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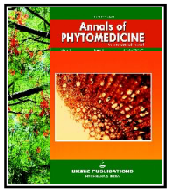

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Antioxidant substances and phytonutrients in sweet potato tubers of different flesh colour

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Abstract

Sweet potato tubers combine the properties of cereals, fruits and vegetables owing to its content of starch, pectin and vitamins, respectively. Despite a carbohydrate rich food, sweet potato has low glycemic index. It is now also considered as an antidiabetic food. Depending on the flesh colour, sweet potato tubers are also rich in β-carotene, anthocyanins and total phenols. An experiment was conducted on sweet potatoes of different flesh colour to establish the relation of tuber flesh colours on the possession of different antioxidant substances along with other phytonutrients, and to identify sweet potato cultivars of different flesh colour having potential for enriching the human diets with antioxidants and other essential nutrients. Antioxidant substances and other nutrition facts of different orange fleshed, purple fleshed and white fleshed sweet potato cultivars were analysed following standard procedures. Significant differences in all the nutritional parameters including antioxidant substances were observed in sweet potatoes of different flesh colour. Marked variation in biochemical constituents among the cultivars of same flesh colour were also observed. Orange fleshed cultivars were found to contain higher amount of β-carotene ranging from 4.76 mg/100 g to 11.16 mg/100 g. The total sugar content varied from 1.36-3.14% among the cultivars. The dry matter content of tubers ranged between 23.68% and 34.11%. Among all the cultivars, both the highest carbohydrate (21.23%) and starch content (15.28%) were recorded in 'Cross-4', a purple fleshed sweet potato. All the purple fleshed sweet potato cultivars were found to contain high anthocyanins ranging from 9.38 mg/100 g to 18.41 mg/100 g. Antioxidant substances were found to be directly related with the tuber flesh colours. This study suggests that increased consumption of orange-fleshed sweet potatoes having high β-carotene can contribute considerably to alleviate dietary deficiency of vitamin A. Pigmented cultivars of purple-fleshed sweet potatoes having high anthocyanins and total phenols, and orange-fleshed sweet potatoes rich in β-carotene can also act as good sources of antioxidant.

1. Introduction

Sweet potato (*Ipomoea batatas* L. Lam) belongs to the family Convolvulaceae and is grown for its fleshy, starchy tubers. Though, a perennial, the crop is grown as an annual crop of 4-5 months. The tubers are generally consumed either by boiling, baking, frying or converting into different value added products. The tender leaves of sweet potato vines are also used as a vegetable in many countries. However, the leaves are generally used as animal feeds, particularly for dairy cattle and goats (Scott, 1992; Lebot, 2009). Due to wide adaptability, high yield, ability to grow in marginal condition, short duration, high nutritional value and sensory versatility in terms of taste, texture, and peel and flesh colour, sweet potato is gaining popularity as a future food security crop (Mitra, 2017).

It is an important root crop of Asia and is now grown all over the world spreading throughout the tropical and subtropical countries. Asia accounts for about 78% of the world area under this crop and about 92% of the world production. China is the leading producer of sweet potato in the world. India is one of the leading producers of sweet potato along with China, America, Brazil, Peru, Mexico and Thailand. Sweet potato ranks the seventh most important food crop in the world and fourth most import food crop in tropical countries (FAOSTAT, 2009). In terms of total production in the world among all food crops, it finds a place after wheat, rice, maize, potato, barley and cassava.

Apart from cheap source of energy, the tubers are rich in starch (10-25%), sugars (1.5-3.5%), dietary fibre (1.7-2.4%), minerals like calcium (15-40 mg/100 g), phosphorous (25-45 mg/100 g), potassium (210-430 mg/100 g), magnesium (15-35 mg/100 g) and vitamins like ascorbic acid (7-35 mg/100 g) along with pyridoxine, thiamine, niacin and riboflavin. Sweet potato tubers combine the properties of cereals, fruits and vegetables owing to its content of starch, pectin and vitamins, respectively. Due to very high dietary energy production of about 195 MJ/ha/day, sweet potato is considered as 'Energy Storehouse of Nature'. Despite a carbohydrate rich food; sweet potato has low glycemic index (<55), and is placed in the list of foods for diabetic people. Depending on the flesh

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colour, sweet potato tubers are rich in β-carotene, anthocyanins and total phenolic compounds (Mitra, 2014; Padda and Picha, 2007; Ludvik *et al*., 2004). Therefore, sweet potato has tremendous potential for contributing to the human diets around the world.

