

1 **SUPPLEMENTARY**

2 **Exploring the nutritional, physico chemical and hypoglycemic properties of green**  
3 **banana flours from unexploited banana cultivars of Southern India**

4 Shini V S<sup>1,2</sup>, Abraham Billu<sup>1,2,3</sup>, Abhijith Suvachan<sup>1</sup>, P Nisha<sup>1,2\*</sup>

5 <sup>1</sup>CSIR – National Institute for Interdisciplinary Science and Technology (NIIST),  
6 Thiruvananthapuram, Kerala 695019, India

7 <sup>2</sup>Academy of Scientific and Innovative Research (AcSIR), Ghaziabad - 201002, India

8 <sup>3</sup>School of Science, RMIT University, Melbourne, Victoria 3083, Australia

9

10 \*Corresponding Author

11 P. Nisha,

12 Agro Processing and Technology Division,

13 CSIR-National Institute for Interdisciplinary Science and Technology,

14 Thiruvananthapuram 695019, Kerala, India.

15 Tel.: +91 471 2515348

16 Fax: +91 471 2495050

17 E-mail address: [pnisha@niist.res.in](mailto:pnisha@niist.res.in), [bp.nisha@yahoo.com](mailto:bp.nisha@yahoo.com)

18 **ORCID ID of Corresponding Author:**

19 P. Nisha: <http://orcid.org/0000-0002-9292-2226>

20

21

22

23

24 **Table 1** Common features of different cultivars

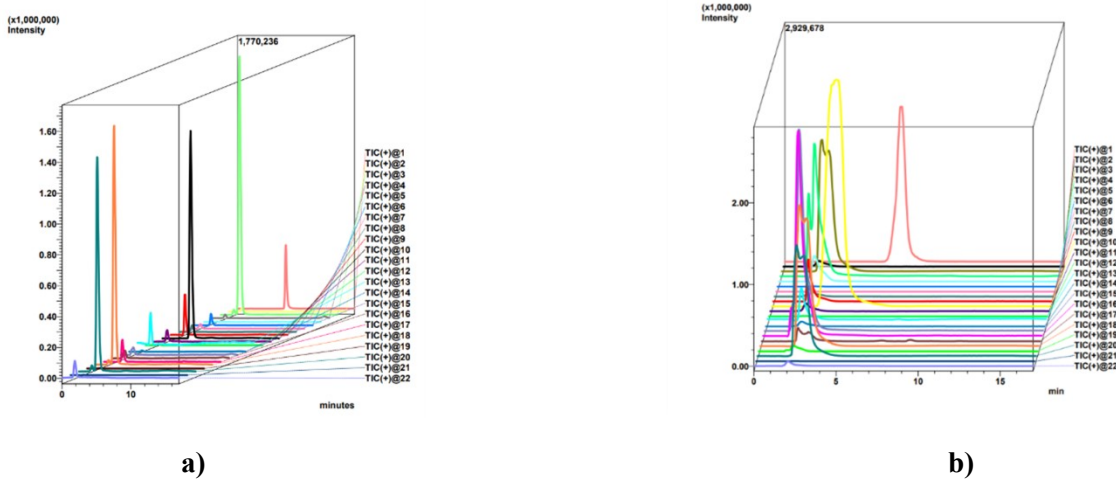
<b>Cultivars</b>	<b>Features</b>
Nendran	<p>The nendran banana, also well-known as Kerala banana, is a common variety of banana mostly grown in the southern region of India, especially in the state of Kerala. It is highly unique for its texture, taste, and nutritional benefits, making it a staple in traditional South Indian cuisine. Nendran is longer in size, and it is firm and starchy with a thick green peel that gradually turns yellow when ripen. This banana can offer a unique taste at different stages of its development. The flesh of the fruit remains yellowish or creamy in color. In terms of nutrition, it has many health benefits due to being the richest source of vitamin B6, vitamin C, dietary fiber, and potassium. Apart from other cultivars, it is often consumed to weight gain. Moreover, powdered raw bananas are commonly used as infant food.<sup>1,2</sup></p>
Palayankodan	<p>Palayankodan banana is a popular variety most widely cultivated in the southern Indian state of Kerala. It is a dessert type and one of the sweet banana cultivars readily available in Kerala. The climatic condition of these regions favors the large-scale production of this variety; hence it is the cheapest of all the varieties. The bunches of Palayankodan are commonly small to medium in size. This cultivar is highly appreciated for its sole texture, flavor, and culinary versatility. The flesh of this variety is smooth, tender, and creamy when it is ripe, making it delightful to eat, and having a sub-acid taste. Apart from their culinary uses, these soft ripe banana varieties are known for their</p>

	<p>natural cooling effects on the body, therefore, it is often consumed to relieve digestive problems and enhance digestion; also due to this property, Palayankodan is consumed during the summer season. These banana cultivars are valued for their nutritional profile. They are rich sources of vitamin C and B6, potassium, and dietary fiber, which contributes to overall health benefits.<sup>1,2</sup></p>
Malayannan	<p>Malayannan banana is one of the varieties of bananas native to southern India. It is broadly cultivated in Kerala and is considered one of the traditional varieties of bananas. Malayannan is medium to large and its peel has a yellow color as it is ripe. Like other varieties, Malayannan offers several nutritional benefits, they are a good source of dietary fiber, minerals like potassium and magnesium, and vitamins such as vitamin C and vitamin B6.<sup>1,2</sup></p>
Peyan	<p>Peyan is a common banana variety, mostly cultivated in the southern area of India, mainly in Kerala state. The peyan is a medium-sized banana and is primarily used as a vegetable for culinary purposes. They are a rich source of vitamins (vitamin C and B6), minerals (potassium), and dietary fiber. They are also rich in antioxidants, which help the body protect against oxidative stress and stimulate overall well-being.<sup>2</sup></p>
Robusta	<p>Robusta is a common dessert-type banana, that produces large-sized well fruits and falls under high yielding group. These cultivars have a thick peel, and they retain green color even after ripening. Riped bananas are very delicious having soft, creamy white, and buttery</p>

