



Research Journal of
Phytochemistry

ISSN 1819-3471



Academic
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Estimation of Protocatechuic Acid in Greater Cardamom Fruit Extracts by HPTLC Method

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Abstract: The aim of present study was development of simple, rapid and accurate HPTLC method for estimation of Protocatechuic acid in various extracts of *Amomum subulatum* Roxb. fruit constituents (Family Zingiberacea), commonly known as Badi Elaichi or Greater Cardamom. The powdered drug was subjected to extraction by soxhlet apparatus using methanol and acetone separately as well as petroleum ether (40-60), chloroform, methanol and water successively. The extracts were screened for presence of various phytoconstituents using preliminary chemical tests. Protocatechuic acid was estimated in methanol and acetone extract by HPTLC method. Detection and quantification was performed at wavelength 254 nm. The acetone and methanol extracts were found to contain 1.04846 and 0.8634% w/w protocatechuic acid, respectively by using validated method. Since, this method resolves and quantifies protocatechuic acid accurately and precisely, it can be useful for quantification of the compound in herbal formulation.

Key words: Protocatechuic acid, HPTLC, *Amomum subulatum* Roxb.

INTRODUCTION

The quality of herbal medicine is implication of safety and efficacy, which is profile of constituents present in it. It is difficult to establish quality control parameters of plant based drug due to complex nature and inheritant variability of chemical constituents. So, modern analytical techniques should be implicated to over come this problem (Rajani and Kanaki, 2008).

Since, ancient time seeds of *Amomum subulatum* Roxb. had been valued for its aroma and flavor, as spice and condiment. The seeds are reported in Ayurvedic system of medicine and are an official drug in Ayurvedic Pharmacopoeia which are marketed under the name of greater cardamom (Anonymous, 1999). Traditionally it has been used for digestive problems, treating flatulence, loss of appetite, gastric complaints, congestion of liver and also recommended in cases of inflammatory condition of eyes (Anonymous, 2006). Orally administered *A. subulatum* was found to be useful in prevention of hyperlipidaemia and provide antioxidant protection (Joshi and Joshi, 2007). An anti-wrinkle cream containing *A. subulatum* was evaluated in the treatment of facial skin wrinkles by prospective, open, phase III clinical trial and showed that the active constituents of *A. subulatum* (protocatechualdehyde and protocatechuic acid) have potent antioxidant activity (Ravichandran *et al.*, 2005). Greater cardamom (*A. subulatum*) have significant ability to inhibit lipid peroxidation in rat liver homogenate due to their polyphenol content, strong

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reducing power and superoxide radical scavenging activity (Yadav and Bhatnagar, 2007). Protocatechualdehyde, Protocatechuic acid, 1,7-bis (3,4-dihydroxyphenyl) hepta-4E, 6E-dien-3-one and 2,3,7-trihydroxy-5-(3,4-dihydroxy-E-styryl)-6,7,8,9-tetrahydro-5H-benzocycloheptene was isolated from greater cardamom and evaluated for its antioxidant activity (Kikuzaki *et al.*, 2001).

It was found to possess antioxidant activity, attributed to presence of protocatechuic acid. So, *A. subulatum* fruit extracts were subjected to HPTLC analysis by developing a method for estimation of protocatechuic acid in methanol and acetone extract. The proposed method has been validated as per ICH guidelines (ICH Q2A, 1994; ICH Q2B, 1996).

MATERIALS AND METHODS

Present study was conducted at BMCPER, Modasa, Gujarat and RBPMPC, Atkot, Dist Rajkot, Gujarat, India during January 2007 to November 2008.

Collection and Authentication of the Fruits and Seeds

The fruits of *Amomum subulatum* Roxb. were collected from local market of Modasa and authenticated by Dr. H.B. Singh Scientist and Head of Raw Materials Herbarium and Museum Department of National Institute of Science and Communication and Information Resources, New Delhi (NISCAIR) and preserved at the herbarium in Department of Pharmacognosy, B.M. Shah College of Pharmaceutical Education and Research, Modasa.

