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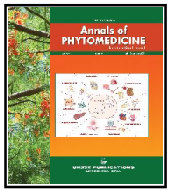

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Unlocking the nutritional and antioxidant potential of sweet potato, *Ipomoea batatas* (L.) Lam. genotypes for human health

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Abstract

Plant-based antioxidants and pharmaceuticals shield cells, lower disease risk, and offer therapeutic benefits, notably by increasing human well-being. Sweet potato, recognized for its elevated plant-based antioxidant content, is instrumental in combating various ailments. This research examined the antioxidant properties and sensory traits of 31 sweet potato genotypes. Analysis revealed significant variations in antioxidant compounds across genotypes, with notable concentrations observed in CHFSP-23, distinguished by its deep purple hue. The genotype CHFSP-04 boasts the highest carotenoid content (11.46 mg/g) and ascorbic acid content (18.61 mg/100 g). Anthocyanin, which is key for colouration and antioxidant potency, is variable, with CHFSP-23 exhibiting the highest concentration. Sensory appraisal underscores genotype preferences, offering insights for breeding and marketing, with CHFSP-1 and CHFSP-23 being lauded for taste and colour, respectively. Correlation studies highlight synergistic relationships among anthocyanins and other antioxidants, highlighting the potential of sweet potatoes as functional foods with diverse health benefits for the agri-food sector.

1. Introduction

The Sweet potato *Ipomoea batatas* (L.) Lam. owing to its socioeconomic benefits, it is a vital crop on a global scale, particularly for smallholder farmers (Roesler *et al*., 2008). The International Potato Center (CIP, 2017) underscores the value of sweet potatoes in ensuring food security for developing countries because of their adaptability to various soil and climatic conditions. Owing to its distinct properties, sweet potato is fundamental in several sectors, such as food processing, starch manufacturing, and bioenergy production (Yang *et al*., 2015). Aerobic metabolism leads to the internal formation of free radicals and reactive oxygen species (ROS), which are believed to play a central role in the development of degenerative diseases, including cirrhosis, Alzheimer's disease, cancer, ageing and arthritis (Rimbach and De Pascual-Teresa, 2005). Numerous studies have highlighted the diversity of molecular analysis in sweet potatoes (Mounika *et al.,* 2024). Among the major tuber crops cultivated in India, sweet potatoes are the third most widely grown tuber crop behind cassava and potatoes, with a substantial productivity of 252.1 metric tonnes per hectare and a cultivable area of 106.2 thousand hectares, producing an exceptional yield of 1121.33 thousand metric tonnes (Anon., 2021). It is largely cultivated in Uttar Pradesh, Bihar, West Bengal, Orissa, Madhya Pradesh, Tamil Nadu, Kerala, Karnataka and Andhra Pradesh (Hazra., 2015).

Antioxidants play an essential role in neutralizing the adverse effects of these diseases. However, caution is needed when synthetic antioxidants are applied. Notably, butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT), which are commonly used in the food industry, are associated with increased risks of cancer and liver damage. Similarly, synthetic antioxidants such as vitamin E and β-carotene are correlated with increased adult mortality (Hue *et al.,* 2012). Plant-derived antioxidants are regarded as superior alternatives and are effective in reducing the risks associated with cancer and cardiovascular and neurodegenerative diseases (Art and Hollman, 2005). One of the significant sources of natural antioxidants is sweet potato. Their leaves, buds, vines, and tubers contain a variety of these crucial molecules. These antioxidants are composed primarily of diverse phytochemicals, including anthocyanins, flavonoids, carotenoids and phenolics, in addition to other beneficial components. They exhibit properties such as antimutagenicity, antihyperglycemic action, hepatoprotection, and antihypertensive effects. They also aid in improving memory, reducing age-related macular degeneration, and alleviating cardiovascular issues (Amir *et al.,* 2015; Asadi *et al.,* 2017). Compared with various commercial vegetables such as cabbage, kale, spinach, broccoli, and lettuce, sweet potatoes contain higher concentrations of polyphenolic antioxidants (Xi *et al.,* 2015). Phenolic compounds, known for their health benefits, have potential in cancer prevention and possess anti-inflammatory, antibacterial and antiviral properties (Taira *et al.*,2013). The anthocyanins found in sweet potato roots and leaves are distinguished by their outstanding

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antioxidant effectiveness. Specifically, anthocyanins from purple-fleshed sweet potato (PFSP) demonstrate hypoglycemic effects by inhibiting amylase and glucosidase activities, which can help regulate blood sugar levels (Mahadita *et al.,* 2016) and reduce insulin secretion (El-Sheikha and Ray, 2017). Given the antioxidant-rich profile of sweet potato, this study aims to identify and quantify these beneficial compounds that are crucial for determining product quality.