	<p>flesh. Robusta is equivalent to other banana varieties for its nutritional value. They are also excellent sources of vitamin C, vitamin B6, potassium, and dietary fiber. Due to their nutritional contents and antioxidant properties, they improve immunity, support bone growth, and aid in weight loss.<sup>1,2</sup></p>
Kappa	<p>Kappa bananas, also known as chenkadali. It is a dessert type, a unique flavorful variety characterized by its reddish-purple skin. The fruit is fairly large-sized with thicker and tougher outer skin than yellow bananas, the peel color changes from brown to dark brown when it ripens. The flesh is sweeter, softer, and creamy with a raspberry flavor and pleasant aroma. These offer essential nutrients like dietary fiber, vitamins C and B6, and minerals, which provide many health benefits. They also contain <math>\beta</math>-carotene and lutein, which contribute to the red color of this variety and promote eye health.<sup>1,2</sup></p>
Mysore Ethan	<p>Mysore ethan banana is a Nendran ecotype. It is used as a dessert and cooking banana. These varieties have pale yellow color pulp. Similar to other varieties it contains a substantial amount of vitamins, minerals, and dietary fiber, which are beneficial for human beings.<sup>2</sup></p>
Monthan	<p>Monthan banana is widely produced for processing. These varieties of fruits are pale green, knobbed, bold, and stocky. The new clones of Monthan namely Chakkia and Kanchi vazhai have more economic value. It is mostly used as a cooking type, moreover, being a delightful vegetable, pseudostem core has many medicinal properties and</p>

	culinary uses. <sup>1,2</sup>
Zanzibar	Zanzibar banana is a nendran clone. These cultivars are grown for both vegetable and fruit purposes. It is larger-sized fruit than Nendran but has less number of fruits compared to other varieties. <sup>2</sup>
Yangambi	Yangambi banana is an important commercial banana variety recommended for cultivation in Kerala. It is a small dessert banana with an excellent taste and also has nutritional benefits. <sup>2</sup>

25



26

27

28 **Fig. 1** Representative LC-MS/MS chromatogram showing (a) standard amino acids (40 ppb mix) and  
 29 (b) amino acid in the sample (PALA)

30 1–Tryptophan, 2–Serine, 3–Leucine, 4–Histidine, 5–Asparagine, 6–Methionine, 7–Cystine, 8–  
 31 Threonine, 9–Valine, 10–Phenylalanine, 11–Glutamic acid, 12–Glycine, 13–Proline, 14–Aspartic acid,  
 32 15–Glutamine, 16–Lysine, 17–Tyrosine, 18–Isoleucine, 19–Arginine, 20–Hydroxyproline, 21– Cysteine,  
 33 22–Alanine

34

35

36 A)

ID#	Name	Type	m/z	Ret. Time
1	tryptophan	Target	204.80>188.10	7.016
2	serine	Target	106.10>60.25	1.867
3	leucine	Target	132.20>86.10	2.678
4	histidine	Target	155.80>110.20	1.800
5	asparagine	Target	133.10>74.05	1.885
6	methionine	Target	150.10>104.05	2.178
7	cystine	Target	241.10>152.00	1.857
8	threonine	Target	120.10>74.10	1.847
9	valine	Target	118.00>72.00	2.037
10	phenyl alanine	Target	166.00>120.15	4.074
11	glutamic acid	Target	148.00>84.15	1.875
12	glycine	Target	76.10>29.95	1.851
13	proline	Target	116.10>70.10	1.893
14	aspartic acid	Target	133.80>73.85	1.873
15	glutamine	Target	146.80>84.05	1.829
16	lysine	Target	146.90>84.10	1.827
17	tyrosine	Target	182.00>136.00	2.666
18	isoleucine	Target	132.00>86.30	2.713
19	arginine	Target	174.50>70.15	1.827
20	hydroxy proline	Target	132.00>86.15	2.706
21	cysteine	Target	122.00>76.05	1.941
22	alanine	Target	90.00>44.15	1.843

46 B) Tryptophan (204.80>188.10)



47 Serine (106.10>60.25)



48 Leucine (132.20>86.10)

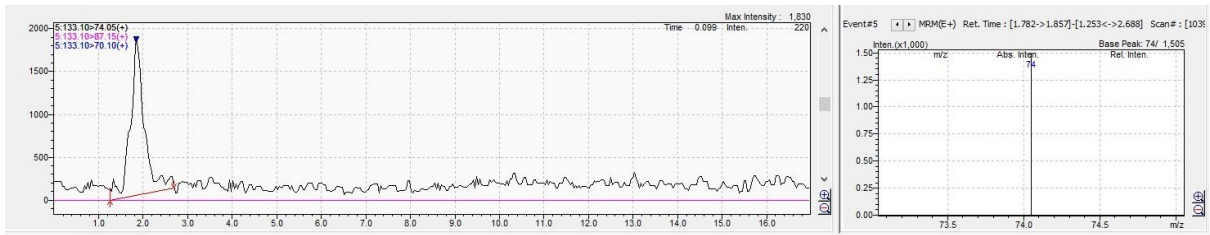


49 Histidine (155.80>110.20)



50 Asparagine (133.10>74.05)

51



52 Methionine (150.10>104.05)

53

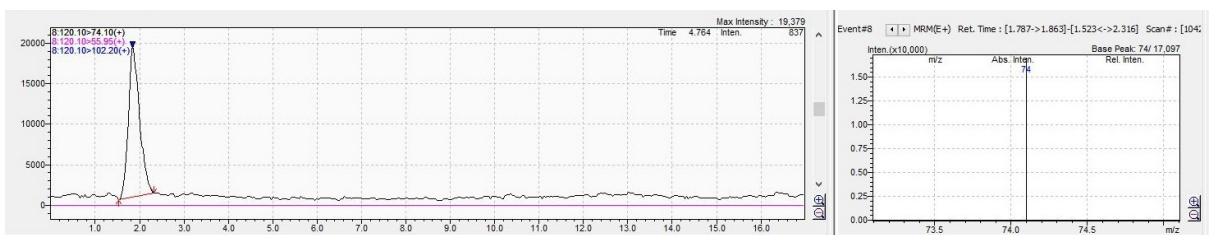


54 Cystine (241.10>152.00)

55



56 Threonine (120.10>74.10)



57 Valine (118.00>72.00)

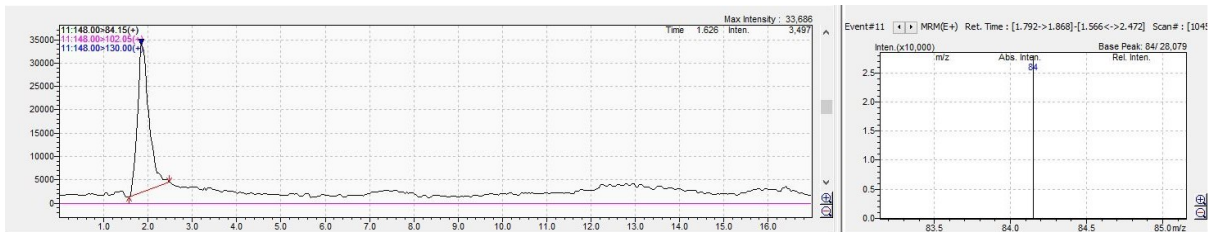




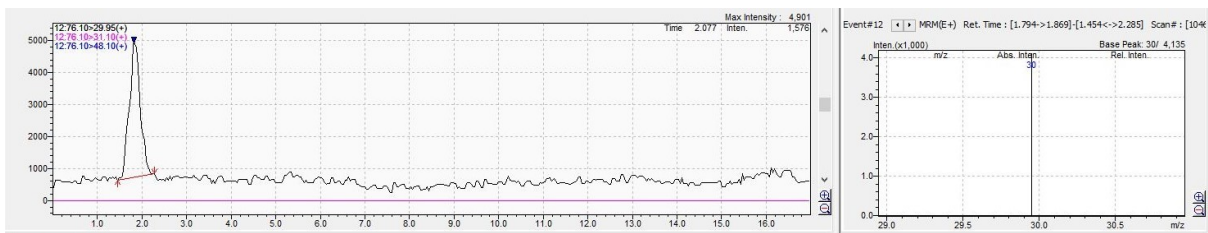
58 Phenylalanine (166.00>120.15)



