



Pigmentation Diversity and Nutritional Profiling of Multicolored Tropical Carrots (*Daucus carota* L.)

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Introduction

Carrot (*Daucus carota* L.) exhibits a remarkable range of root coloures—purple, orange, red, and yellow—arising from the presence of anthocyanins, β -carotene, lycopene, and lutein, respectively. With growing public awareness of nutritional and health security, carrot consumption has increased substantially among consumers and within the nutraceutical industry, owing to its high bioavailability of vitamins, phytonutrients, and other bioactive compounds. In the present study, we report for the first time an investigation on self-coloured carrot varieties and their hybrids bearing mixed-colour roots, focusing on the profiling of flavonoid compounds to assess their nutritional value, aesthetic appeal, and consumer acceptability.

Materials & Methods

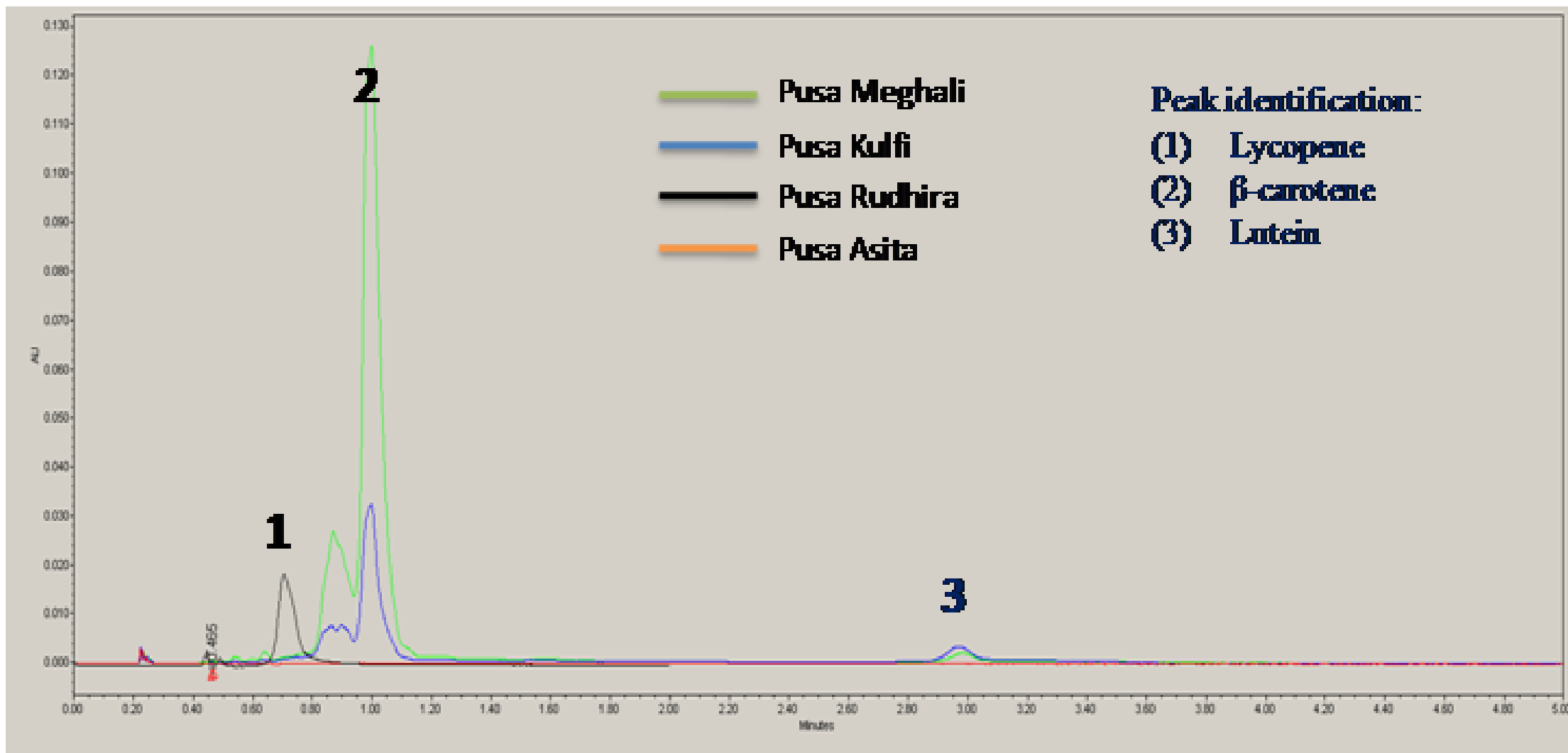
- The tropical carrot varieties viz. Pusa Rudhira (red), Pusa Meghali (orange), Pusa Kulfi (mustard yellow), and Pusa Asita (purple) with a self-coloured epidermis, cortex, and core
- The four parental varieties were crossed in all possible combinations and developed 86 inbred and 12 F₁ hybrids
- The roots of parental varieties and their hybrids were used for the profiling of anthocyanins and carotenoids