Extraction and Phytochemical Investigations

One hundred grams powder of fruit constituents of *A. subulatum* were extracted with methanol and acetone separately. Successive extraction was performed by using Petroleum ether (40-60), chloroform and Methanol successively by soxhlet apparatus and lastly remaining marc was refluxed with water. The extracts were concentrated and air dried, weighed and percentage yield was determined. Qualitative chemical tests for identifying various phytoconstituents present were carried out on all extracts of *A. subulatum* Roxb. fruit constituents (Evans, 2002).

Estimation of Protocatechuic Acid by HPTLC in Methanol and Acetone Extract of *A. subulatum* Roxb Fruit Constituents

Materials

Standard Protocatechuic acid was purchased from LGC Promochem Pvt. Ltd. Bangalore. All the chemicals used in the experiments are of analytical grade.

Experimental Condition

Sample Applicator

Camag Linomat V Automatic Sample Spotter.

Stationary Phase

Precoated silica gel plates 60 F254 (10×10 cm, with 0.2 mm thickness, E. Merck, Darmstadt, Germany). The plates were prewashed by methanol and activated at 60°C for 5 min prior to chromatography.

Solvent System

Chloroform: Acetic acid (9:1) (Harborne, 2005).

Development Chamber

The CAMAG glass twin-through chamber (1010 cm) previously saturated with the solvent for 60 min (temperature 25.2°C, relative humidity 40%). The development distance was 8 cm subsequent to the scanning.

Scanner

Camag TLC scanner III in absorbance mode at 254 nm and operated by Win-Cats software 4.03 version. Evaluation was *via* peak areas with linear regression.

Calibration Curve of Standard Protocatechuic Acid

A stock solution of Protocatechuic acid was prepared by dissolving 10 mg of compound in ethanol and volume was made up to 10 mL in volumetric flask. From this solution 0.1, 0.2, 0.3, 0.4, 0.5, 0.6 and 0.8 μ L spots were applied on plate as shown in Fig. 1.

Estimation of Protocatechuic Acid in Alcoholic and Acetone Extract

To determine content of Protocatechuic acid in Methanolic and acetone extract, an accurately weighed 50 mg of extracts were transferred to 10 mL volumetric flask separately. Then dissolved in ethanol and diluted up to 10 mL with ethanol. The solutions were filtered with what man no. 1 filter paper. Spots of 5 and 10 μ L of both the solutions were applied to TLC plate along with 0.2, 0.4, 0.6 and 0.8 μ L of Protocatechuic acid Standard (1 mg mL^{-1}) spots on same plate as shown in Fig. 2. Peak of Protocatechuic acid in extract solution was identified by matching the R_f with peak obtained in Protocatechuic acid Standard solution.

The method was validated in terms of linearity, precision, repeatability, specificity, Limit of Detection (LOD), Limit of Quantification (LOQ) (ICH Q2A, 1994; ICH Q2B, 1996).