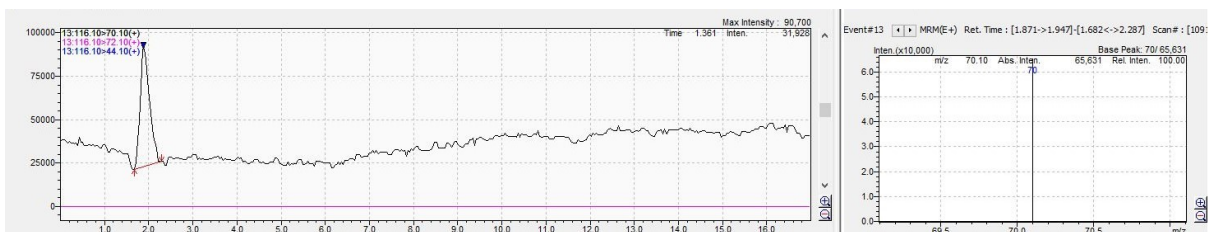
59 Glutamic acid (148.00>84.15)



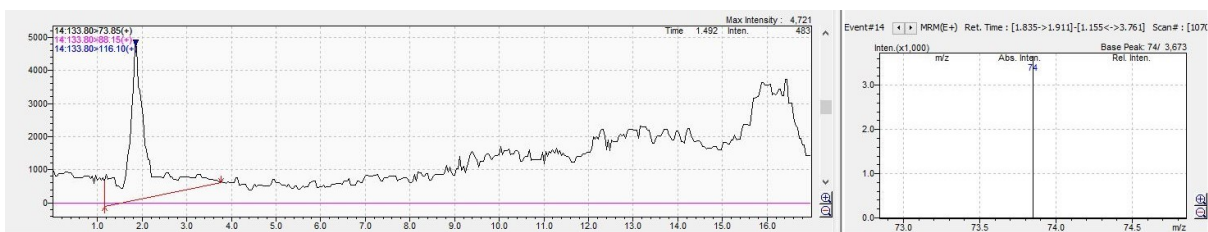
60 Glycine (76.10>29.95)



61 Proline (116.10>70.10)

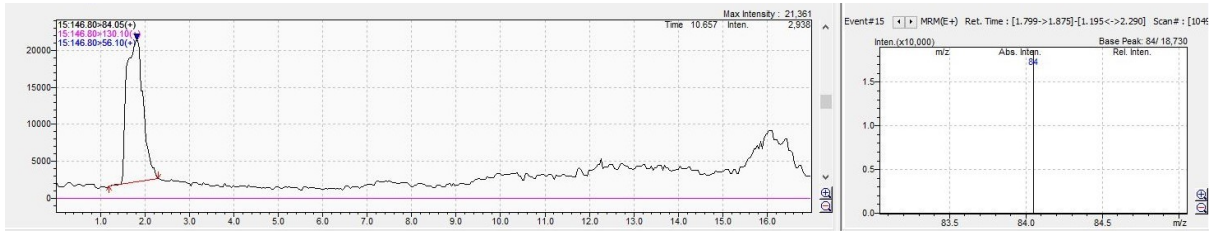


62 Aspartic acid (133.80>73.85)

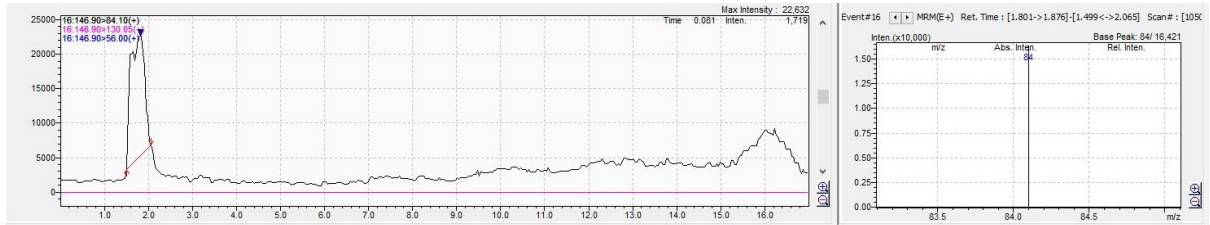


63 Glutamine (146.80>84.05)





64 Lysine (146.90>84.10)

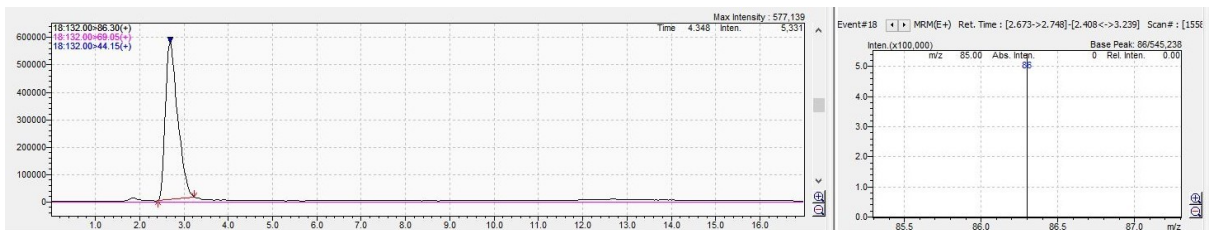


65

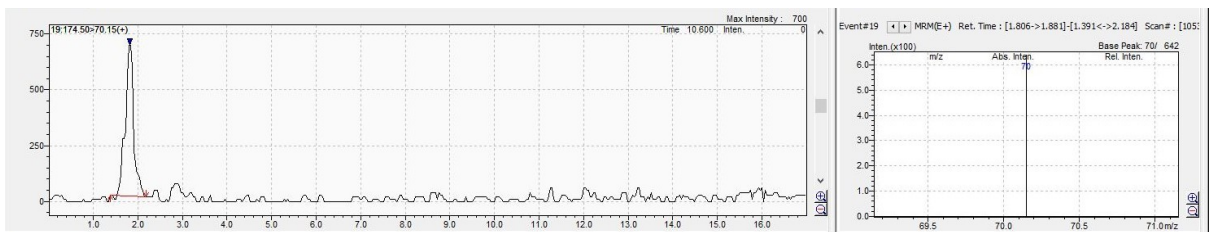
66 Tyrosine (182.00>136.00)