Orange-fleshed sweet potato is now gaining importance among the tropical tuber crops, which has great possibility for being adopted as a regular diet of the consumer food chain to tackling the problem of vitamin A deficiency. Being rich in β-carotene, the orange- fleshed sweet potato is also gaining importance as the cheapest source of antioxidant having several physiological attributes like anti-oxidation, anticancer and protection against liver injury, and is most suiting as biofortified crop to combat malnutrition. Thus, there is a great possibility of this subsistence crop to supplement as an alternative staple food source in the era of extensive population growth and nutrition crisis. Increased consumption of orange-fleshed sweet potato in either fresh or cooked form can contribute considerably in alleviating dietary deficiency of vitamin A and, thereby combating night blindness (Mitra *et. al*., 2010).The carotenoid pigments give orange-fleshed sweet potatoes their distinctive colours.

Of late, there has been increasing interest in purple-fleshed sweet potato also due to the high anthocyanin and total phenol content. Diacylatedanthocyanins isolated from the storage roots of a purple-fleshed sweet potato 'Ayamurasaki', were identified to possess a postprandial antihyperglycemic (antidiabetic) effect in rat through retardation of maltase activity. Anthocyanins and phenolic acids have also been reported to possess potential cancer chemopreventive effects. Anthocyanin-rich purple fleshed sweet potato has also been reported to reduce the risk of life-style related diseases, including cancer (Khalid *et al*., 2017). Dietary phenolic compounds have been recognized by the board of nutrition in the United States as an important health-promoting agent. In addition to being potent antioxidants, phenolic compounds are also able to bind to cellular receptors and transporters, which consequently influence gene expression, cell signaling and cell adhesion. The capability of phenolic compounds to scavenge free radicals is the primary mechanism where phenolic compounds protect the cells from free radical attack. Because of the protective effect of anthocyanins against chronic diseases, different types of food processing methods have been designed to preserve the bioavailability of anthocyanins in sweet potatoes. In Japan, the purple fleshed "Ayamurasaki" extract has been observed *in vitro* to be a potent antioxidant or radical scavenger, and angiotensin I converting enzyme inhibitor. It was also reported from a study on rat that purple-fleshed "Ayamurasaki" juice exhibited an ameliorative effect against carbon tetrachloride induced liver injury, and polyacylatedanthocyanins were the leading scavengers among all bioactive compounds found in purple-fleshed sweet potatoes (Suda *et al*., 2003). Sakai *et al*., (1009) also reported a purple fleshed sweet potato "Akemurasaki" with high anthocyanin content. As reported by Ishiguro *et al*. (2007), the main polyphenolic components in purple fleshed cultivars were chlorogenic acid and caffeoylquinic acid. Similar to anthocyanins, phenolic acids have free radical scavenging property. The anthocyanin pigments give purple-fleshed sweet potatoes their distinctive colours also.

Since the discovery of the physiological functionality of sweet potatoes and their predominant anthocyanin pigments, the food industry, primarily in Japan, has incorporated sweet potato as ingredients in processed food products. The demand for food products made from purple-fleshed sweet potato has been increased all over Japan since consumers became aware of the health benefit of consuming bioactive compounds like anthocyanins. The paste and flour from purple fleshed sweet potatoes have been used in many countries for making noodles, bread, jams, chips, confectionery, juice, alcoholic drinks and food dyes. Habtemariam (2019) included sweet potato in the list of crops with growing importance as antidiabetic agents.

However, most of the growers and consumers are not much aware of the nutritive value of orange-fleshed and purple-fleshed sweet potato cultivars. Moreover, the biochemical constituents of sweet potato varies among the cultivars grown in different places. Therefore, assessment of biochemical composition of different cultivars in different places is essential for selecting the cultivars having high nutritive values. Considering all these aspects, assessment of nutritional quality including antioxidant substances of the tubers of different cultivars of orange-fleshed, purple-fleshed and white-fleshed sweet potato were made for selecting promising cultivars having high nutritional quality.

