RESEARCH ARTICLE

Comparative Assessment of Phytochemicals, Antioxidant, and Antimicrobial Potential of Stem Bark and Small Branches of *Buchanania cochinchinensis* (Lour.) MR Almeida for Substitution in Ayurvedic Drugs

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Abstract

Aim: Present study was intended to investigate the physicochemical parameters, phytochemical constituents, and biochemical studies of the stem bark (STB) and small branches (SBs) of *Buchanania cochinchinensis* (Lour.) MR Almeida.

Materials and methods: The parameters were checked in different solvent systems, viz., petroleum ether, acetone, and methanol.

Results: Significant antioxidant (10–85%) and antimicrobial (5–20 mm) activities were observed in acetone and methanolic extracts of STB and SB as compared to the controls. In acetone and methanolic extracts, the observed values for total phenol content (TPC) ranged from 10 mg to 93 mg of gallic acid equivalent per gram of extract and the total flavonoid content (TFC) ranged from 30 mg to 87 mg of quercetin equivalent (QE) per gram of extract. Bovine serum albumin (BSA) protein interaction studies of all the extracts were performed and the observed values for binding constant ranged from 22 to 62×10^{-5} μM^{-1}.

Conclusion: Overall, acetone and methanolic extracts of STB and SB of plant have shown significant results in medicinal aspects mentioned above.

Clinical significance: These comparative findings of STB and SB of *Buchanania cochinchinensis* (Lour.) MR Almeida provide undeniable systematic facts of its beneficial prospective as an Ayurvedic drug.

Keywords: Antimicrobial, Antioxidant, *Buchanania*, Medicinal plants, Natural products, Phytochemicals.

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Introduction

Nature and natural products are the major source of medicines especially in the developing countries. These herbal drugs are valuable in diverse treatments. Plants remain an imperative feature in healthcare as the developing and underdeveloped countries mostly rely on plants and natural products for their traditional medicines.[1] The diverse applications of herbal drugs or natural products are due to the presence of a wide class bioactive organic compounds.[1–3] In recent past, important organic compounds have been isolated from the natural product, and these natural products and their derivatives have been introduced in market as active drugs even in allopathic system.[2–4] Several species of flora belonging to different families have been investigated regarding the presence of any possible beneficial properties for medicinal use.

Buchanania cochinchinensis (Lour.) MR Almeida (BC) is commonly known as Chironji belongs to Anacardiaceae family and contains multiple class of phytochemicals such as terpenoids, saponins, and tannins.[5] Tannins, alkaloids, saponins, reducing sugars, triterpenoids, and flavonoids are the major chemical constituents of BC. The reported phytochemical constituents of BC are linoleic acid, β-amyrin, palmitoleic acid, myristic acid, cystine, alanine, histidine, stearic acid, palmitic acid, myricetin 3′-rhamnoside-3-galactoside, triacylglycerol, diacylglycerol, monoacylglycerol, acyl monogalactosyldiacylglycerol, acylated steryl glucoside, digalactosyldiacylglycerol, phosphatidylethanolamine, phosphatidylcholine, phosphatidylglycerol, phosphatidylinositol, lysophosphatidylethanolamine, lysophosphatidylcholine, and sterols.[3–8]

Customary awareness and associated information reports an immense significance of almost every part of the plant for a number of healing approaches. The roots of BC are helpful in handling diarrhea.[9] The root extract has also been used as a cough medicine and for remedy of bile secretion and blood-related diseases. Leaf juices of BC cure digestive disorders and can also be used as expectorant, aphrodisiac, purgative, blood purifier, and thirst-quencher.[8–12] The fruit kernels of BC are used as ointment in skin diseases and as antioxidants.[5,6]

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Recent studies revealed that BC is an important plant as it helps in wound-healing, gastric ulcer treatment and has antistress, anti-diarrheal, anti-venom, antimicrobial, antioxidant anti-inflammatory, analgesic, and anti-Alzheimer properties.[5–17] During the course of our study of the biologically active constituents of BC, we examined the chemical constituents of the small branches (SBs) and stem bark (STB) in various extracts. In the current study, we investigated the phytochemical, antioxidant, and antimicrobial properties of the extracts (petroleum ether, acetone, and methanol) of SB and STB obtained from BC.

Materials and Methods

Plant Material Collection

The STB and SB of BC were collected from Gwalior, Madhya Pradesh, India. The STB and SB were dried in shade and their dried powder was stored in airtight jars for further study.

Preparation of Plant Extracts

Three solvents, viz., petroleum ether, acetone, and methanol, were used to extract the phytochemicals. To extract the phytochemicals, approximate 25 g of the dried powder (STB or SB) was soaked in the screw tight glass jar for 48 hours. The extracts were filtered and evaporated, and the yield percentages were calculated as:

$$\text{Percentage of extract yield} = \frac{R}{S} \times 100$$

where R = wt. of the dry residues of the extract; S = wt. of the dry powder of STB or SB i.e., 25 g.

Physicochemical and Phytochemical Analysis

Physicochemical parameters, viz., the pH, loss on drying (LOD), ash values, and extractive values were investigated as per the Ayurvedic Pharmacopeia of India (API) protocols.[4] The qualitative analysis of phytochemicals, viz., phenols, tannins, carbohydrates, saponins, alkaloids, flavonoids, furanoids, quinone, proteins, coumarins, steroids, and triterpenoids was done as per recent studies.[1,3] Quantitative analysis of phytochemicals was done by using direct mass study.[13–17]

Biochemical Assays

Biochemical assays, viz., the TPC and TFC were analyzed by following the recent protocols. Antioxidant assays, viz., nitric oxide scavenging activity, ferric-reducing power estimation, 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay, ferric-reducing antioxidant power (FRAP) assay, metal-chelating activity assay, scavenging activity of superoxide anion assay, and phosphomolybdenum antioxidant assay of various extracts were performed per our recent reports.[13–17] Also, bovine serum albumin (BSA) protein-binding ability of various extracts was assessed per our recent reports.[13–17]

Determination of Antimicrobial Activities

Antimicrobial activities were determined on three fungal and three bacterial strains. The antimicrobial studies of various extracts were performed per the recent reports.[13–17]

Statistical Analysis

Studies were executed in triplicates and the results were presented as ± mean. Excel (window 8), analysis of variance, and Tukey's test were used for statistical analysis. $p \leq 0.05$ was considered statistically significant.

Results and Discussions

Physicochemical Parameters

The observed pH values for SB and STB of BC were 5.63 ± 0.09 and 5.52 ± 0.11, respectively. The pH range was similar in both the SB and STB of BC, indicating the presence of similar kind of phytochemicals in SB and STB. It is well-documented that the pH plays a significant role in the medicinal activities of phytochemicals. Furthermore, the pH values ranging from 4 to 7 exhibited a relatively high antioxidant activity.[7–9] In line with this, the concerned plant sample, in this context, is supposed to correlate well in terms of its antioxidant activities.