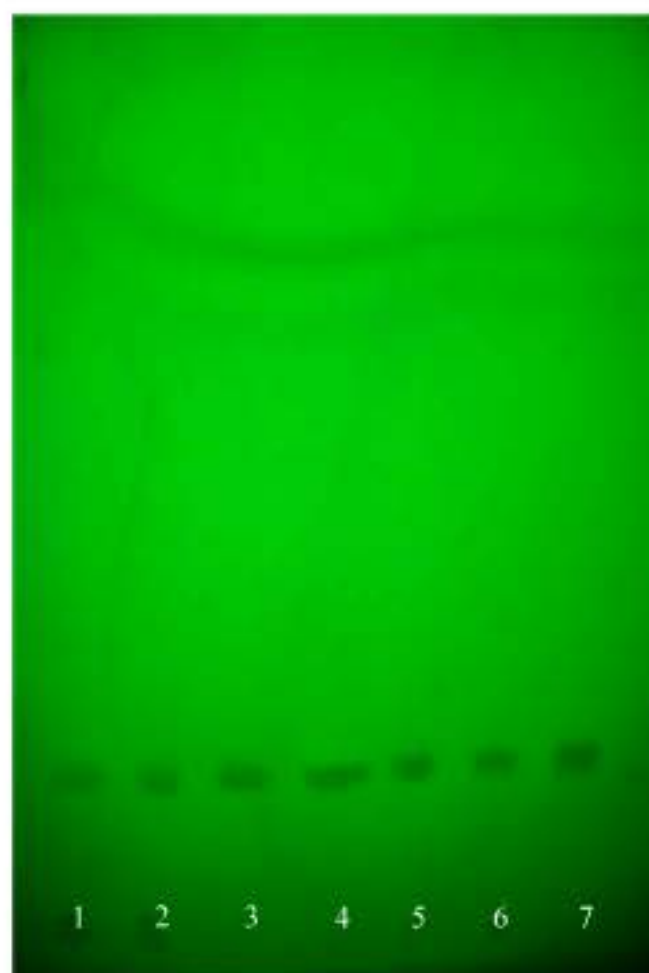


Fig. 1: Image of HPTLC plate (254 nm) for calibration curve. 1: 100 ng of protocatechuic acid standard, 2: 200 ng of protocatechuic acid standard, 3: 300 ng of protocatechuic acid standard, 4: 400 ng of protocatechuic acid standard, 5: 500 ng of protocatechuic acid standard, 6: 600 ng of protocatechuic acid standard, 7: 800 ng of protocatechuic acid standard



Fig. 2: Image of HPTLC plate (254 nm). 1: 5 μ L Acetone extract (5 mg mL⁻¹), 2: 10 μ L acetone extract (5 mg mL⁻¹), 3: 5 μ L methanol extract (5 mg mL⁻¹), 4: 10 μ L methanol extract (5 mg mL⁻¹), 5: 0.2 μ L protocatechuic acid standard (1 mg mL⁻¹), 6: 0.4 μ L protocatechuic acid standard (1 mg mL⁻¹), 7: 0.6 μ L protocatechuic acid standard (1 mg mL⁻¹), 8: 0.8 μ L protocatechuic acid standard (1 mg mL⁻¹), solvent system chloroform: acetic acid (9:1), detection at 254 nm

RESULTS

Result in Table 1 showed that 15.06% w/w methanol extract having dark brownish black color with characteristic odour and semisolid consistency, 14.56% w/w acetone extract having dark brownish black color with characteristic odour and semisolid consistency were obtained after extraction. While successive extraction was performed with Petroleum ether, chloroform, methanol and water successively and its % yield, colour, odour and consistency are shown in Table 1.

Qualitative chemical examinations of various extracts revealed the presence of carbohydrates, flavonoids, amino acids, steroids, triterpenoids, glycosides and tannins. Methanol and Acetone extracts showed presence of carbohydrates, flavonoids, amino acids, steroids, triterpenoids, glycosides and tannins and phenolics. Petroleum ether showed presence of steroids and terpenoids, while successive chloroform extract showed presence of steroidal compounds (Table 2).

Estimation of Protocatechuic Acid by HPTLC Methanol and Acetone extract of *A. subulatum* Roxb.

HPTLC Finger Printing of Both Extract

Figure 3 showed that in Acetone extract 8 peaks were observed its R_f and area is shown in Table 3, out of which Peak No. 2 at R_f 0.16 was assigned as Protocatechuic acid by matching R_f with standard Protocatechuic acid which is shown in image of HPTLC plate (Fig. 2).

Table 1: Physical characters of various extracts of *A. subulatum* Roxb. fruit constituents

Extract	% Dry wt. (g)	Colour	Odour	Consistency
Methanol	15.06	Dark Brownish black	Characteristic	Semisolid
Acetone	14.56	Dark Brownish black	Characteristic	Semisolid
Successive extraction				
Petroleum Ether (40-60°C)	08.11	Brownish	Characteristic	Waxy
Chloroform	03.05	Brownish	Characteristic	Semisolid
Methanol	14.16	Dark Brownish black	Characteristic	Semisolid
Aqueous	02.09	Brown	Characteristic	Semisolid

Table 2: Phytochemical screening of various extracts of *A. subulatum* Roxb fruit constituents