2. Materials and Methods

2.1 Plant materials

The present study included 29 genotypes of sweet potato collected from Northeast India along with 2 suitable checks, *i.e.*, Sree Bhadra and ST-14 collected from AICRP, Manipur, and Imphal, thereby comprising 31 genotypes in total. The experiment was conducted with proper cultural practices at the research farm of the vegetable department, CHF, CAU, Pasighat-791102, Arunachal Pradesh, India, which is situated at an altitude of 154 m above mean sea level and has geographical coordinates of approximately N 28° 04' 37.19" latitude and E 95° 19' 29.16" longitude. The growing soil media is sandy loam with a pH of 6.2 and organic carbon of 3.2 %. The taxonomical identification was done by Dr. Chandra Deo, Professor, Department of Vegetable Science, College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh under the Collection ID-CHF/CAU/Veg/*Ipomoea*-1. No pesticides are applied during crop growth. Tubers were harvested 120 days after planting. Harvested tubers were collected, washed cleanly and stored at -200°C in a refrigerator. All the phytochemical analyses were carried out in three replications in the Department of Basic Sciences and Humanities, CHF, CAU, Pasighat-791102, Arunachal Pradesh, India.

2.2 Phytochemical analysis

2.2.1. Phenols

Phenol content was assessed via the method described by Malick and Singh (1980). A 1 g sample was homogenized in 10 ml of 80% ethanol. This mixture was centrifuged at 10,000 revolutions per minute (rpm) for 20 min. The supernatant was collected, and the solvent was evaporated to dryness. The residue was then dissolved in 5 ml of water. From this mixture, 0.2 ml were aliquoted and diluted with distilled water to a final volume of 3 ml. To each tube, 0.5 ml of Folin-Ciocalteu reagent was added, followed by the addition of 2 ml of 20 % Na_2CO_3 after 3 min. The tubes were placed in boiling water for 1 min and then allowed to cool. The phenol content was determined by measuring the absorbance of the sample against a blank solution *via* a UV-visible spectrophotometer at 650 nanometres. The phenol content was calculated from the phenol standard curve and expressed as mg GAE/g of fresh weight.

2.2.2 Total flavonoids

Flavonoid content was determined following the method outlined by Bouayed *et al*. (2011). 1 g of sample was extracted with 10 ml of distilled water. The mixture was shaken at room temperature (25°C) for approximately 180 min and then cooled for 10 min. The resulting filtrate was filtered through Whatman No. 1 filter paper and used for flavonoid analysis. The total flavonoid content was assessed *via* an aluminium chloride calorimetric assay. In a volumetric flask, 1 ml of the extract was mixed with 4 ml of distilled water. To this mixture, 0.30 ml of 5% sodium nitrate were added, followed by 0.3 ml of 10% aluminium chloride after 5 min. After an additional 5 min, 2 ml of 1 M sodium hydroxide were added, and the solution was diluted to a final volume of 10 ml with distilled water. A series of quercetin reference standard solutions (20, 40, 60, 80 and 100 µg/ml) were prepared in the same manner. The absorbances of the test and standard solutions were measured at 410 nm *via* a UV-visible spectrophotometer, with a reagent blank used as the reference. The total flavonoid content was calculated and expressed as milligrams of quercetin equivalent (QE) per 100 g of extract.

2.2.3 Total carotenoids

The carotenoid content was estimated *via* the method outlined by Nayak *et al.* (2014), with slight modifications. First, 100 mg of fresh tuber were homogenized in 5 ml of 80% acetone *via* a clean mortar and pestle. The mixture was then centrifuged at 5,000 revolutions per minute (rpm) for 5 min, and the supernatant was collected for analysis. To determine the total carotenoid content, the absorbance of the supernatant was measured at three wavelengths, 664 nm, 648 nm, and 470 nm, *via* a UV-visible spectrophotometer. These absorbance values were used to estimate the carotenoid content.