Total ash value determined for the SB and STB of BC was 8.80 ± 0.65% and 8.01 ± 0.33%, respectively. However, the total ash of STB was slightly less than that of SB which means the mineral content of SB is higher than that of STB. The total ash value represents the diagnostic purity index. The observed acid-insoluble ash values for SB and STB were 78.66 ± 2.22% and 81.61 ± 2.44%, respectively.

Table 1: Qualitative analysis of phytochemicals present in the various extracts of stem bark and branches *of Buchanania cochinchinensis* (Lour.) MR Almeida (+++, excellent; ++, good; +, present; –, not present)

	Solvent of extraction					
	Petroleum ether		*Acetone*		*Methanol*	
Phytochemical	*STB*	*Branches (SB)*	*STB*	*Branches (SB)*	*STB*	*Branches (SB)*
Glycosides	++	++	++	++	++	++
Terpenoids	+++	+++	+++	+	+++	+++
Proteins	–	–	–	–	–	–
Amino acids	–	–	–	–	–	–
Alkaloids	–	–	+	–	+	–
Carbohydrates	+	+	–	–	+	+
Flavonoids	–	–	++	++	++	++
Phenols	–	–	+++	+++	+	+
Saponins	–	–	–	–	++	++
Steroid	–	–	+	+	–	–
Tannins	–	–	++	++	++	++

The observed water-soluble ash values for SB and STB were 0.76 ± 0.08% and 0.78 ± 0.04%, respectively. The observed LOD for SB and STB was 0.302 ± 0.06% and 0.292 ± 0.05%, respectively.

The observed extractive values for SB and STB in petroleum ether were 0.66% and 0.49%, respectively. In acetone, these were 2.08% and 4.37%, respectively. The observed extractive values for SB and STB in methanol were 7.98% and 18.34%, respectively. As compared to petroleum ether extracts, excellent yield was observed with solvents acetone and methanol (methanol >> acetone). It highlights the presence of polar compounds in the plant.[3–7]

Qualitative and Quantitative Analysis of Phytochemicals

Various qualitative and quantitative phytochemical approaches were determined to detect phytochemicals (Table 1). Terpenoids were observed in all extracts of STB and SB. Alkaloids, tannins, steroid, carbohydrates, saponins, phenols, and flavonoids were observed in the acetone and methanolic extract of STB and SB. Overall, maximum phenols were observed in the acetone extract (Table 1). The flavonoids and polyphenols are used in protection against allergies, antioxidative activities, inflammation, microbes, platelet aggregation, ulcers, tumor, viruses, and hepatic toxicity.[7,10–16]

Similarly, steroids, derived from plants, also have been reported to possess antibacterial and insecticidal properties besides having cardiotonic effect. Saponins are reported to have antidiabetic and hypocholesterolemic properties, while triterpenoids display anticancer and analgesic properties.[11–15] Secondary metabolites play a potent role in pharmacological industrial sector. Dissimilarities were identified between previous and current studies. The variances might include changes in divergences in the genetic structural, geographic location, and environmental effects of the plants and their extraction method used. In our study, acetone and methanol offer better solvent systems for the extraction of various metabolites from such plants.

Quantitative phytochemical tests were used to ensure the occurrence of phytochemicals in various extracts of STB and SB (Tables 2 to 4). Direct mass analysis of the extracted metabolite was performed and compared with the National Institute of Advanced Industrial Science and Technology, Natural Product library, and National Institute of Standards and Technology.

Biochemical Assays

In vitro Antioxidant Activity

Under DPPH assay, the observed value for control (ascorbic acid) was 91.30 ± 2.78%. Under the same experimental conditions, the

Table 2: Quantitative analysis of phytochemicals present in the petroleum ether extracts of stem bark and small branch *of Buchanania cochinchinensis* (Lour.) MR Almeida

Mass	*m/z*[2]	*Name of compound*
Petroleum ether extract of SB		
102	75, 57, 45	*N*-Methoxy-*N*-methylacetamide
113	112, 94, 68, 44	4-Imidazolecarboxylic acid
124	80, 53, 44	2-Pyrazinecarboxylic acid
141	138, 124, 105	4-Hydroxy-3,6-dimethylpyran-2-one
144	131, 102	Methyl 3-Hydroxyisoxazole-5-carboxylate
152	131, 124, 113	8-Azaguanine
157	150, 125, 113, 102	4-Hydroxy-3,5,6-trimethylpyran-2-one
167	166, 78, 62, 45	*m*-Phenylenediboronic acid
193	186, 167, 152, 145, 131, 112	7-Hydroxy-6-methoxychromen-2-one
198	152, 124	3-Acetyl-5-sec-butyl-4-hydroxy-1,5-dihydro-2*H*-pyrrol-2-one
220	127, 141, 113, 98, 27	Diethyl bis (hydroxymethyl) malonate
227	193, 186, 152, 131	7,8-Dihydroxy-6-methoxychromen-2-one
253	152, 145, 113, 85	Methyl 5-bromo-5-deoxy-β-D-idofuranosiduronic acid gamma-lactone
256	253, 124, 75, 63	*p*-Nitrophenylphosphorodichloridate
263	262, 166, 53, 43	Diheptyl disulfide
274	253, 225, 198, 157, 124	*N*-[2-(1*H*-Indol-3-yl)ethyl] acetamide
279	263, 220, 193, 113	6-Acetyl-1-bromo-2-methoxynaphthalene
282	141, 128, 113	9-Octadecenamide
337	167, 145, 131	Ibogamine-18-carboxylic acid, 3,4-dehydro-, methyl ester
356	274, 157, 141	8-Hydroxy-8-(3-octyloxiran-2-yl) octanoic acid
375	372, 272, 246, 232, 141, 127, 113	2-Chloro-10-(3-(4-methyl-1-piperazinyl)propyl)phenothiazine dimaleate
485	167, 144, 131	2(3*H*)-Furanone, 4-[2-[[6-*O*-[(2*E*)-3-(3,4-dihydroxyphenyl)-1-oxo-2-propen-1-yl]-β-D-glucopyranosyl]oxy]-1-methylethyl]dihydro-4-hydroxy
537	356, 274, 152, 135, 124	5-Cholestene-3β,4β-diol 3-mono(*p*-anisate)
569	539, 274, 124	10-Methyl-6-(3-furyl)-15,18-dihydroxy-1,5,16-trimethyl-8,14-dioxo-7,11-dioxahexacyclononadec-19-yl](hydroxy)acetate