Nature	Methanol	Acetone	SPE	SCH	SMET	SAQ
Alkaloids	-	-	-	-	-	-
Carbohydrates	+	+	-	-	+	+
Flavonoids	+	+	-	-	+	+
Amino acids	+	+	-	-	+	+
Steroids	+	+	+	+	+	-
Triterpenoids	+	+	+	-	+	-
Saponins	-	-	-	-	-	-
Glycosides	+	+	-	-	+	+
Tanins and phenolics	+	+	-	-	+	+

SPE: Petroleum ether, SCH: Chloroform, SMET: Methanol, SAQ: Aqueous

Table 3: Rf and area of peaks observed in HPTLC chromatogram of 10 μ L Acetone extract (5 mg mL⁻¹) solution of *Amomum subulatum* Roxb.

Peak No.	Rf	Area
1	0.09	12149.8
2	0.16	2734.5
3	0.27	657.5
4	0.35	1190.8
5	0.64	1891.7
6	0.78	13094.5
7	0.84	2981.1
8	0.91	2119.3

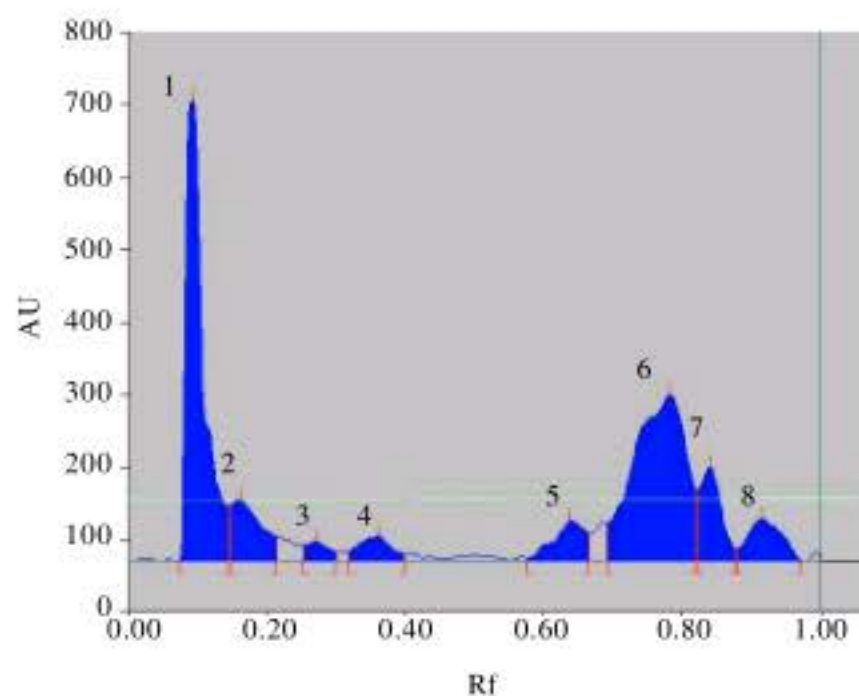


Fig. 3: HPTLC finger print chromatogram of 10 μ L Acetone extract (5 mg mL⁻¹) solution of *Amomum subulatum* Roxb

Figure 4 showed that in Methanol extract 11 peaks were observed its Rf and area is shown in Table 4. Here, Peak No. 2 at Rf 0.16 was assigned as Protocatechuic acid by matching Rf with standard Protocatechuic acid which is shown in image of HPTLC plate (Fig. 2).