2.2.4 Ascorbic acid

The ascorbic acid content was measured *via* the method described by Jagota and Dani (1982). One gram of each sample was ground in a mortar with a small amount of neutral glass powder. The mixture was then combined with an equal volume of 6% metaphosphoric acid and EDTA solution, and the volume was adjusted to 50 ml with 3% metaphosphoric acid. The mixture was subsequently centrifuged at 5,000 rpm for 10 min, filtered through Whatman No. 1 filter paper, and collected in a volumetric flask. An aliquot of 0.1 ml of this extract was diluted with 1.2 ml of 3% metaphosphoric acid, and the final volume was brought to 4 ml with distilled water. To each tube, 0.4 ml of Folin-Ciocalteu reagent was added, and the mixture was mixed thoroughly. The tubes were incubated at room temperature for 10 min and then centrifuged at 3,000 rpm for 10 min. After centrifugation, the supernatant was read against the blank solution at 760 nm *via* a UV-visible spectrophotometer. The ascorbic acid concentration in the sample was determined from the slope of the ascorbic acid standard curve.

2.2.5 Anthocyanin

The estimation of anthocyanin content was performed following the procedure outlined by Ranganna (1986). One gram of sample was blended with 10 ml of ethanolic HCl. The resulting mixture was then transferred to a 100 ml volumetric flask and brought up to the mark with additional solvent. The flask was subsequently stored overnight in a refrigerator at 4°C. To measure the anthocyanin content, 0.2 ml of the solution from the volumetric flask were collected and diluted to a volume of 10 ml with ethanolic HCl. The absorbance value of the filtrate was recorded at a wavelength of 535 nanometres *via* a spectrophotometer. The total anthocyanin content was calculated as mg/100 g of the sample.

2.2.6 DPPH free radical scavenging activity

Antioxidant activity was evaluated *via* the method described by Aoshima *et al.* (2004), with slight modifications. A 0.2 g sample was homogenized in 5 ml of ethanol. An aliquot of 0.5 ml of this sample extract was mixed with 0.3 ml of DPPH reagent (0.5 millimolar concentration in ethanol) by vortexing. The mixture was then incubated in darkness at room temperature for 30 min. After

incubation, the discolouration of DPPH was measured at 517 nm against a blank using a UV-visible spectrophotometer.

2.3 Statistical analysis

The data from the laboratory analyses were subjected to statistical evaluation *via* a completely randomized design (CRD). Variance among the genotypes was assessed for significance *via* Duncan's multiple range test.

3. Results

Sweet potatoes are renowned for their strong antioxidant properties, largely attributed to their rich content of beneficial compounds. Key antioxidants found in sweet potatoes, such as beta-carotene, vitamin C, and phenolic compounds, are essential for counteracting oxidative stress in the body. The antioxidant capacity of sweet potatoes is significantly affected by the colour of their flesh, which can range from white and yellow to orange and purple (Figure 1). Orange-fleshed varieties are particularly rich in beta-carotene, a potent antioxidant that is a precursor to vitamin A, offering significant immune and vision benefits. In contrast, purple-fleshed sweet potato is rich in anthocyanins, another type of antioxidant known for its anti-inflammatory and heart health effects. This colour-linked variation in antioxidant content highlights the diverse health benefits offered by different types of sweet potatoes, making them a nutritionally rich food choice. The rich, natural array of antioxidants found in sweet potatoes makes them a valuable dietary choice for those seeking to increase their health and nutritional intake.

Figure 1: Tuber diversity in the flesh and skin colour of sweet potato genotypes.

3.1 Phenols

An investigation involving 31 sweet potato genotypes revealed a range of total phenol contents ranging from 0.61 to 2.62 mg GAE/g (Table 1). The highest total phenol content was observed in CHFSP-23 (2.62 ± 0.111), characterized by dark purple skin and dark purple flesh. In addition, CHFSP-3 (2.24 ± 0.157) had pink skin and purple flesh, and CHFSP-13 (1.86 ± 0.007) had purple skin, yellow flesh, and scattered purple flesh. Conversely, the lowest total phenol content was recorded in CHFSP-28 (0.61 ± 0.119), which was distinguished by pink skin and white flesh.