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Mass	*m/z*[2]	*Name of compound*
656	356, 198, 152, 91	*p*-Octylphenyl 2-chloro-4-(*p*-heptylbenzoyloxy)benzoate
680	566, 356, 157, 141	5-Cholestene-3β,4β-diol bis(*p*-chlorobenzoate)
736	225, 124, 87, 53	Trihexadecyl borate
Petroleum ether extract of STB		
102	75, 57, 45	*N*-Methoxy-*N*-methylacetamide
131	89, 47, 43	*N*-Methoxydiacetamide
134	102, 89, 71, 59	3-Methyl-1,3,5-pentanetriol
144	131, 102	Methyl 3-hydroxyisoxazole-5-carboxylate
155	44, 43, 42	6-Amino-2,4,5(3*H*)-pyrimidinetrione 5-oxime
157	150, 125, 113, 102	4-Hydroxy-3,5,6-trimethylpyran-2-one
164	131, 103, 85, 74	2-Deoxy-D-galactose
220	127, 141, 113, 98, 27	Diethyl bis(hydroxymethyl)malonate
227	193, 186, 152, 131	7,8-Dihydroxy-6-methoxychromen-2-one
242	169, 155, 151, 141, 127, 113	1-Bromo-2-methylhexadecane
256	253, 124, 75, 63	*p*-Nitrophenylphosphorodichloridate
267	220, 192, 166, 102	2-(2-(5-Nitro-2-furyl)vinyl)quinoxaline
274	253, 225, 198, 157, 124	*N*-[2-(1*H*-Indol-3-yl)ethyl]acetamide
295	220, 198, 166, 103	Ethyl(5-methoxy-2-nitrobenzoyl)pyruvate
305	257, 228, 198, 76	*N*-(2-Iodobenzoyl)glycine
314	267, 258, 152, 134	5,7-Dihydroxy-2-(*p*-methoxyphenyl)-6,8-dimethyl-4-chromanone
318	295, 220, 164	2-Benzyl-1-methyl-5-nonylpyrrolidin-3-ol
371	267, 102, 91, 77	*N*-Benzyl-*N*-(1-benzoyl-1-methylpropyl)benzamide
373	305, 273, 228	1,3,6,8-Tetrahydroxy-2-(1-hydroxyhexyl)anthracene-9,10-dione
383	255, 174, 144	Methyl tetracosanoate
433	231, 157, 134, 102	Ethyl 3,5-dicyano-2,4-bis(*p*-methoxyphenyl)-6-oxo-3-piperidinecarboxylate
447	273, 150	3,4,5-Trihydroxy-6-[5-hydroxy-2-(4-hydroxyphenyl)-4-oxochromen-7-yl]oxyoxane-2-carboxylic acid
485	167, 144, 131	2(3*H*)-Furanone, 4-[2-[[6-*O*-[(2*E*)-3-(3,4-dihydroxyphenyl)-1-oxo-2-propen-1-yl]-β-D-glucopyranosyl]oxy]-1-methylethyl]dihydro-4-hydroxy
502	383, 157, 114, 102	*N*(2)-Tosyl-L-glutamic acid bis(*p*-vinylanilide)
562	243, 164, 141, 43	Methyl 2,3,4-Tri-*O*-acetyl-6-*O*-triphenylmethyl-β-D-galactopyranoside
625	383, 341, 267, 152	Glycerol 1,2-distearate
680	566, 356, 157, 141	5-Cholestene-3-β,4-β-diol bis(*p*-chlorobenzoate)
736	225, 124, 87, 53	Trihexadecyl borate
757	599, 438, 383, 178, 164	2,2′-Bis(dibromomethyl)-1,1′-bianthraquinone
887	267, 152, 134, 55	1,2,3-Propanetriyl tris(trans-9-octadecenoate)

Table 3: Quantitative analysis of phytochemicals present in the acetone extracts of STB and SB *of Buchanania cochinchinensis* (Lour.) MR Almeida

Mass	*m/z*[2]	*Name of compound*
Acetone extract of SB		
113	112, 94, 68, 44	4-Imidazolecarboxylic acid
136	134, 102, 89, 71, 59	3-Methyl-1,3,5-pentanetriol
141	138, 124, 105	4-Hydroxy-3,6-dimethylpyran-2-one
144	131, 102	Methyl 3-hydroxyisoxazole-5-carboxylate
152	131, 124, 113	8-Azaguanine
157	150, 125, 113, 102	4-Hydroxy-3,5,6-trimethylpyran-2-one
169	166, 78, 62, 45	*m*-Phenylenediboronic acid
178	177, 144, 141, 113, 102	5-Amino-4,6-dichloro-2-methylpyrimidine
186	185, 157, 155, 126, 102	2,3-Naphthalenedialdehyde
199	152, 124	3-Acetyl-5-sec-butyl-4-hydroxy-1,5-dihydro-2*H*-pyrrol-2-one

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Mass	*m/z*[2]	*Name of compound*
219	127, 141, 113, 98, 27	Diethyl bis(hydroxymethyl)malonate
245	242, 169, 155,141, 127, 113	1-Bromo-2-methylhexadecane
256	213, 185, 171, 157, 113	Hexadecanoic acid
264	262, 166, 53, 43	Diheptyl disulfide
274	253, 225, 198, 157, 124	*N*-[2-(1*H*-Indol-3-yl)ethyl]acetamide
279	263, 220, 193, 113	6-Acetyl-1-bromo-2-methoxynaphthalene
281	141, 128, 113	9-Octadecenamide
304	245, 243, 185, 141, 102	*n*-Hexanoyl-L-leucineanilide
311	181, 152, 136, 83	(3,4-Dimethoxyphenethylaminomethyl)methylmalonic acid
319	243, 157, 143, 43	1,2,3,5-Tetra-*O*-acetyl-β-D-ribofuranose
341	340, 169, 144, 113	5-(3-Chloro-4-thiocyanatophenylazo)-8-quinolinol
363	319, 169 152, 113, 102	1-Acetyl-2-morpholino-5,5-diphenyl-2-imidazolin-4-one
373	372, 272, 246, 141, 113	2-Chloro-10-(3-(4-methyl-1-piperazinyl)propyl)phenothiazine dimaleate
396	396, 363, 184, 155, 103	1-Acetyl-2-morpholino-5,5-diphenyl-2-imidazolin-4-one
443	281, 267, 185, 113	L-Ascorbic acid 6-stearate
469	304, 256, 178, 157, 136, 103	Glycyrrhetinic acid
572	199, 103, 77	1-(3-Benzamido-5-*o*-benzoyl-2-benzoylthio-2,3-dideoxy-β-D-ribofuranosyl)-2,4(1*H*,3*H*)-pyrimidinedione
610	304, 256, 178, 157, 136	Hesperidin
672	219, 199, 178, 157, 141	4-((1*E*)-3-((2-((3-(((3-Bromo-2-methylimidazo(1,2-*a*)pyridin-8-yl)oxy)methyl)-2,4-dichlorophenyl)methylamino)-2-oxoethyl)amino)-3-oxo-1-propenyl)-*N*,*N*-dimethylbenzamide monomethanesulfonate
680	566, 356, 157, 141	5-Cholestene-3β,4β-diol bis(*p*-chlorobenzoate)
822	373, 311, 219, 155	[3,4-Dihydroxy-6-[5-hydroxy-2-(4-hydroxyphenyl)-4-oxo-7-[3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl]oxychromen-3-yl]oxy-5-[(2*S*,3*R*,4*R*,5*R*,6*S*)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxyoxan-2-yl]methyl acetate
896	610, 373, 264, 136	Pentopyranoside, (3β,5ξ,9ξ,16β,18ξ,22β)-22-(benzoyloxy)-16,28-dihydroxyolean-12-en-3-yl 3-*O*-hexopyranosyl
Acetone extract of STB		
102	75, 57, 45	*N*-Methoxy-*N*-methylacetamide
113	112, 94, 68, 44	4-Imidazolecarboxylic acid
121	80, 53, 44	2-Pyrazinecarboxylic acid
134	102, 89, 71, 59	3-Methyl-1,3,5-pentanetriol
137	136, 102, 89, 71, 59	3-Methyl-1,3,5-pentanetriol
141	138, 124, 105	4-Hydroxy-3,6-dimethylpyran-2-one
150	103, 91, 77	4-(3-Hydroxybutyl)phenol
154	44, 43, 42	6-Amino-2,4,5(3*H*)-pyrimidinetrione 5-oxime
157	150, 125, 113, 102	4-Hydroxy-3,5,6-trimethylpyran-2-one
164	131, 103, 85, 74	2-Deoxy-D-galactose
178	177, 144, 141, 113, 102	5-Amino-4,6-dichloro-2-methylpyrimidine
185	157, 155, 126, 102	2,3-Naphthalenedialdehyde
199	152, 124	3-Acetyl-5-sec-butyl-4-hydroxy-1,5-dihydro-2*H*-pyrrol-2-one
219	127, 141, 113, 98, 27	Diethyl bis(hydroxymethyl)malonate
227	193, 186, 152, 131	7,8-Dihydroxy-6-methoxychromen-2-one
236	236, 219, 178, 141, 121	6,7,8-Trimethoxychromen-2-one
243	169, 155, 151, 141, 127, 113	1-Bromo-2-methylhexadecane
250	236, 199, 141, 134, 102	2-Amino-3-[4-hydroxy-3-(3-methylbut-2-enyl)phenyl]propanoic acid
253	236, 219, 199, 141	5,6,7-Trimethoxychromen-2-one
255	253, 124, 75, 63	*p*-Nitrophenylphosphorodichloridate
273	253, 225, 198, 157, 124	*N*-[2-(1*H*-Indol-3-yl)ethyl]acetamide
288	185, 129, 115	Tetradecanoic acid