67 Isoleucine (132.00>86.30)



68 Arginine (174.50>70.15)

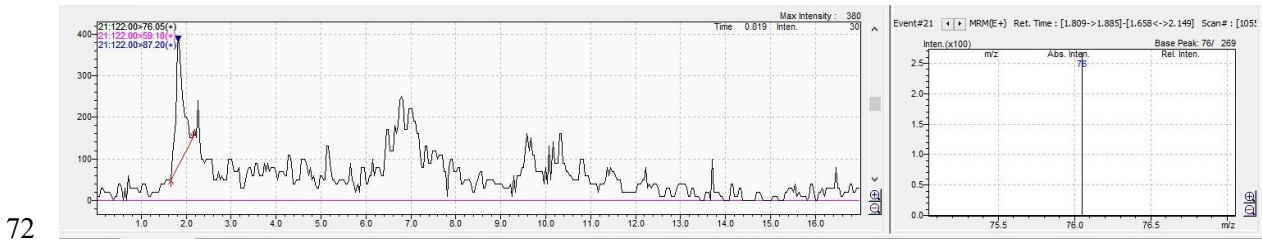


69 Hydroxyproline (132.00>86.15)

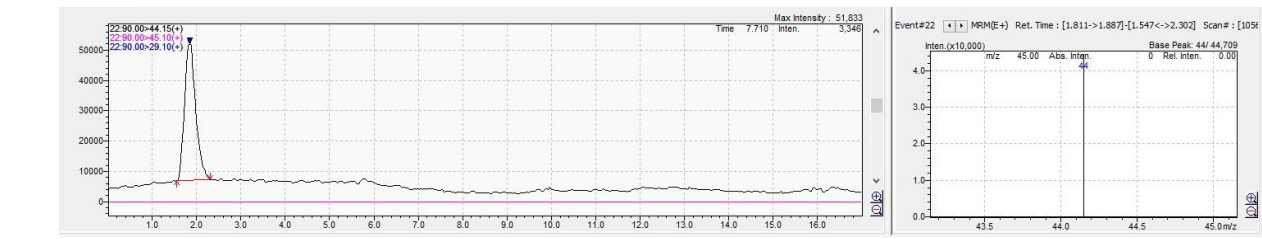


70

71 Cysteine (122.00>76.05)

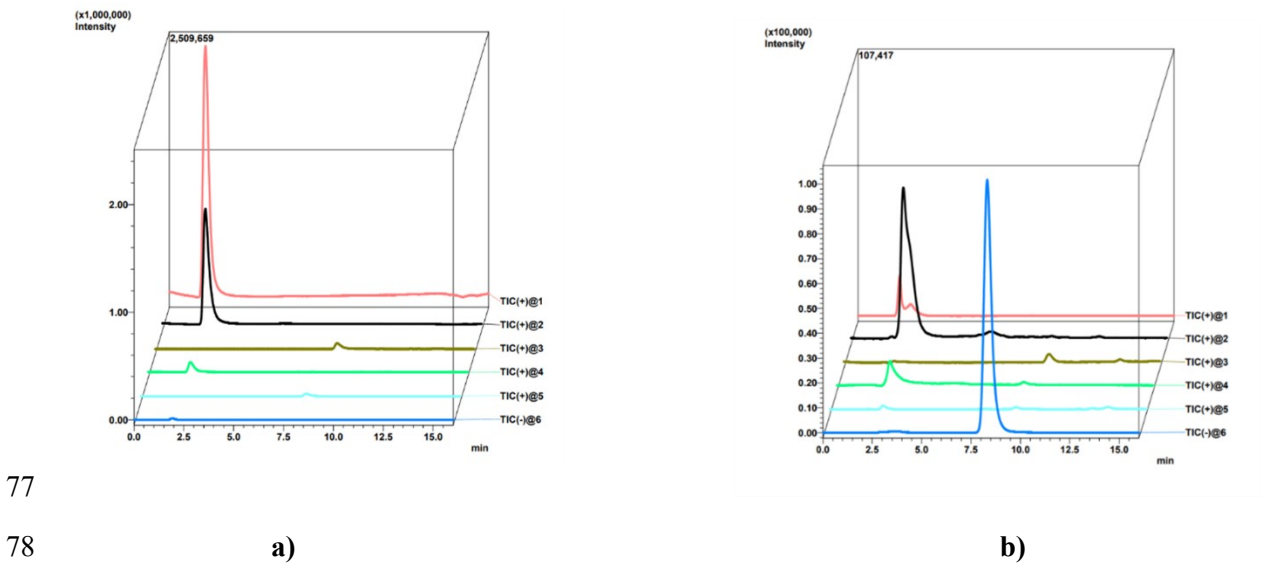


73 Alanine (90.00>44.15)



75 **Fig. 2** Representative LC-MS/MS Ion chromatogram showing (A) analytical performance of 22

76 standard amino acids (40 ppb mix) and (B) Ion chromatogram of amino acids in the sample (PALA)



79 **Fig. 3** Representative LC-MS/MS chromatogram showing (a) standard vitamins (100 ppb mix+350

80 ppb ascorbic acid), and (b) vitamin concentration in the sample (PALA)

81 1-Thiamine, 2-Pyridoxine, 3-Folic acid, 4-Nicotinic acid (niacin), 5-Riboflavin, 6-Ascorbic acid

82

83 A)

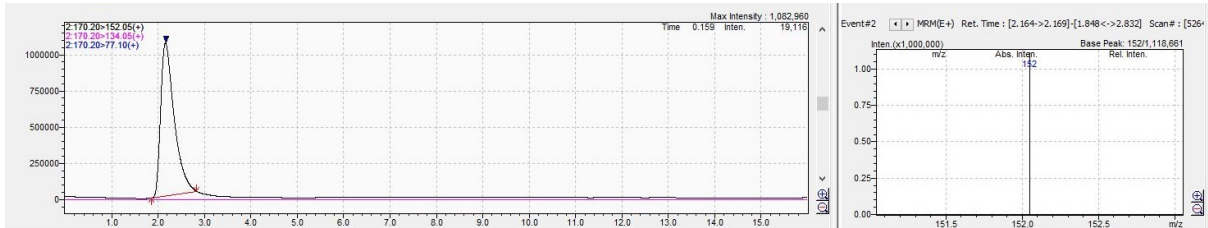
84

ID#	Name	Type	m/z	Ret. Time
1	thiamine	Target	265.20>122.15	1.935
2	Pyridoxine	Target	170.20>152.05	2.328
3	folic acid	Target	377.20>243.10	9.383
4	nicotinic acid	Target	124.10>78.15	2.225
5	Riboflavin	Target	442.20>295.05	8.456
6	ascorbic acid	Target	175.20>115.10	2.039