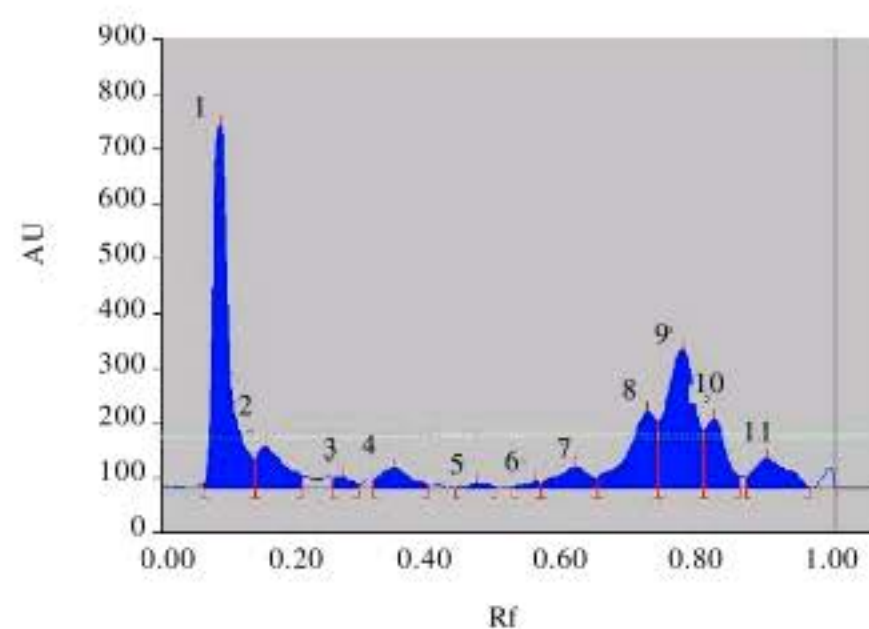


Fig. 4: HPTLC finger print of chromatogram 10 μ L Methanolic extract (5 mg mL⁻¹). Solution of *Amomum subulatum* Roxb.

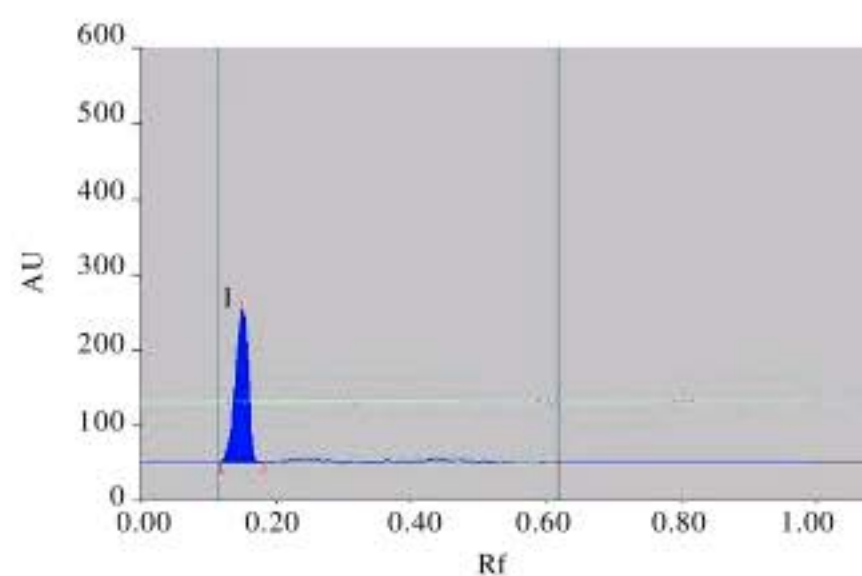


Fig. 5: Chromatogram of standard Protocatechuic acid (Rf 0.16); Mobile phase: Chloroform: acetic acid (9:1)

Table 4: Rf and area of peaks observed in HPTLC chromatogram of 10 μ L Methanolic extract (5 mg mL⁻¹) solution of *Amomum subulatum* Roxb.

Peak No.	Rf	Area
1	0.06	11852.6
2	0.16	2307.6
3	0.25	430.5
4	0.31	1227.2
5	0.44	209.8
6	0.52	205.8
7	0.90	1388.7
8	0.65	4478.8
9	0.74	8049.2
10	0.81	2824.1
11	0.87	2054.4

Estimation of Protocatechuic Acid in Acetone and Methanol Extracts

Standard Protocatechuic acid showed single peak in HPTLC Chromatogram and single spots were observed on HPTLC plate as shown in Fig. 1, 5 and 6.