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Mass	*m/z*[2]	*Name of compound*
291	273, 236, 227, 178	2-(4,5-Dihydroxy-2-methylphenyl)-6-hydroxy-4-methoxybenzoic acid
299	253, 236, 134	2-(3-Hexyl-4-methyl-2,5-dioxopyrrol-1-yl)-3-hydroxybutanoic acid
315	267, 258, 152, 134	5,7-Dihydroxy-2-(*p*-methoxyphenyl)-6,8-dimethyl-4-chromanone
321	295, 220, 164	2-Benzyl-1-methyl-5-nonylpyrrolidin-3-ol
325	255, 154, 134	(3*S*,6*Z*)-3-Methyl-6-[[2-(2-methylbut-3-en-2-yl)-1*H*-indol-3-yl]methylidene] piperazine-2,5-dione
371	305, 273, 228	1,3,6,8-tetrahydroxy-2-(1-hydroxyhexyl)anthracene-9,10-dione
391	243, 199, 157, 141, 103	β-D-Galactopyranosepentaacetate
401	253, 243, 121, 102	(5-Benzoyloxy-1,2,6-trihydroxycyclohex-3-en-1-yl)methyl benzoate
419	250, 236, 103	6-Benzoyl-2-(*p*-methoxyphenyl)-5-phenyl-5,6-dihydro-2*H*-1,2-thiazine 1,1-dioxide
537	356, 274, 152, 135, 124	5-Cholestene-3β,4β-diol 3-mono(*p*-anisate)
578	373, 178, 134, 102	3-[5-(3,5-Dihydroxydecanoyloxy)-3-hydroxydecanoyl]oxy-5-hydroxydecanoic acid
484	167, 144, 131	2(3*H*)-Furanone, 4-[2-[[6-*O*-[(2*E*)-3-(3,4-dihydroxyphenyl)-1-oxo-2-propen-1-yl]-β-D-glucopyranosyl]oxy]-1-methylethyl]dihydro-4-hydroxy
597	288, 164, 150, 121	(2*S*)-7-[(2*S*,3*R*,4*S*,5*S*,6*R*)-4,5-Dihydroxy-6-(hydroxymethyl)-3-[(2*S*,3*R*,4*R*,5*R*,6*S*)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxyoxan-2-yl]oxy-2-(3,4-dihydroxyphenyl)-5-hydroxy-2,3-dihydrochromen-4-one
612	304, 256, 178, 157, 136	Hesperidin
993	610, 373, 264, 136	Pentopyranoside, (3β,5ξ,9ξ,16β,18ξ,22β)-22-(benzoyloxy)-16,28-dihydroxyolean-12-en-3-yl 3-*O*-hexopyranosyl

Table 4: Quantitative analysis of phytochemicals present in the methanolic extracts of STB and SB of *Buchanania cochinchinensis* (Lour.) MR Almeida

Mass	*m/z*[2]	*Name of compound*
Methanolic extract of SB		
102	75, 57, 45	*N*-Methoxy-*N*-methylacetamide
133	132, 102, 89, 71, 59	3-Methyl-1,3,5-pentanetriol
149	131, 102	Methyl 3-hydroxyisoxazole-5-carboxylate
152	131, 124, 113	8-Azaguanine
157	156, 150, 125, 113, 102	4-Hydroxy-3,5,6-trimethylpyran-2-one
164	131, 103, 85, 74	2-Deoxy-D-galactose
180	178, 144, 141, 113, 102	5-Amino-4,6-dichloro-2-methylpyrimidine
197	152, 124	3-Acetyl-5-sec-butyl-4-hydroxy-1,5-dihydro-2*H*-pyrrol-2-one
206	144, 130, 117	4,6-*O*-ethylidene-α-D-glucopyranose
214	128, 113, 66, 43	3,4-Di-*O*-acetyl-6-deoxy-L-glucal
217	180, 152, 113, 84	L-Alanyl-L-glutamine
219	127, 141, 113, 98, 27	Diethyl bis(hydroxymethyl)malonate
226	193, 186, 152, 131	7,8-Dihydroxy-6-methoxychromen-2-one
237	164, 152, 133, 87, 67	*N*-(Ethylthio)thiocarbonyl-L-aspartic acid
255	213, 185, 171, 157, 113	Hexadecanoic acid
269	220, 192, 166, 102	2-(2-(5-Nitro-2-furyl)vinyl)quinoxaline
272	253, 225, 198, 157, 124	*N*-[2-(1*H*-Indol-3-yl)ethyl]acetamide
279	263, 220, 193, 113	6-Acetyl-1-bromo-2-methoxynaphthalene
282	141, 128, 113	9-Octadecenamide
286	185, 129, 115	Tetradecanoic acid
332	237, 219, 206, 178	3-Decanoyl-4,7-dihydroxycoumarin
338	282, 237, 219, 197, 178, 164, 156, 133	(1α,2β,4aβ,6β,8aα)-6-ethyl-1-(2-(methoxycarbonyl)ethyl)-2,6,8a-trimethyldecahydro-2-naphthalenecarboxylic acid
373	372, 272, 246, 141, 113	2-Chloro-10-(3-(4-methyl-1-piperazinyl)propyl)phenothiazine dimaleate
391	332, 269, 156, 133	Methyl 2,3,4-tri-*O*-acetyl-1-deoxy-1-thioureido-β-D-glucopyranuronate
405	152, 76	4,4′-Diiodobiphenyl