2. Materials and Methods

The present experiment was conducted in the laboratory of the department of Post Harvest Technology, Bidhan Chandra Krishi Viswavidyalaya (Agril. University), West Bengal, India during 2019-20. The experiment was carried out to study the variability in biochemical attributes in fresh tubers of fifteen cultivars, five each of orange-fleshed, purple fleshed and white-fleshed sweet potato.

Fresh tubers of five orange-fleshed, five purple-fleshed and five white-fleshed sweet potato harvested at 120 days after planting were collected from the research field of All India Coordinated Research Project on Tuber Crops, Kalyani Centre, BCKV, West Bengal, India for biochemical analysis.

The experiment was laid out in completely randomized design with three replications for each parameter in different cultivars. The data were analysed statistically following the method as described by Gomez and Gomez (1984).

The analysis of variance table for a single factor CRD was formed for each parameter with the following steps. First, correction factor (C.F.) was calculated by dividing square of grand total $(GT)^2$ by total number of observations (rxt). Then, total sum of squares (TSS) was calculated by adding square value of all individual observations for each parameter and subtracting the total value by correction factor. Similarly, treatment sum of squares (TrSS), here cultivar sum of square was calculated by adding square value of total replicated values of all cultivars and by dividing this value by numbers of replication and the subsequent value was subtracted by correction factor. Error sum of squares (ESS) was calculated by subtracting cultivar sum of squares from total sum of squares.

Then, MS (variance) of source of variations was calculated, and finally F (variance ratio) was calculated by dividing treatment MS by error MS, which was then compared with the F value at 5%. In case of all the parameters studied, F (variance ratio) was higher than the F value at 5% level of significance, indicating significant difference between the cultivar means. To identify the best cultivar

for a particular parameter, and also to find the significant difference among the cultivars, critical difference (CD) was calculated for each parameter.

Of the fifteen cultivars used in this experiment, five cultivars namely 'Bidhan Jyoti', 'ST-14', 'CIPSWA-2', '362-7' and 'S-594' were orange fleshed; five cultivars namely 'X-134', 'X-140', 'X-24, 'Cross 4' and 'DOP MIX 93-13' were purple fleshed; and 'Bidhan Jagannath', 'BCSP-7', 'TSP-16-8', 'TSP-12-10' and 'TSP-12-12' were white fleshed. The following quality parameters of fifteen cultivars under study were assessed.

Dry matter (%), Moisture (%), Total soluble solids (TSS) in ^{0}Brix, Carbohydrate content (%), Starch content (%), Total sugar content (%), Ascorbic acid content (mg/100 g), β-carotene content (mg/100 g), Retinol activity equivalent (RAE), Anthocyanin content (mg/100 g), Crude protein content (%, dry weight) and Total phenol content (g/100 g, dry weight).

After washing, peeling and shredding, fresh tubers were dried at 60°C in mechanical dryer for about 48 h till the tubers gained constant weight to determine the dry matter content (%). The dried samples were ground to powder and was pass through a 250 µm sieve. The sweet potato powder was then kept in self-sealing pouches at 4°C for further analysis. Total soluble solids content was measured by using a Hand Refractometer from the extract of fresh sweet potato tuber. The shadow level of the scale was adjusted to '0' reading with a drop of distilled water. Subsequently, the water was blotted out with filter paper, the refractometer was air dried and a drop of freshly squeezed juice was placed on the plate (specimen chamber) to record the refractometer reading. The total soluble solids content was expressed in °Brix. The ascorbic acid (mg/100 g), β-carotene (mg/100 g), carbohydrate (%), starch (%), and total sugar content in per cent were determined on the basis of fresh weight following standard procedures. Total carbohydrate was assessed following the procedure as described by Sadasivam and Manickam (1996). Starch and total sugar content of the tubers were estimated following the titrimetric method as described by Moorthy and Padmaja (2002), which involved extraction of sugars with 80% ethanol. The extract was filtered and the filtrate was used for the analysis of sugars. The residue was acid hydrolysed using 2N HCL for the estimation of starch. The hydrolysates were titrated against 1% potassium ferricyanide and 2.5N NaOH solution using methylene blue as indicator. The 2, 6-Dichloroindophenol titrimetric method was used for ascorbic acid estimation (Ranganna, 2002). Standard ascorbic acid and metaphosphoric acid (3%) were used in determining dye factor. The ascorbic acid content was measured by titrimetric method using 2, 6-Dichlorophenolindophenol dye. Determination of β-carotene was done following the spectrophotometric method (AOAC, 1995). The true form of vitamin A or retinol activity equivalents (RAE) was calculated on the basis of conversion factor suggested by Institute of Medicine, Food and Nutrition Board (2001) considering 12 µg β-carotene is equal to 1 µg RAE. Total anthocyanins of the tubers were estimated using optical density (OD) as described by Fuleki and Francis (1968). The method consists of extracting the anthocyanins with ethanol (95%) and 1.5 N hydrochloric acid at a ratio of 85:15 and measuring the O.D. of the extract diluted with the extracting solvent at 535 nm in a UV-Vis spectrophotometer. The total anthocyanin content was calculated with the aid of the coefficient of extinction (98.2) and taking dilution factor into account.