Results: 1

Table 1. Nutritional Profile of Parental Carrot roots

	WhitePale	IPC-126	IPC-122	Pusa Meghali
Moisture(%)	89.38±0.04	88.17±0.16	88.07±0.14	88.90±0.18
Total Solids(%)	10.62±0.04	11.83±0.16	11.93±0.14	11.10±0.18
TSS (°Brix)	5.23±0.26	9.38±0.21	9.13±0.44	8.46±0.12
Lycopene(mg/100g)	0.21±0.01	0.45±0.02	10.79±0.09	6.09±0.02
β -carotene (mg/100g)	0.92±0.01	0.51±0.03	2.05±0.05	1.18±0.01
Total Carotenoids (mg/100g)	1.19±0.01	1.24±0.01	12.52±0.06	7.89±0.02
Anthocyanin (mg/100g)	0.03±0.00	86.54±0.17	nf	nf

Fig 2. Typical chromatogram of carotenoids found in parental carrot roots



Bar Chart illustrating the distribution of total monomeric anthocyanin in fresh carrot samples

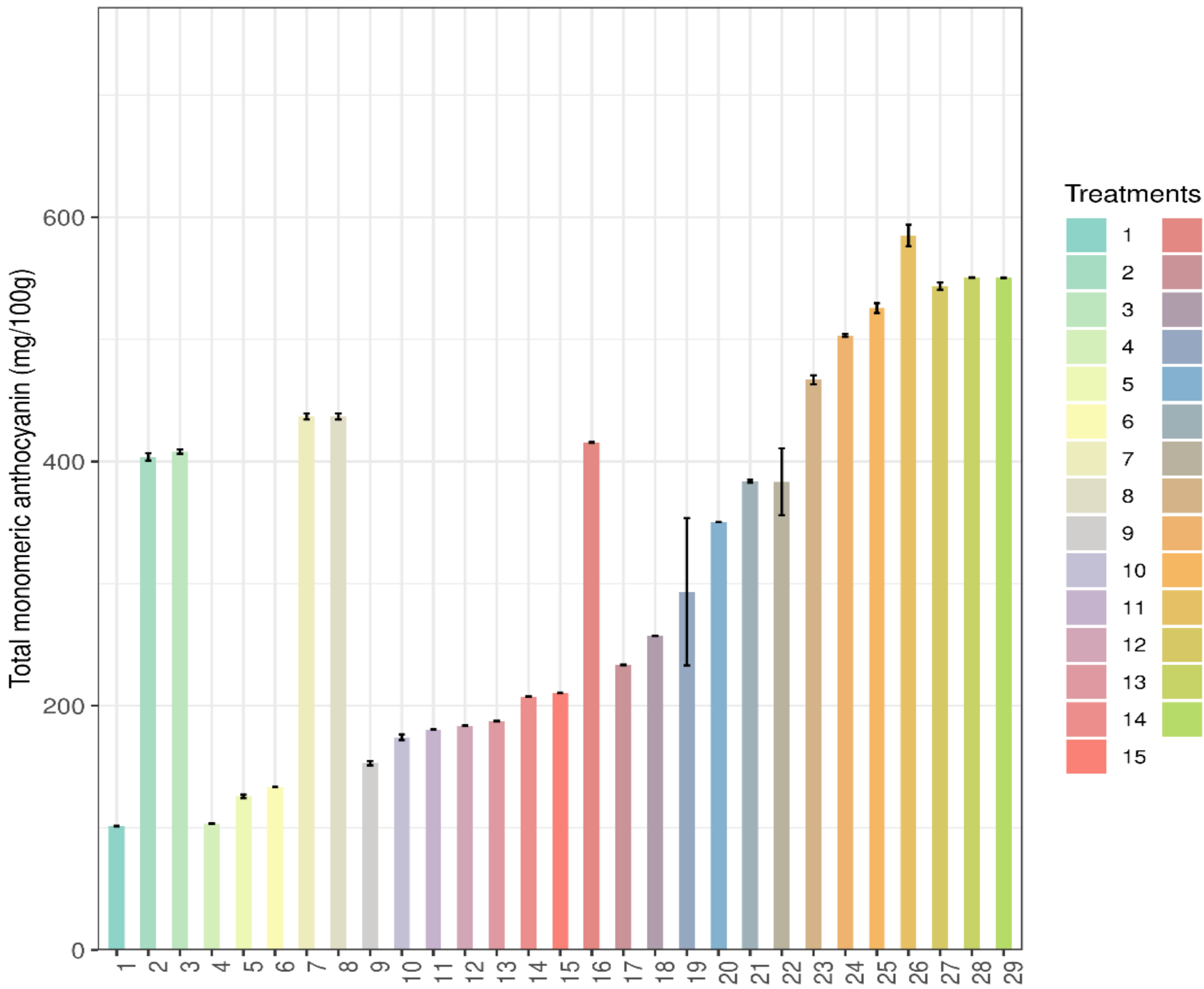


Fig 1. Different coloured varieties used in the hybridization



Fig 3. Root colour traits of multicolored carrot lines and hybrids used in this study

Results: 2

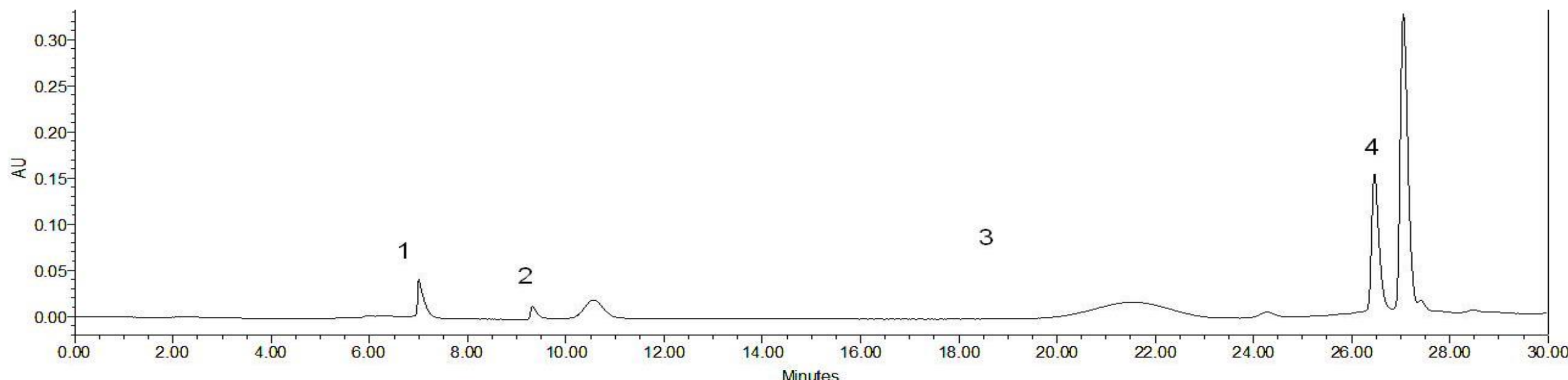


Fig. 3. Typical chromatogram of anthocyanin found in the carrot var. Pusa Asita

- 1) Cyanidin 3-xylosylglucosylgalactoside.
- 2) Cyanidin 3-xylosylgalactoside
- 3) Cyanidin-3-(2'-xylose 6''-feruloyl-glucose-galactoside
- 4) Cyanidin-3-(2'-xylose 6''-sinapoyl-glucose-galactoside)
- 5) Cyanidin 3-xylosylglucosylgalactoside and
- 6) Peonidin 3-(2'-xylose 6''-feruloyl-glucose-galactoside).

Conclusions and perspectives

Carrots serve as an important dietary source of β -carotene, lycopene, total carotenoids, and anthocyanins, all of which contribute to their high bioavailability and nutritional value in the human diet. Most previous studies have focused on individual flavonoid components in carrots, largely because specific varieties are trait-oriented. However, information on the combined flavonoid composition of carrot roots remains limited. In this study, we examined self-coloured carrot varieties and their hybrids representing varying proportions of β -carotene, lycopene, total carotenoids, and anthocyanins, and observed significant variation in their flavonoid content.

The findings highlight the potential of these compounds for enhanced dietary utilization and a wide range of industrial applications, including their use as functional ingredients in food products, pharmaceuticals, natural preservatives, and colourants. Promoting the cultivation of carrot varieties and hybrids rich in anthocyanins, lycopene, β -carotene, and total carotenoids can therefore contribute not only to nutritional security among undernourished populations but also to increased income generation for vegetable growers through the commercial production of high-value, nutrient-rich carrots in India.