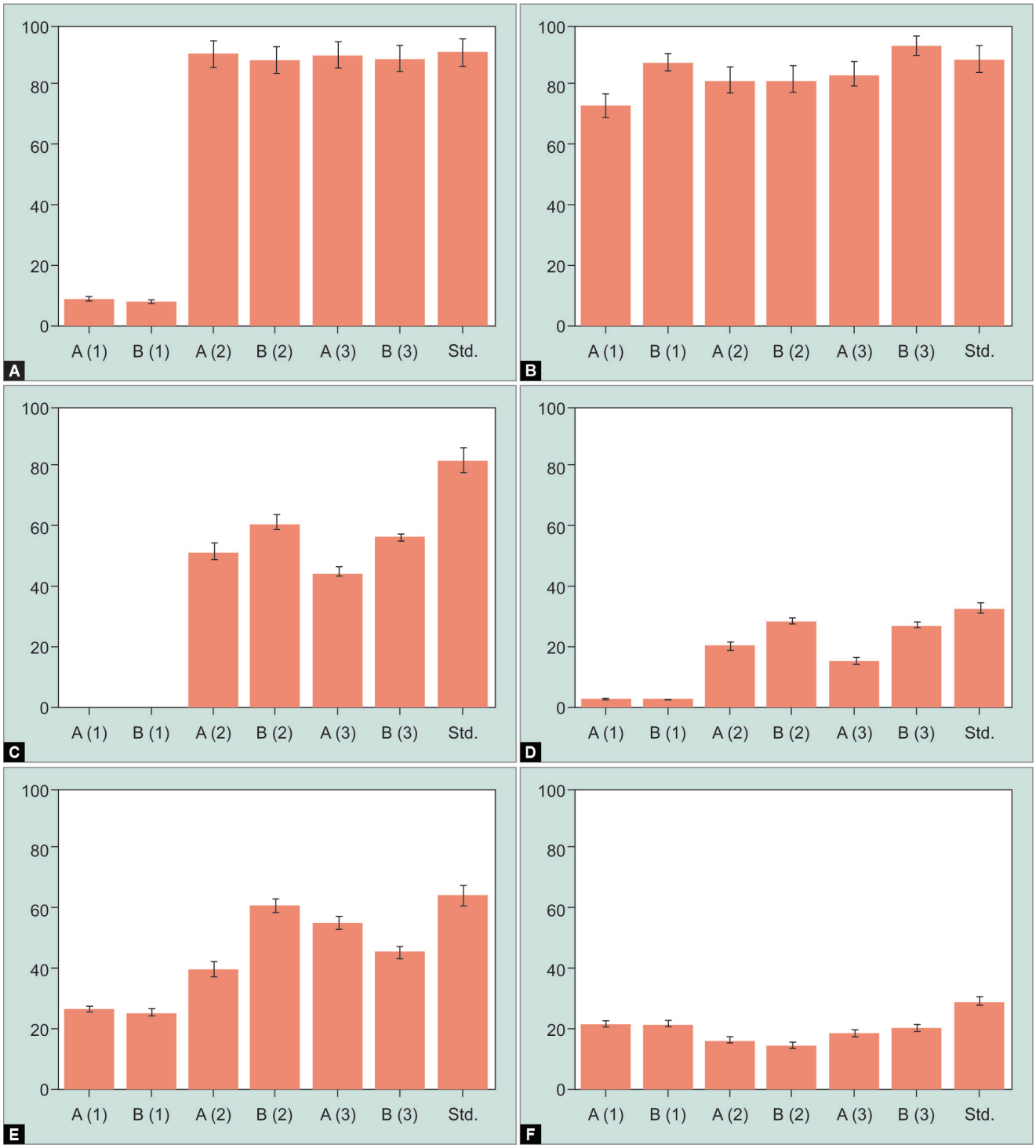
Contd…

Contd…

Mass	*m/z*[2]	*Name of compound*
443	281, 267, 185, 113	L-Ascorbic acid 6-stearate
479	173, 143, 91	2,7-Dibenzyl-1,8-diphenyl-2,7-octanediol
576	199, 103, 77	1-(3-Benzamido-5-*o*-benzoyl-2-benzoylthio-2,3-dideoxy-β-D-ribofuranosyl)-2,4(1*H*,3*H*)-pyrimidinedione
640	304, 256, 178, 157, 136	Hesperidin
686	338, 320, 113, 97	Cis,cis-*N*,*N*′-methylenebis(13-docosenamide)
712	360, 279, 214, 149, 102	1-Hydroxy-2-(2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl)-9*H*-xanthene-3,6,7-triyl triacetate
757	338, 178, 149, 133	3-Hydroxy-1-[3-hydroxy-1-oxo-1-(2,3,4,5,6-pentahydroxyhexoxy)decan-5-yl]oxy-1-oxodecan-5-yl] 3,5-dihydroxydecanoate
Methanolic extract of STB		
102	75, 57, 45	*N*-Methoxy-*N*-methylacetamide
113	112, 94, 68, 44	4-Imidazolecarboxylic acid
125	124, 80, 53, 44	2-Pyrazinecarboxylic acid
131	113, 84, 53, 43	3-Guanidinopropionic acid
137	136, 102, 89, 71, 59	3-Methyl-1,3,5-pentanetriol
142	138, 124, 105	4-Hydroxy-3,6-dimethylpyran-2-one
144	131, 102	Methyl 3-hydroxyisoxazole-5-carboxylate
157	150, 125, 113, 102	4-Hydroxy-3,5,6-trimethylpyran-2-one
164	131, 103, 85, 74	2-Deoxy-D-galactose
171	170, 153, 125, 103	Gallic acid
178	177, 144, 141, 113, 102	5-Amino-4,6-dichloro-2-methylpyrimidine
219	127, 141, 113, 98, 27	Diethyl bis(hydroxymethyl)malonate
227	193, 186, 152, 131	7,8-Dihydroxy-6-methoxychromen-2-one
236	236, 219, 178, 141, 121	6,7,8-Trimethoxychromen-2-one
243	169, 155, 151, 141, 127, 113	1-Bromo-2-methylhexadecane
256	253, 124, 75, 63	*p*-Nitrophenyl phosphorodichloridate
269	220, 192, 166, 102	2-(2-(5-Nitro-2-furyl)vinyl)quinoxaline
280	140, 128, 114, 112	9-Octadecenamide
283	184, 148, 137, 124, 114, 111	12-Hydroxy-9-octadecenoic acid
299	253, 236, 134	2-(3-Hexyl-4-methyl-2,5-dioxopyrrol-1-yl)-3-hydroxybutanoic acid
313	267, 258, 152, 134	5,7-Dihydroxy-2-(*p*-methoxyphenyl)-6,8-dimethyl-4-chromanone
321	295, 220, 164	2-Benzyl-1-methyl-5-nonylpyrrolidin-3-ol
341	340, 169, 144, 113	5-(3-Chloro-4-thiocyanatophenylazo)-8-quinolinol
366	363, 319, 169 152, 113, 102	1-Acetyl-2-morpholino-5,5-diphenyl-2-imidazolin-4-one
375	305, 273, 228	1,3,6,8-Tetrahydroxy-2-(1-hydroxyhexyl)anthracene-9,10-dione
391	243, 199, 157, 141, 103	β-D-Galactopyranosepentaacetate
437	391, 236, 171, 166, 144, 131	Dimethyl 5′,6′-bis(methylthio)-*p*-terphenyl-2′,3′-dicarboxylate
443	281, 267, 185, 113	L-Ascorbic acid 6-stearate
462	420, 303, 283, 256, 236	(1α,2α,3α)-1,2,3,5,8-Pentahydroxy-6-methoxy-3-methyl-1,2,3,4-tetrahydroanthraquinone 1,2,8-triacetate
467	304, 256, 178, 157, 136, 103	Glycyrrhetinic acid
487	485, 167, 144, 131	2(3*H*)-Furanone, 4-[2-[[6-*O*-[(2*E*)-3-(3,4-dihydroxyphenyl)-1-oxo-2-propen-1-yl]-β-D-glucopyranosyl]oxy]-1-methylethyl]dihydro-4-hydroxy
536	356, 274, 152, 135, 124	5-Cholestene-3β,4β-diol 3-mono(*p*-anisate)
662	373, 178, 134, 102	3-[5-(3,5-Dihydroxydecanoyloxy)-3-hydroxydecanoyl]oxy-5-hydroxydecanoic acid