Table 1: Nutrition facts of sweet potato tubers of different flesh colour

Cultivar	Dry matter (%)	Moisture (%)	TSS (^{0}Brix)	Carbohydrate (%) (fw)	Starch (%) (fw)	Total sugars (%) (fw)
S-594	23.68	75.82	8.2	18.63	14.34	2.54
362-7	24.16	76.37	10.4	20.40	13.53	3.14
CIP SWA-2	26.63	74.24	9.6	20.72	12.67	2.75
ST-14	25.31	74.69	8.4	19.98	12.21	1.81
BidhanJyoti	25.76	74.52	9.8	18.19	12.52	2.69
X-24	26.39	73.61	6.8	17.37	11.68	1.80
X-134	34.11	65.89	8.2	19.67	12.94	1.94
X-140	26.17	73.83	7.6	16.58	9.51	2.41
Cross- 4	27.58	72.42	9.2	21.23	15.28	2.91
H-200	25.72	74.28	7.4	17.81	12.32	1.53
BCSP-7	24.71	75.29	6.2	16.17	10.54	1.36
TSP 16-8	26.73	73.27	8.6	18.24	11.83	2.34
TSP 12-10	28.16	71.84	9.4	18.13	12.66	1.98
TSP 12-12	25.87	74.13	8.8	17.82	12.32	2.23
Bidhan Jagannath	26.32	73.68	9.0	18.38	11.17	2.59
SEM	0.48	0.62	0.37	0.39	0.41	0.14
CD (p=0.05)	1.46	1.87	1.14	1.16	1.24	0.43

fw=fresh weight

Table 2: Protein and antioxidant substances in sweet potato tubers of different flesh colour

Cultivar	Crude protein (%) (dw)	Ascorbic acid (mg/100 g) (fw)	β-carotene (mg/100 g) (fw)	Retinol activity equivalent (RAE) (µg /100 g)	Anthocyanin (mg/100 g) (fw)	Total phenols (g /100 g) (dw)
S-594	6.46	11.74	4.76	396.67	0.43	0.92
362-7	5.86	16.91	6.42	535.00	0.51	0.46
CIP SWA-2	5.48	10.32	5.17	430.83	0.33	0.78
ST-14	4.12	17.94	11.16	930.00	0.61	0.84
Bidhan Jyoti	4.92	19.84	7.82	651.67	0.46	0.62
X-24	3.87	14.36	1.37	114.17	11.15	1.43
X-134	5.47	10.14	0.63	52.50	10.53	1.34
X-140	6.14	8.38	0.81	67.50	9.38	1.29
Cross- 4	5.92	15.72	1.42	118.33	18.41	1.68
H-200	4.37	11.13	1.12	93.33	10.17	1.39
BCSP-7	5.72	17.54	0.23	19.16	0.14	0.51
TSP-16-8	5.19	13.68	0.47	39.17	0.18	0.48
TSP-12-10	6.18	16.45	0.52	43.33	0.22	0.64
TSP-12-12	5.37	11.86	0.17	14.17	0.11	0.57
Bidhan Jagannath	6.34	18.56	3.38	281.67	0.31	0.98
SEM	0.27	1.14	1.78	51.14	3.71	0.11
CD (p=0.05)	0.82	3.46	5.38	151.53	11.36	0.32

fw = fresh weight ; dw = dry weight

Figure 1: Some orange-fleshed, white-fleshed and purple-fleshed sweet potato cultivars.

