg**	-	-	-	-	-	-
	100 µg	-	0.1mm	-	-	-	-
	200 µg	-	0.2mm	0.1mm	0.2mm	0.1mm	0.2mm
Compound-2 (Syringaldehyde)	**50 µg**	-	-	-	-	-	-
	100 µg	-	-	0.1mm	-	-	-
	200 µg	0.2mm	-	0.1mm	-	-	-
Compound-3 (*p*-Coumaric acid + Syringaldehyde)	**50 µg**	-	-	-	-	-	-
	100 µg	-	0.2mm	0.1mm	-	-	-
	200 µg	0.1mm	0.4mm	0.2mm	0.2mm	0.2mm	0.1mm
Tetracycline	**10µg**	7 mm	5 mm	5 mm	3 mm	10 mm	8 mm

DISCUSSION AND CONCLUSION

Ancient medicine is a vital source of knowledge for use of new compounds for the development of antimicrobial agents. *p*-Coumaric acid in the above study revealed that it was effective at 100 and 200 µg concentration in inhibiting the microbial growth. Further, it is also known as hydroxycinnamic acid possessing rich antioxidant properties, major composition of lignin and is believed to reduce the risk of stomach cancer (Ferguson *et al*., 2005) by reducing the formation of carcinogenic nitrosamines. *p*-Coumaric acids showed antibacterial activity (MIC = 1 mg ml"1) against *E. coli*, Past. multocida and *N. gonorrhoeae* (Alves *et al*., 2013). Syringaldehyde is naturally

found in wood of spruce and maple trees, this compound contains many functional groups with aldehydes and aromatic and phenol etc. Syringaldehyde possess antihyperglycemic activity in wistar rats as reduction in plasma glucose (Wang *et al*., 2013) and also in STZ induced rats (Huang *et al*., 2013), and the molecular mass of the compound is 182.1733 g/mol. From the above study it can be concluded that *p*-Coumaric acid and Syringaldehyde in cumulation at 100 and 200 µg were synergistic and exerted inhibition on the microbial strains studied.

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