observed values for various extracts, viz., petroleum ether, acetone, and methanol extracts of SB and STB were 9.04 ± 0.91%, 8.22 ± 0.88%, 90.83 ± 3.02%, 88.83 ± 3.77%, 90.48 ± 2.55%, and 89.18 ± 2.91% respectively. In present study, polar solvent extracts, i.e., acetone and methanol extracts of SB and STB of BC under study demonstrated almost similar antioxidant properties to that of ascorbic acid (Fig. 1A). Clearly, the DPPH properties are similar in both STB and SB.

Under metal-chelating assay, EDTA was used as a control and the observed value for the assay was 89.17 ± 2.84%. Under similar experimental conditions, the observed value for petroleum ether,



Figs 1A to F: *In vitro* antioxidant assays of the various extracts *of Buchanania cochinchinensis* (Lour.) MR Almeida. (A) DPPH radical scavenging activity; (B) Metal-chelating scavenging activity; (C) Ferric-reducing antioxidant power scavenging activity; (D) Reducing power; (E) Superoxide radical scavenging activity; (F) Nitric oxide radical scavenging activity. Code: A, SB; B, STB. Solvents: petroleum ether (1), acetone (2), and methanol (3). Values are expressed as mean ± SD ($n = 3$)

acetone, and methanol extracts of SB and STB was 73.61 ± 2.14%, 88.05 ± 3.65%, 81.93 ± 2.89%, 82.23 ± 3.12%, 84.24 ± 2.54%, and 93.62 ± 3.53%, respectively (Fig. 1B). Clearly, the STB demonstrated a higher activity as compared to that of SB in petroleum ether and methanolic extract (Fig. 1B).

In other antioxidant assay, i.e., FRAP, the observed values for control (ferrous sulfate) were 82.73 ± 2.42%; and under the same conditions, the value for acetone and methanol extracts of SB and STB was 52.34 ± 1.93%, 61.71 ± 2.19%, 45.29 ± 2.21%, and 57.01 ± 2.11%, respectively (Fig. 1C). It was noticed that

petroleum ether extracts of SB and STB have no FRAP antioxidant activities but polar solvents showed significant activities under the FRAP assay.

The percentage of antioxidant activity for ascorbic acid (control) was 33.23 ± 1.44 and for petroleum ether, acetone, and methanol extracts of SB and STB was 2.66 ± 0.037, 2.41 ± 0.12, 20.31 ± 1.07, 28.92 ± 1.28, 15.48 ± 1.31, 27.43 ± 1.83, respectively. Clearly, the antioxidant properties of acetone and methanol extracts are almost similar to that of ascorbic acid (Fig. 1D). Low activities were observed for petroleum ether extracts (2.4–2.7% only). The STB's acetone and methanolic extracts have low activities (15.40–20.30% only) as compared to the control.

The percentage of radical scavenging activity (antioxidant superoxide) against NO, for ascorbic acid (control) was 64.98 ± 2.38 and for petroleum ether, acetone, and methanol extracts of SB and STB was 26.81 ± 1.11, 25.65 ± 1.19, 40.26 ± 1.96, 61.41 ± 2.58, 55.75 ± 2.12, and 45.99 ± 2.22, respectively. Clearly, acetone and methanol extracts have better antioxidant properties compared to that of petroleum ether, but all less than that of ascorbic acid (Fig. 1E). Here petroleum ether and methanolic extracts of SB demonstrated more superoxide radical scavenging activity compared to that of STB

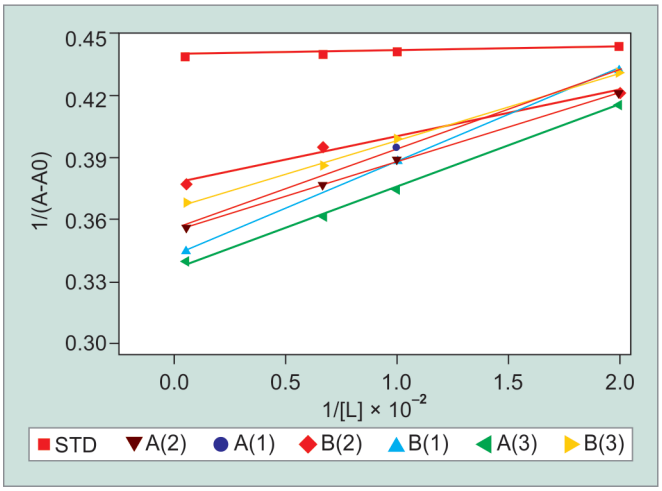


Fig. 2: Quantitative analysis of rate constants of the various extracts of STB and SB of *Buchanania cochinchinensis* (Lour.) MR Almeida observed in bovine serum albumin study

Table 5: Total phenolic and flavonoid contents of various extracts of SB and STB of *Buchanania cochinchinensis* (Lour.) MR Almeida. Code: A = STB, B = SB. Solvents: petroleum ether (1), acetone (2), and methanol (3). Values are expressed as mean ± SD (n = 3)

Extract	*Total phenolic content (mg of GAE/g) Y = 0.303X + 0.007), R^2 = 0.999*	*Total flavonoid content (mg of QE/g) (Y = 0.040X + 0.012), R^2 = 0.999)*
A(1)	2.811 ± 0.21	3.755 ± 0.49
B(1)	2.971 ± 0.27	6.254 ± 0.65
A(2)	32.34 ± 2.15	75.25 ± 2.31
B(2)	92.91 ± 3.11	87.05 ± 3.57
A(3)	15.672 ± 1.67	30.52 ± 1.64
B(3)	10.068 ± 1.61	67.54 ± 2.78