The estimation of crude protein and phenol content was done on the dry weight basis. Total phenols were estimated following the procedure as described by Swain and Hillis (1955), using sodium carbonate (20%), folin- ciocalteau reagent and methanol (80%). A standard curve was drawn using gallic acid as standard. Different concentrations of gallic acid were prepared and optical density was read at 660 nm wavelength. The concentration of samples was calculated based on the standard curve. The titrimetric Kjeldahl digestion method as described in AOAC (1995) was used for nitrogen (N) estimation and crude protein content was calculated by multiplying the total nitrogen content with a factor of 6.25 and was expressed in per cent.

3. Results

Significant differences in all the nutritional parameters were observed among the cultivars of sweet potato studied. The total soluble solids (TSS) content of the tubers ranged from 6.4 ^{0}Brix in 'BCSP-7', a white fleshed cultivar to 10.4 ^{0}Brix in '362-7', an orange fleshed cultivar. Like TSS content, the lowest total sugar content in tubers was also recorded in 'BCSP-7'. The total sugar content was found to vary from 1.36-3.14% among the cultivars of different flesh colour. The dry matter content of tubers ranged from 23.68% in 'S-594', an orange fleshed cultivar to 34.11% in 'X-134', a purple fleshed cultivar. Among all the cultivars, both the highest carbohydrate (21.23%) and starch content (15.28%) were recorded in 'Cross-4', a purple fleshed sweet potato (Table 1). The crude protein content of the cultivars varied between 3.87 and 6.56 g/100 g of dry powder in 'X-24' a purple fleshed cultivar and 'S-594', an orange fleshed cultivar, respectively. The level of total phenols having antioxidant properties varied between 0.46 and 1.68 g/100 g of dry weight in '362-7' an

orange fleshed cultivar and 'Cross-4' a purple fleshed cultivar, respectively. Marked variation in ascorbic acid content ranging from 8.38 to 19.84 mg/100 g of fresh tuber was recorded among the cultivars studied. Distinct variations in β-carotene content among the cultivars of different flesh colour were also observed. Orange fleshed cultivars were found to contain higher amount of β-carotene ranging from 4.76 mg/100 g in 'S-594' to 11.16 mg/100 g in 'ST-14'. Both the purple fleshed and white fleshed cultivars contained very less or negligible amount of β-carotene. Among the purple fleshed cultivars, the highest β-carotene content amounting 1.42 mg/100 g was recorded in Cross-4. Whereas, tubers of white fleshed sweet potato, except the yellowish white cultivar 'Bidhan Jagannath' registered the lowest value of β-carotene. True value of vitamin A in terms of retinol activity equivalents (RAE) was also recorded maximum in orange fleshed cultivars ranging from 396.67 to 930.00 µg /100 g. Wide variations in anthocyanin content were also observed among the cultivars of different flesh colour. Very less amount of anthocyanin content was recorded in both the orange fleshed and white fleshed cultivars of sweet potato. Unlike orange fleshed and white fleshed cultivars, purple fleshed sweet potato cultivars were found to contain high anthocyanin ranging from 9.38 mg/100 g in 'X-140' to 18.41 mg/100 g in 'Cross-4'. Total phenol content in the tubers was also found to vary significantly among the cultivars. The highest total phenol content of 1.68 g/100 g of dry weight was recorded in a purple fleshed cultivar 'Cross-4' (Table 2). Both the orange fleshed and white fleshed cultivars witnessed comparatively lower total phenol content as compared to the purple fleshed cultivars of sweet potato.