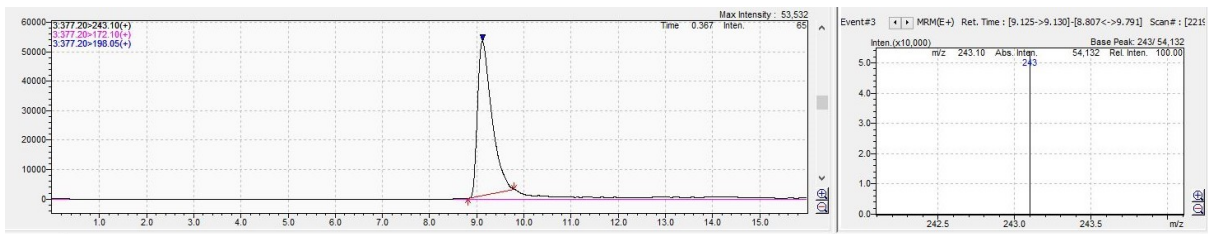
85

86

87 B) Pyridoxine (170.20>152.05)



89 Folic acid (377.20>243.10)

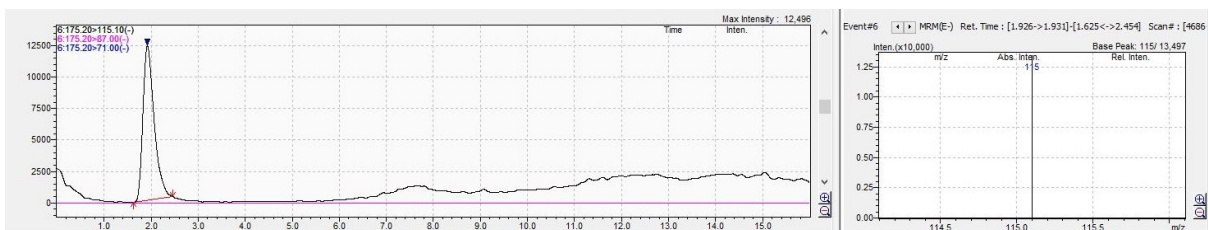


90 Nicotinic acid (124.10>78.15)



91

92 Ascorbic acid (175.20>115.10)



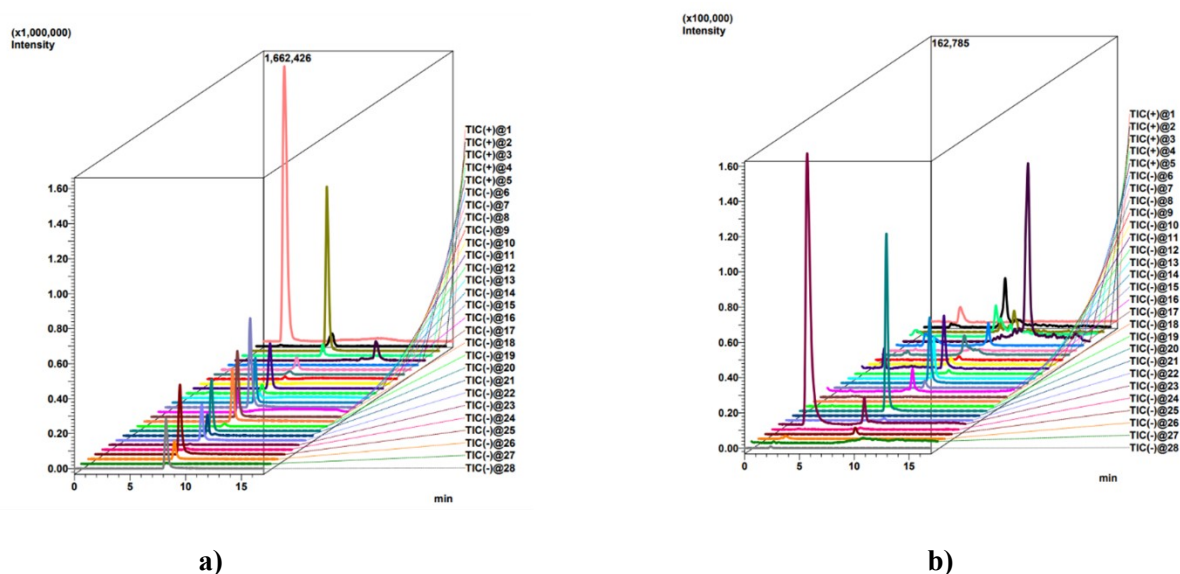
93

94 Fig. 4 Representative LC-MS/MS Ion chromatogram showing (A) analytical performance of 6

95 standard vitamins (100 ppb mix+350 ppb ascorbic acid), and (B) Ion chromatogram of vitamins in the

96 sample (PALA)





98

99

100 **Fig. 5** Representative LC-MS/MS chromatogram showing (a) standard polyphenols (150 ppb mix)  
 101 and (b) polyphenols concentration in the sample (PALA)

102 1-Catechol, 2-Catechin, 3-Quinine, 4-Nariginine, 5-Tocopherol, 6-Gallic acid, 7-Chlorogenic acid, 8-  
 103 Epicatechin, 9-Syringic acid, 10-Vannilic acid, 11-Caeffic acid, 12-Epigallo catechin, 13-Ferulic acid,  
 104 14-Mycretin, 15-Quercetin, 16-p-Coumaric acid, 17-Luteolein, 18-Apigenin, 19-Kaempferol, 20  
 105 Rutin, 21-Diadzein, 22-Hesperitin, 23-Shikimic acid, 24-Elagic acid, 25- Morin, 26-Genstein, 27-  
 106 Cinnamic acid and 28-Chrysine