Table 6: Quantitative analysis of rate constants of the various extracts of STB and SB of *Buchanania cochinchinensis* (Lour.) MR Almeida observed in bovine serum albumin study

Std/extract	*Equation of line*	*R^2*	*Binding constant (k)*
Acetylsalicylic acid	$Y = 0.002X + 0.438$	0.971	$2.31 \pm 0.05 \times 10^{-5}$ μM^{-1}
Petroleum ether extract of branches	$Y = 0.061X + 0.342$	0.999	$61.5 \pm 2.45 \times 10^{-5}$ μM^{-1}
Petroleum ether extract of STB	$Y = 0.039X + 0.354$	0.999	$39.5 \pm 1.11 \times 10^{-5}$ μM^{-1}
Acetone extract of branches	$Y = 0.022X + 0.378$	0.982	$22.4 \pm 1.01 \times 10^{-5}$ μM^{-1}
Acetone extract of STB	$Y = 0.031X + 0.356$	0.994	$31.3 \pm 1.16 \times 10^{-5}$ μM^{-1}
Methanolic extract of branches	$Y = 0.032X + 0.366$	0.996	$32.7 \pm 1.14 \times 10^{-5}$ μM^{-1}
Methanolic extract of STB	$Y = 0.039X + 0.336$	0.997	$33.3 \pm 1.15 \times 10^{-5}$ μM^{-1}

Table 7: Antibacterial activities of various extracts of *Buchanania cochinchinensis* (Lour.) MR Almeida of SB and STB. Code: A = SB, B = STB. Solvents: petroleum ether (1), acetone (2), and methanol (3). Values are expressed as mean ± SD (n = 3)

Strain	*Conc. (ppm)*	*C*	*A(1)*	*B(1)*	*A(2)*	*B(2)*	*A(3)*	*B(3)*
Streptococcus mutans	250	9 ± 0.2	0 ± 0.0	0 ± 0.0	8 ± 0.2	7 ± 0.3	2 ± 0.2	4 ± 0.2
	500	12 ± 0.5	0 ± 0.0	0 ± 0.0	9 ± 0.4	13 ± 0.4	6 ± 0.5	8 ± 0.4
	1,000	23 ± 0.7	3 ± 0.1	4 ± 0.2	13 ± 0.5	16 ± 0.8	11 ± 0.8	13 ± 0.5
Salmonella enteric	250	9 ± 0.2	0 ± 0.0	0 ± 0.0	4 ± 0.3	4 ± 0.2	3 ± 0.2	0 ± 0.0
	500	13 ± 0.3	0 ± 0.0	0 ± 0.0	9 ± 0.5	7 ± 0.6	5 ± 0.6	5 ± 0.3
	1,000	19 ± 0.8	3 ± 0.1	2 ± 0.1	19 ± 0.7	14 ± 0.6	6 ± 0.6	6 ± 0.5
Staphylococcus aureus	250	7 ± 0.4	0 ± 0.0	0 ± 0.0	3 ± 0.4	3 ± 0.3	5 ± 0.3	4 ± 0.3
	500	10 ± 0.5	0 ± 0.0	2 ± 0.1	7 ± 0.5	7 ± 0.4	7 ± 0.4	7 ± 0.4
	1,000	17 ± 0.5	6 ± 0.4	9 ± 0.7	9 ± 0.8	11 ± 0.5	11 ± 0.5	10 ± 0.4
Pseudomonas aeruginosa	250	9 ± 0.2	3 ± 0.2	2 ± 0.0	7 ± 0.2	3 ± 0.3	4 ± 0.2	4 ± 0.3
	500	14 ± 0.6	3 ± 0.2	3 ± 0.1	8 ± 0.5	7 ± 0.5	7 ± 0.4	9 ± 0.5
	1,000	21 ± 0.8	8 ± 0.4	6 ± 0.2	14 ± 0.5	10 ± 0.3	11 ± 0.8	12 ± 0.7

Table 8: Antifungal activities of various extracts of *Buchanania cochinchinensis* (Lour.) MR Almeida of SB and STB. Code: A = SB, B = STB. Solvents: petroleum ether (1), acetone (2), and methanol (3).Values are expressed as mean ± SD ($n = 3$)

Strain	*Conc. (ppm)*	*C*	*A(1)*	*B(1)*	*A(2)*	*B(2)*	*A(3)*	*B(3)*
Aspergillus parasiticus	250	8 ± 0.3	0 ± 0.0	0 ± 0.0	7 ± 0.3	3 ± 0.2	0 ± 0.0	0 ± 0.0
	500	11 ± 0.3	4 ± 0.0	5 ± 0.4	8 ± 0.3	6 ± 0.2	4 ± 0.2	2 ± 0.1
	1,000	19 ± 0.7	8 ± 0.3	7 ± 0.5	12 ± 0.7	10 ± 0.3	7 ± 0.3	6 ± 0.4
Candida albicans	250	7 ± 0.3	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0
	500	10 ± 0.3	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	2 ± 0.2	5 ± 0.3
	1,000	15 ± 0.7	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	4 ± 0.3	8 ± 0.5
Aspergillus niger	250	5 ± 0.3	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	2 ± 0.1	0 ± 0.0
	500	8 ± 0.3	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	3 ± 0.3	4 ± 0.2
	1,000	14 ± 0.7	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	5 ± 0.4	5 ± 0.4

extracts. Acetone extracts of STB showed more activity compared to that of SB extracts.

The percentage of radical scavenging activity (antioxidant superoxide) against NO, for ascorbic acid (control) was observed 29.21 ± 1.58 and for petroleum ether, acetone, and methanol extracts of SB and STB was 21.65 ± 1.12, 21.76 ± 1.22, 16.34 ± 1.61, 14.59 ± 1.45, 18.61 ± 1.08, and 20.51 ± 1.24, respectively. Clearly, petroleum ether and methanolic extracts have better antioxidant property compared to that of acetone extracts of SB and STB as compared with ascorbic acid; it highlights STB and SB as useful drugs (Fig. 1F). Here we noticed that both STB and SB have almost the same activities.

For phosphomolybdenum antioxidant assay, the percentage of antioxidant activity for ascorbic acid (without treatment) was 85.31 ± 2.11 and for petroleum ether, acetone, and methanol extracts of SB and STB was 1.63 ± 0.19, 0.69 ± 0.05, 31.26 ± 1.94, 37.66 ± 2.12, 25.73 ± 1.55, and 32.21 ± 2.29, respectively. Evidently, petroleum ether extracts have poor antioxidant property than acetone and methanol extracts of SB and STB, as compared with ascorbic acid. Here SB extracts have fewer activities than STB extracts.

Total Flavonoid and Phenol Contents

The outcomes of the total phenolics were estimated in equivalents of gallic acid and the total flavonoids in QEs (Table 5). Like the antioxidant properties, the polar solvents, i.e., acetone and methanolic extracts demonstrated higher phenolic and flavonoid content, indicating the linear relationship between these two values. In acetone and methanolic extracts, the observed values for total phenolic content ranged from 10 to 93 mg of gallic acid and TFC ranged from 30 to 87 mg of quercetin (Table 5).