Concentration of Protocatechuic acid in acetone extract and methanol extract were found to be 1.048 and 0.863% w/w, respectively calculated by regression equation:

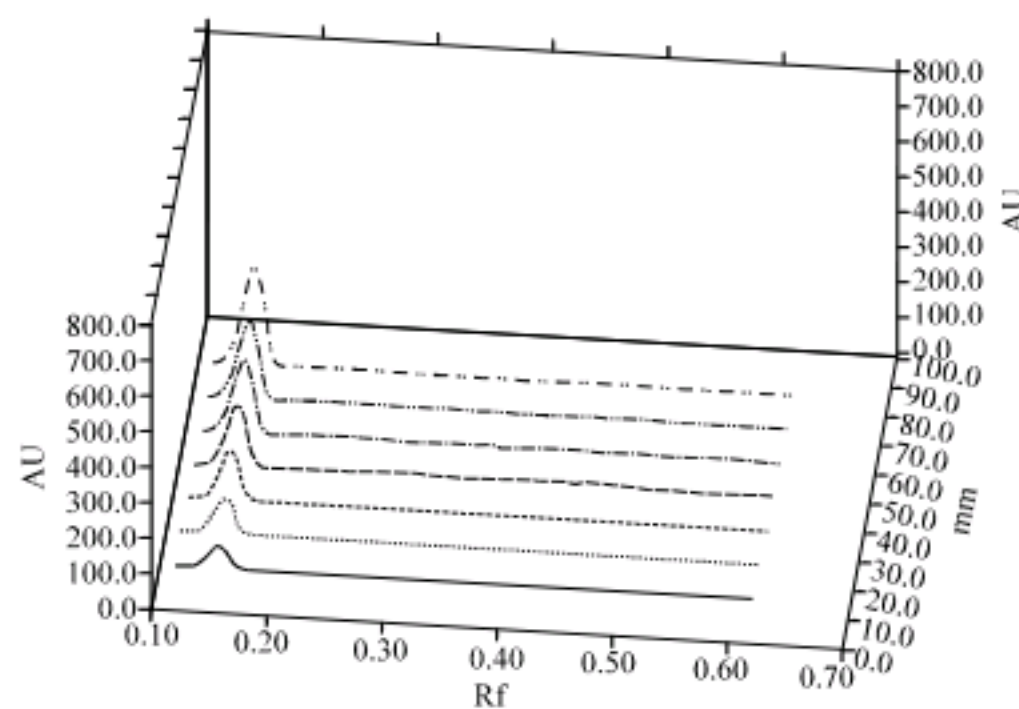


Fig. 6: Three dimensional image of calibration spots of protocatechuic acid (all tracks at 254 nm)

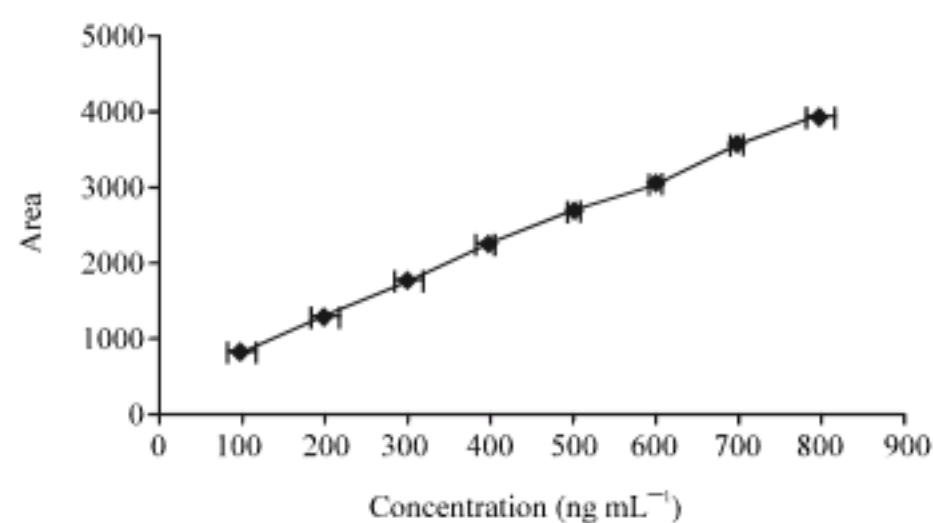


Fig. 7: Calibration curve of protocatechuic acid Standard. ($R^2 = 0.9994$), data expressed as Mean $\pm$ SEM, n = 5

$$y = 4.6142x + 315.61$$

Obtained from calibration curve of standard protocatechuic acid (Fig. 7).