4. Discussion

Among various nutritional parameters, TSS, carbohydrate, starch and ascorbic acid content were not much influenced by the flesh colour of sweet potato. Both higher and lower ranges of these constituents were recorded in the tubers irrespective of flesh colour. Generally, traditional orange-fleshed cultivars contain low dry matter as compared to white-fleshed and purple fleshed cultivars but some of the orange-fleshed cultivars under the study, namely; 'CIPSWA-2' and 'Bidhan Jyoti' had higher dry matter content of about 26-27%. Orange-fleshed cultivars with higher dry matter content had also been reported earlier (CIP, 2001; Mitra, 2008; Roy *et al*., 2012; Mitra, 2018). Along with some purple fleshed cultivars like 'X-134' and 'Cross-4', and some white fleshed cultivars like 'TSP-12-10' and 'TSP 16-8', orange-fleshed cultivars, namely; 'CIPSWA-2' and 'Bidhan Jyoti' having high dry matter can also be used to develop cultivars with higher dry matter content because of the strong consumer preference and industrial demand for cultivars with higher dry matter. Starch was found to be the predominant carbohydrate in all the cultivars, and was directly correlated to the dry matter content of the tubers. Cultivars with higher dry matter registered higher level of starch also. These results are in line with the findings reported by Mitra *et al*. (2010) and Roy *et al*. (2012). Mitra *et al*. (2010) also recorded high starch content of 15.37% in an orange fleshed sweet potato cultivar which contained high dry matter of 26.52%. The white fleshed cultivar 'BCSP-7' with very low sugar content (1.36%) can be used for culinary purpose. Higher protein content was not confined to any specific flesh coloured tubers. Relatively higher protein content of about 6-7% on dry weight basis was recorded in two each of purple fleshed, orange fleshed and white fleshed cultivars (Table 2). Protein content in this range in orange fleshed cultivars of sweet potato was also reported by Roy *et al*. (2012). The variation in antioxidant substances were also found among the cultivars of different flesh colour. Like protein content, ascorbic acid content also was not dependent on the flesh colour of tubers. Some cultivars, irrespective of flesh colour contained relatively higher ascorbic acid of about 18-20 mg/100 g of fresh tuber. Mitra (2012) and Rautenbach *et al*. (2010) also reported similar ranges of ascorbic acid in some orange fleshed sweet potato cultivars. Anthocyanin content was predominant in purple fleshed cultivars. The purple fleshed cultivars studied were light purple in colour, some cultivars had only some purple rings or streaks. Anthocyanin content was positively related with the intensity of purple colour in the tubers. Relatively deep purple fleshed cultivar 'Cross-4' registered the highest anthocyanins content in the tubers. All the purple fleshed cultivars having higher anthocyanins were also found to be superior in total phenol content than the orange fleshed and white fleshed cultivars. Walter *et al*. (1979) also reported that anthocyanins and chlorogenic acid are the major phenolic compounds present in purple-fleshed sweet potatoes. Purple-fleshed sweet potato has also been reported to have higher antioxidant activity and phenolic content than a certain variety of blueberry, reportedly having exceptionally high levels of antioxidants. Anthocyanins have also been suggested as useful agents in disease prevention by Wang and Stoner (2008) and Cvorovic *et al*. (2010). The β-carotene content was directly related with the flesh colour of the tubers. Orange fleshed cultivars were superior in β-carotene content than both the purple fleshed and white fleshed cultivars. Though, the retinol activity equivalent or true value of vitamin A in these orange fleshed sweet potato cultivars were lower than that of the orange fleshed cultivars reported by van Jaarsveld *et al*. (2006), it was quite higher than the level of vitamin A recommended by the Food and Agriculture Organization/World Health Organization (FAO/WHO, 2001).

High dry matter content in tubers enhances conversion of β-carotene to vitamin A, so the β-carotene in the tubers with high dry matter will be more bioavailable than the orange fleshed cultivars with low dry matter. β-carotene, the provitamin A from dark orange fleshed sweet potato appears to be more bioavailable than that of the dark green leafy vegetables (Mitra, 2008; Jalal *et al*., 1998). Increased consumption of orange-fleshed sweet potatoes having high β-carotene can contribute considerably to alleviate dietary deficiency of vitamin A in the developing countries. Tsou and Hong (1992) also reported that 100-150 g serving of boiled tubers of orange-fleshed sweet potato can supply the daily requirement of vitamin A for young children which can protect them from blindness. Low *et al*. (2001) and Mitra (2012) also recommended food based approach for increasing consumption of β-carotene-rich orange-fleshed sweet potatoes in alleviating vitamin A deficiency.

5. Conclusion

Identified pigmented cultivars of purple-fleshed sweet potatoes having high antioxidant substances like anthocyanins and total phenols, and orange-fleshed sweet potatoes rich in β-carotene along with moderate total phenols can act as cheap sources of antioxidant. Similarly, white fleshed sweet potatoes with low sugar content can be used for culinary purpose. Large doses of any vitamin or mineral through dietary supplements may affect the body's ability to absorb other nutrients and can be associated with some health risks. So, incorporating both orange fleshed and purple fleshed sweet potatoes with low glycemic index and rich in antioxidants within the diet

through a food based approach may be regarded as a good choice for promoting health in the challenged situation.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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