Anti-inflammatory and Protein-binding Assay

Denaturation of proteins causes inflammation. In this study, all extracts showed good inhibition (95–98%) against BSA protein. In the second experiment of BSA protein, the behavior of extracts and acetylsalicylic acid were determined by combining it with the BSA protein. The BSA protein binds to acetylsalicylic acid and various extracts of SB and STB were performed.[1,3] The mean values of protein-binding constants are observed to be $2.31 \pm 0.05 \times 10^{-5}$ μM^{-1} for acetylsalicylic acid (ASA) and $61.5 \pm 2.45 \times 10^{-5}$ μM^{-1}, $39.5 \pm 1.11 \times 10^{-5}$ μM^{-1}, $22.4 \pm 1.01 \times 10^{-5}$ μM^{-1}, $31.3 \pm 1.16 \times 10^{-5}$ μM^{-1}, $32.7 \pm 1.14 \times 10^{-5}$ μM^{-1} and $33.3 \pm 1.15 \times 10^{-5}$ μM^{-1} for various extracts (Fig. 2 and Table 6).

This study confirms the weak interaction of BSA complex with extracts which is used as drug delivery systems in the present world.

Antimicrobial Activities

Antibacterial Activity

Tables 7 and 8 exhibited the antimicrobial activities, and various extracts showed mild effects against the selected bacterial and fungal strains. Like the antioxidant assays and TPC and TFC, polar solvents, i.e., acetone and methanolic extracts showed good inhibition against the selected strains. Table 7 exhibited that acetone and methanol extracts are more effective as compared to the petroleum ether for bacterial strains under study. Acetone extracts have reportedly and significantly repressed the growth of all the strains studied, whereas the methanolic extract could significantly inhibit the growth of *Streptococcus mutans*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. Table 8 exhibited the antifungal results of selected strains. It was noticed that all the extracted compounds inhibit the growth of *Aspergillus parasiticus*. But petroleum ether and acetone extracts were found to be inactive against *Candida albicans* and *Aspergillus niger*. Methanolic extracts were found to be positive against *C. albicans* and *A. niger* as well as *A. parasiticus*.

To understand the antibacterial potential against various gram-positive and gram-negative bacteria, several extracts including ether, ethyl acetate, aqueous, and methanol extracts of plants tested in previously documented studies were reviewed. Methanolic extracts displayed significant activity against *Bacillus subtilis* (8 ± 0.4 mm), *Bacillus cereus* (12 ± 0.8 mm), *P. aeruginosa* (9 ± 0.5 mm), *Proteus vulgaris* (7 ± 0.4 mm), *Salmonella* sp. (12 ± 1.5 mm), *Trichoderma viride* (10 ± 0.9 mm), *Penicillium* sp. (8 ± 0.3 mm), and *A. niger* (6 ± 0.9 mm). Furthermore, no activity of methanolic extract of bark of *Buchanania cochinchinensis* (Lour.) against *S. aureus* and *Escherichia coli* was found.[2–6]

Plant-derived natural products having poor antimicrobial and antifungal activities are reported to represent synergism against microbial pathogens when combined with various chemotherapeutic compounds.

Conclusion

In conclusion, the findings of STB and SB of BC provide undeniable systematic facts of its beneficial prospective as an Ayurvedic drug. The major outcomes of the current study are the following:

- Under physicochemical parameters, significant difference was found between the extractive values of SB and STB under various solvents. A nonsignificant difference was found for pH and ash values.

- Under phytochemical studies, in acetone and methanolic extracts, the observed values for TPC ranged from 10 to 93 mg of GAE/g of extract and TFC it ranged from 30 to 87 mg of QE/g of extract.
- Under biochemical assay, in antioxidant assays, as compared to control(s), acetone and methanol extracts of SB and STB were more potent compared to petroleum ether extracts of SB and STB.

Overall, based upon the physicochemical, photochemical, and biochemical studies, polar solvents (acetone and methanol) are the best solvent system to extract the maximum phytochemical constituents with significant biochemical activities. Hence, the present study provides a scientific evidence to substitute stem bark and small branches in place of roots, which can protect the plant from destruction.

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हिंदी सारांश

आयुर्वेदिक औषधियों के प्रतिनिधि द्रव्य हेतु *बुचनानिया कोचिचांईनेसिस* (लौर.) एम.आर. अलमीड़ा के तने की छाल और छोटी शाखाओं की फाइटोकेमिकल, एंटीओक्सीडेंट और एंटीमाइक्रोबियल क्षमता का तुलनात्मक मूल्यांकन

उद्देश्य: वर्तमान अध्ययन का आशय *बुचनानिया कोचिचांईनेसिस* (लौर.) एम.आर. अलमीड़ा के तने की छाल (एसटीबी) और छोटी शाखाओं (एसबी) के भौतिकरासायनिक मापदंडों, फाइटोकेमिकल घटकों और जैवरासायनिक अध्ययनों की जांच करना।

सामग्री और विधियां: विभिन्न घुलनशील द्रव्यों यथा पेट्रोलियम ईथर, एसीटोन और मिथेनोल आदि में मापदंडों की जांच की गई।

परिणाम: नियंत्रण की अपेक्षा पादप के एसटीबी और एसबी के एसीटोन और मिथेनोलिक निस्सार में महत्वपूर्ण एंटीओक्सीडेंट (10-85%) और एंटीमाइक्रोबियल (5-20 एमएम) गतिविधियां देखी गईं। एसीटोन और मिथेनोलिक निस्सार में, कुल फिनोल कंटेंट (टीपीसी) निस्सार के प्रति ग्राम गेलिक अम्ल एक्विलेंट की मात्रा 10 मि.ग्रा. से 93 मि. ग्रा. है और कुल फ्लेवेनोइड कंटेंट (टीएफसी) निस्सार के प्रति ग्राम के क्वेरसेटिन एक्विलेंट (क्यूई) की मात्रा 30 मि. ग्रा. से 87 मि. ग्रा. है। सभी निस्सारों का बोवीन सिरम एल्बमिन (बीएसए) प्रोटीन इंटरेक्शन अध्ययन किया गया और बाइंडिंग कोंस्टेंट के लिए ओब्जर्व्ड वेल्यूज 22 से $62*10^{-5}$ μM^{-1} है।

निष्कर्ष: कुल मिलाकर, पादप के एसटीबी और एसबी के एसीटोन और मिथेनोलिक निस्सार में उपर्युक्त औषधीय पहलुओं पर महत्वपूर्ण परिणाम देखे गए हैं।

नैदानिक महत्व: *बुचनानिया कोचिचांईनेसिस* (लौर.) एम.आर. अलमीड़ा के एसटीबी और एसबी के तुलनात्मक परिणाम से आयुर्वेदिक औषधि के रूप में इसके लाभकारी पहलुओं के अकाट्य व्यवस्थित तथ्य को उजागर करता है।

मुख्य शब्द: एंटीमाइक्रोबियल, एंटीओक्सीडेंट, *बुचनानिया,* औषधीय पादप, प्राकृतिक उत्पाद, फाइटोकेमिकल।