107

108 A)

109

110

111

112

113

ID#	Name	Type	m/z	Ret. Time
1	Catacol	Target	111.20>78.95	1.870
2	Catachin	Target	291.20>139.10	6.755
3	Quinine	Target	325.20>307.10	6.883
4	Nariginin	Target	273.20>153.05	7.283
5	Tocopherol	Target	429.50>163.15	12.877
6	Gallic acid	Target	169.20>125.05	1.918
7	Chlorogenic acid	Target	353.00>191.20	6.810
8	Epi Catachin	Target	289.00>245.20	6.778
9	Syringic acid	Target	197.20>182.20	7.204
10	Vanilic acid	Target	167.20>152.10	6.790
11	Caffic acid	Target	179.20>135.15	6.917
12	Epigallo catechin	Target	456.90>169.15	2.016
13	Ferulic acid	Target	193.20>134.00	7.361
14	Mycertin	Target	317.00>151.20	7.657
15	Quercetin	Target	301.20>151.05	7.922
16	P-Coumaric acid	Target	163.00>119.15	7.341
17	Luteolin	Target	285.20>151.10	7.922
18	Apigenin	Target	269.20>151.00	8.186
19	Kampferol	Target	285.20>187.05	7.830
20	Rutin	Target	609.20>300.00	7.343
21	Diadzein	Target	252.90>224.15	7.919
22	Hesperitin	Target	301.20>164.10	7.866
23	Shikkimic acid	Target	172.90>111.20	7.239
24	Elagic	Target	300.90>185.10	7.568
25	Morin	Target	301.20>151.00	7.748
26	Genstein	Target	269.20>133.20	7.815
27	Cinnamic acid	Target	147.00>103.05	7.931
28	Chrysine	Target	252.90>143.20	8.395

114

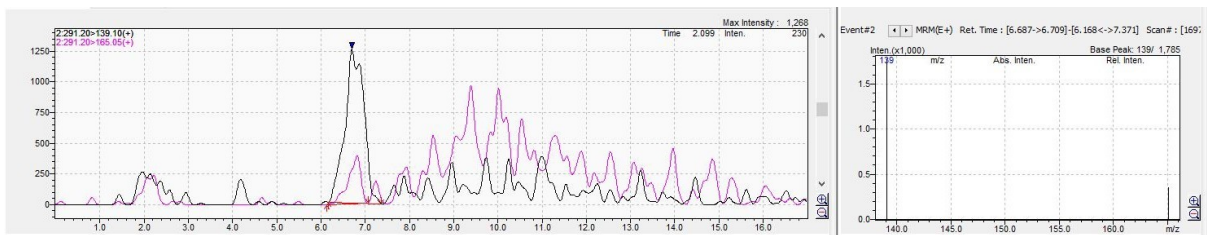
115

116

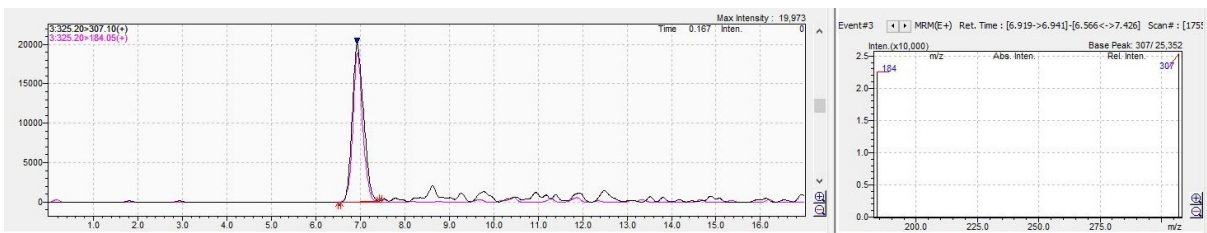
117

118

119 **B) Catechin (291.20>139.10)**

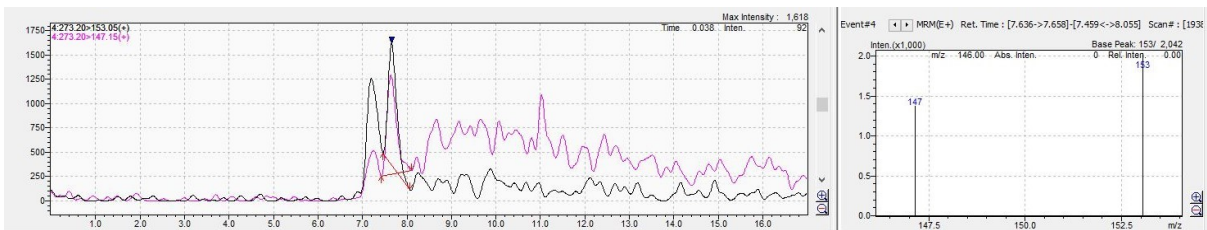


120 **Quinine (325.20>307.10)**

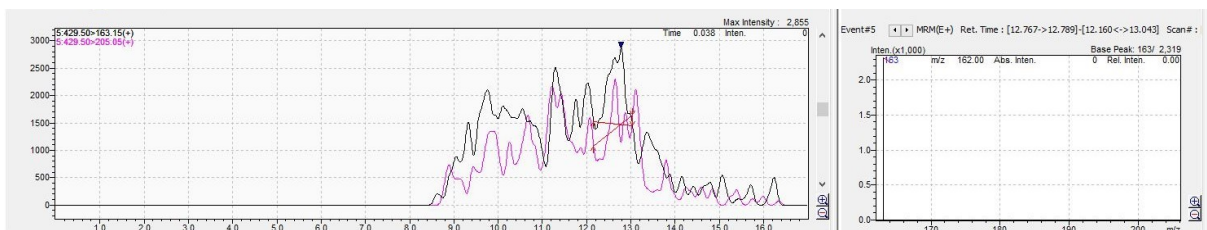


121

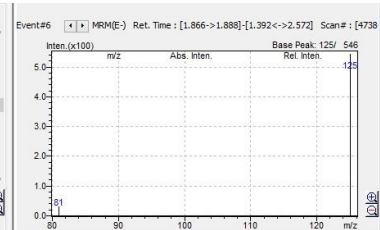
122 **Naringenin (273.20>153.05)**



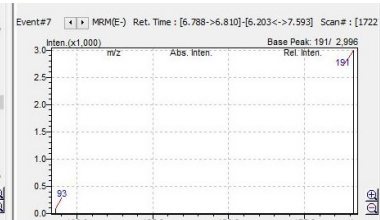
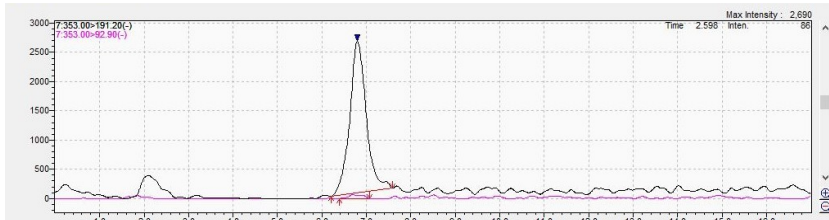
123 **Tocopherol (429.50>163.15)**