Validation of HPTLC Method

Linearity

As shown in Table 5, the correlation coefficient of calibration curve of protocatechuic acid was found to be 0.9994, thus exhibits good linearity between concentration and area.

Accuracy (Recovery%)

The percentage recovery of Protocatechuic acid in methanol and acetone extract was found to be 99.83 and 98.84%, respectively (Table 6, 7). Thus accuracy of the method has shown satisfactory results.

Specificity

As peak of standard protocatechuic acid as well as protocatechuic acid peak in sample was matching, therefore the method was found to be specific.

Table 5: Validation parameters for estimation of protocatechuic acid by HPTLC method

Parameters	Results
Linearity range	100-800 ng spot ⁻¹
Precision (%CV)	
Repeatability of measurements	0.24-0.36%
Repeatability of application	0.29-0.68%
Interday	1.95-2.06%
Intraday	1.12-1.56%
Correlation coefficient (R ²)	0.9994
limit of detection	33 ng spot ⁻¹
Limit of quantification	100 ng spot ⁻¹
Accuracy (% recovery)	
Methanol extract	97.57-102.01%
Acetone extract	96.65 - 100.79%
Specificity	Specific

Table 6: Results of recovery study of the method for Protocatechuic acid in Methanolic extract of *Amomum subulatum* Roxb. fruit constituents

Amount of sample taken	Amount of protocatechuic acid found (mg)	Amount of protocatechuic acid added (mg)	Amount of protocatechuic of acid taken (mg)	Amount of found protocatechuic acid (Mean±SD, n = 5) (mg)	Recovery (%)
25 mg	0.226	2.000	2.226	2.172±0.1181	97.57
50 mg	0.432	2.000	2.432	2.481±0.2477	102.01
75 mg	0.657	2.000	2.657	2.655±0.4182	99.92

Average recovery: 99.83%

Table 7: Results of recovery study of the method for protocatechuic acid in acetone extract of *Amomum subulatum* Roxb. fruit constituents

Amount of sample taken	Amount of protocatechuic acid found (mg)	Amount of protocatechuic acid added (mg)	Amount of protocatechuic of acid taken (mg)	Amount of found protocatechuic acid (Mean±SD, n = 5) (mg)	Recovery (%)
25 mg	0.267	2.000	2.267	2.191±0.8170	96.65
50 mg	0.524	2.000	2.524	2.501±0.4345	99.09
75 mg	0.790	2.000	2.790	2.812±0.5324	100.79

Average recovery: 98.84%

Limit of Detection and Limit of Quantitation

The minimum detectable limit and quantitation limit of Protocatechuic acid was found to be 33 and 100 ng spot⁻¹, respectively.

DISCUSSION

Methanol and acetone extracts showed presence of carbohydrates, flavonoids, amino acids, steroids, triterpenoids, glycosides, tannins and phenolics which confirms the previous findings (Anonymous, 2006). The HPTLC finger printing of acetone and methanol extract separated 8 components and 11 components, respectively. It confirms presence of protocatechuic acid in both extract (Harborne, 2005). Here, acetone extract showed higher concentration of protocatechuic acid as compared to methanol extract. In the past studies only acetone extract was used for the extraction of protocatechuic acid (Kikuzaki *et al.*, 2001). but present study revealed that methanol can also extract protocatechuic acid.

Validation of HPTLC method of estimation of protocatechuic acid exhibits good linearity between concentration and area. Precision, accuracy and specificity of the method has shown satisfactory results.

CONCLUSION

The HPTLC method was found to be rapid, simple and accurate for quantitative estimation of protocatechuic acid in different extracts. The Protocatechuic acid is main

bio-marker compound of *Amomum subulatum* Roxb. fruit constituents. Hence the assay results of this compound can be useful for evaluation of marketed product.

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