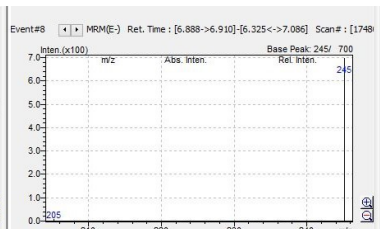
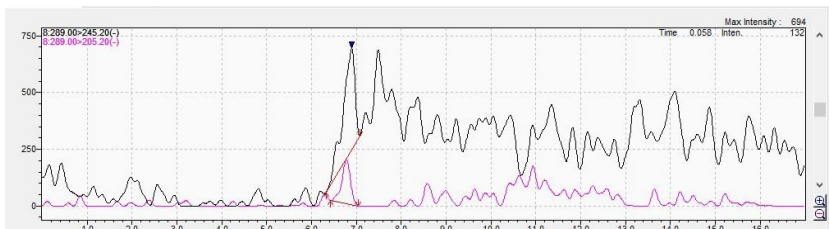
124 **Gallic acid (169.20>125.05)**



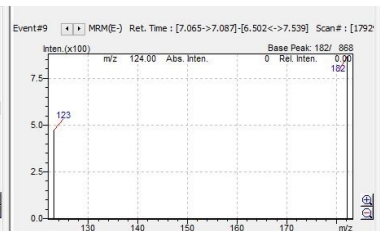
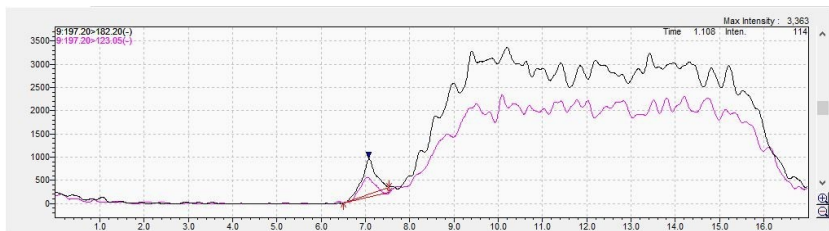
125 Chlorogenic acid (353.00>191.20)



126 Epicatechin (289.00>245.20)

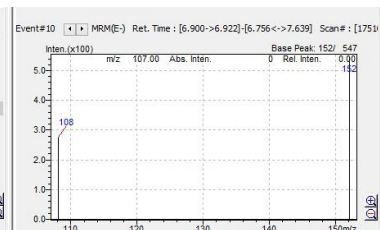


127 Syringic acid (197.20>182.20)

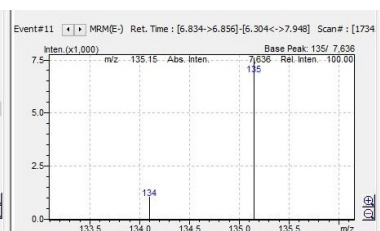
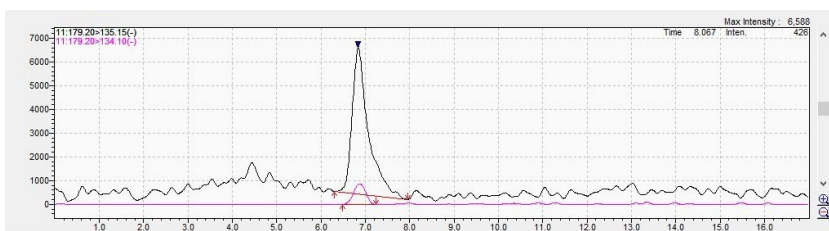


128

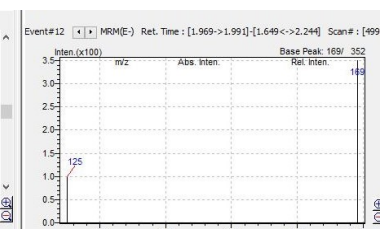
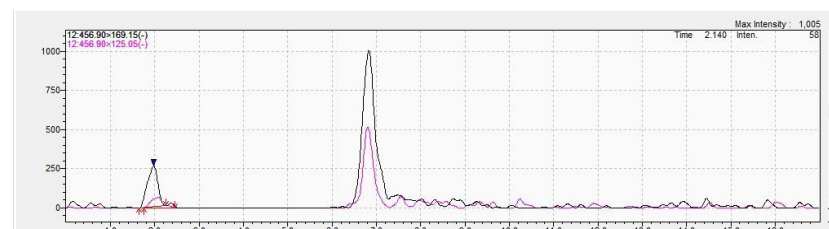
129 Vanillic acid (167.20>152.10)



130 Caffeic acid (179.20>135.15)



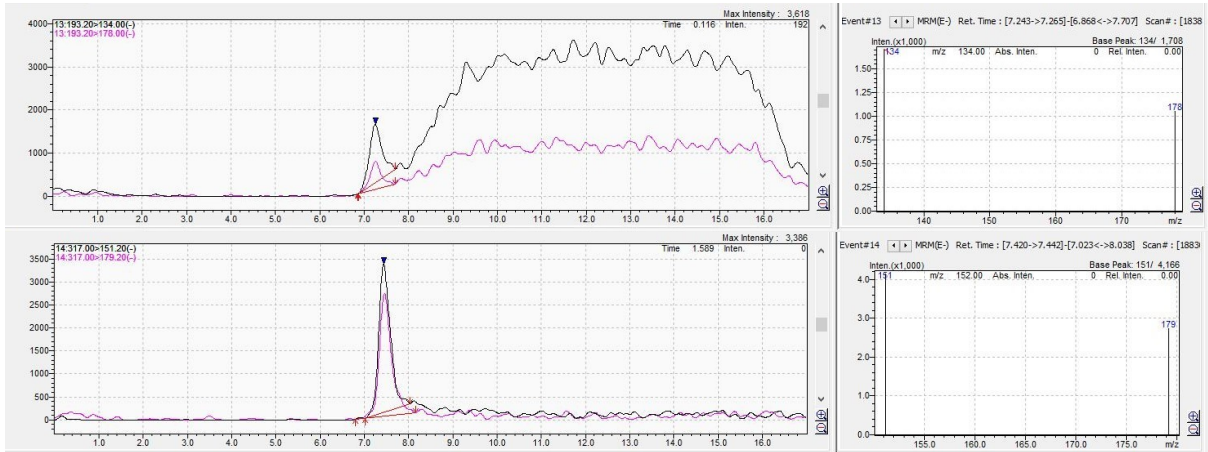
131 Epigallocatechin (456.90>169.15)





132 Ferulic acid (193.20>134.00)

133 Myricetin (317.00>151.20)

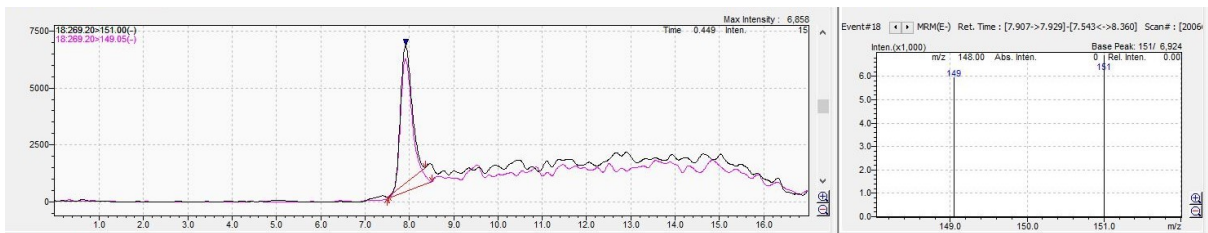


134

135 p-coumaric acid (163.00>119.15)



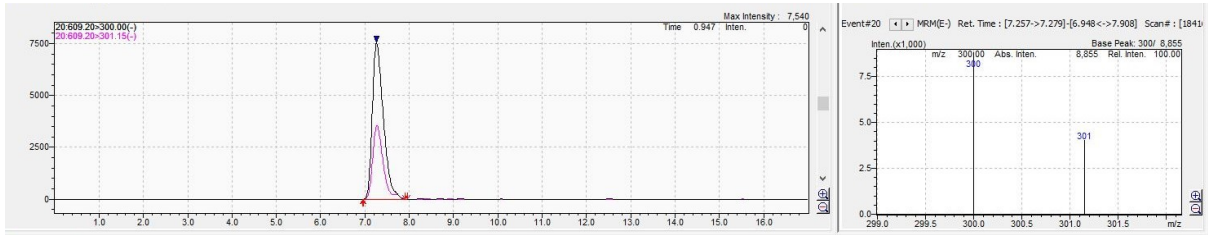
136 Apigenin (269.20>151.00)



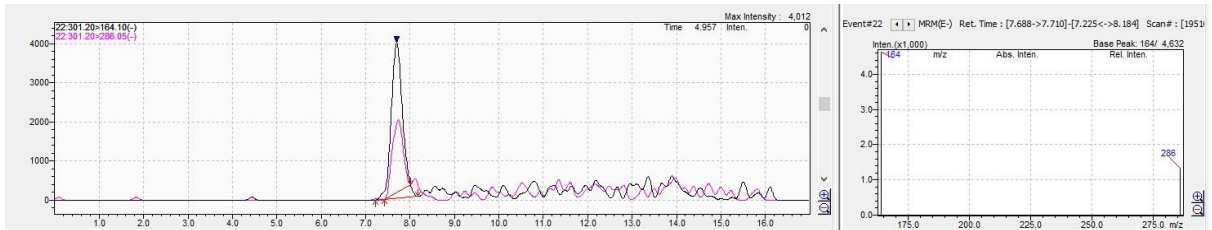
137 Kaempferol (285.20>187.05)



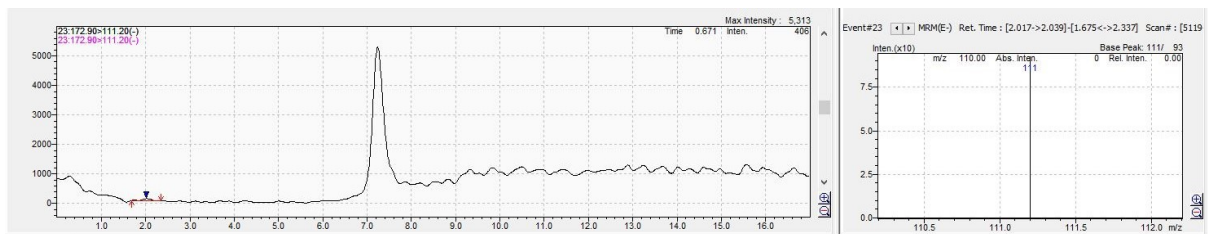
138 Rutin (609.20>300.00)



139 Hesperitin (301.20>164.10)

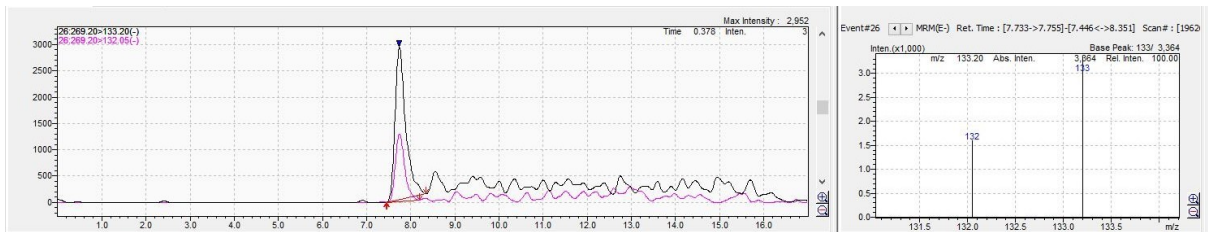


140 Shikimic acid (172.90>111.20)

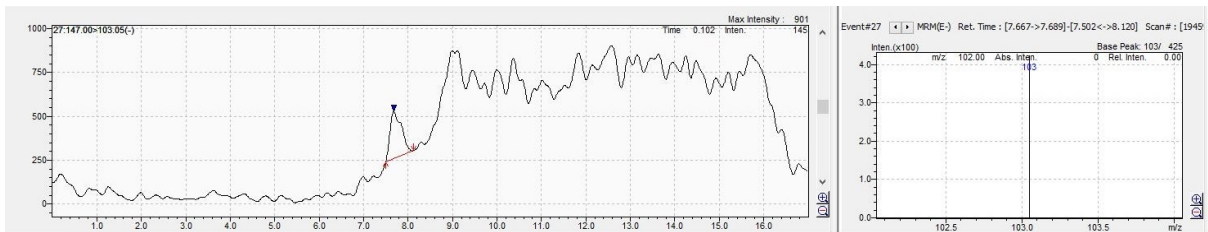


141

142 Genistein (269.20>133.20)



143 Cinnamic acid (147.00>103.05)



144

145 **Fig. 6** Representative LC-MS/MS Ion chromatogram showing (A) analytical performance of 28  
 146 standard polyphenols (150 ppb mix) and (B) Ion chromatogram of polyphenols in the sample (PALA)

147 **References**

148 1 Banana Expert System. Available:

149 [http://www.agritech.tnau.ac.in/expert\\_system/banana/season&variety.html](http://www.agritech.tnau.ac.in/expert_system/banana/season&variety.html) accessed on 25 November

150 2023.

151 2 Improvement and varietal wealth in Banana. Available:

152 [https://www.researchgate.net/publication/304897604\\_Improvement\\_and\\_varietal\\_wealth\\_in\\_Banana](https://www.researchgate.net/publication/304897604_Improvement_and_varietal_wealth_in_Banana)

153 accessed on 26 November 2023.

154

155

156

157