3.2 Flavonoid content

In the present study, an evident variation in the flavonoid content among different sweet potato genotypes was observed. The range of flavonoid concentrations ranged from 0.49 to 1.79 mg QE/g (Table 1). This wide variation underscores the genetic diversity that exists among sweet potato cultivars in relation to their flavonoid content. The genotype CHFSP-20, characterized by purple skin and white flesh, presented the highest flavonoid content, closely followed by CHFSP-18 and CHFSP-02, both of which have white flesh but varying skin colours-pink and white, respectively (Table 1).

3.3 Total carotenoid content

In the present study, the carotenoid contents of the sweet potato genotypes ranged from 3.19 to 11.46 mg/g (Table 1). The genotype CHFSP-04, with its orange skin and flesh, presented the highest carotenoid content, at 11.46 ± 0.182 mg/g. It was closely followed by CHFSP-25 and CHFSP-3, which had carotenoid contents of 10.77 ± 0.382 mg/g and 9.67 ± 0.142 mg/g, respectively. Conversely, the CHFSP-13 genotype presented the lowest total carotenoid content (TCC) at 3.19 ± 0.156 mg/g. These variations suggest a potential genetic basis for the differences in carotenoid content among the genotypes.

3.4 Ascorbic acid content

The ascorbic acid (vitamin C) content of sweet potatoes has been the subject of considerable interest because of its nutritional importance and potential health benefits. In the present study, the ascorbic acid content significantly varied among the genotypes. The orange-fleshed sweet potato genotype CHFSP-4 presented the highest ascorbic acid content, with a value of 18.61 ± 0.654 mg/100 g, followed closely by CHFSP-25 at 17.6 ± 0.577 mg/100 g and then St-14 at 15.6 ± 0.623 mg/100 g. The genotype with the lowest ascorbic acid content was CHFSP-17, with a value of 6.06 ± 0.098 mg/100 g (Table 2).

Table 1: Variation in the phenol, flavonoid and total carotenoid contents of sweet potato genotypes

Genotype	Phenol (mg GAE/g fw)	Flavonoids (mg QE/g)	Total carotenoid content (mg/100 g)
CHFSP-01	1.07 ± 0.024	1.28 ± 0.025	8.87 ± 0.107
CHFSP-02	1.76 ± 0.086	1.70 ± 0.107	4.87 ± 0.153
CHFSP-03	2.24 ± 0.157	1.15 ± 0.170	9.67 ± 0.142
CHFSP-04	0.86 ± 0.056	1.35 ± 0.048	11.46 ± 0.182
CHFSP-05	1.79 ± 0.055	0.94 ± 0.003	8.57 ± 0.128
CHFSP-06	1.22 ± 0.095	1.63 ± 0.100	5.92 ± 0.078
CHFSP-07	1.16 ± 0.055	0.53 ± 0.017	6.61 ± 0.135
CHFSP-08	0.91 ± 0.014	1.42 ± 0.050	8.68 ± 0.156
CHFSP-09	0.83 ± 0.057	0.49 ± 0.016	4.27 ± 0.079
CHFSP-10	1.83 ± 0.072	1.51 ± 0.016	8.47 ± 0.215
CHFSP-11	1.11 ± 0.055	0.69 ± 0.018	8.56 ± 0.255
CHFSP-12	1.16 ± 0.009	1.61 ± 0.066	6.01 ± 0.155
CHFSP-13	1.86 ± 0.007	0.55 ± 0.010	3.19 ± 0.156
CHFSP-14	1.06 ± 0.005	1.30 ± 0.168	7.66 ± 0.254
CHFSP-15	1.62 ± 0.002	1.00 ± 0.051	3.73 ± 0.111
CHFSP-16	0.75 ± 0.004	1.65 ± 0.010	6.86 ± 0.099
CHFSP-17	0.68 ± 0.088	1.10 ± 0.294	3.49 ± 0.123
CHFSP-18	0.83 ± 0.008	1.72 ± 0.105	5.61 ± 0.202
CHFSP -19	0.95 ± 0.007	1.22 ± 0.035	5.64 ± 0.051
CHFSP-20	0.96 ± 0.035	1.79 ± 0.006	5.31 ± 0.095
CHFSP-21	1.57 ± 0.013	1.48 ± 0.035	5.18 ± 0.064
CHFSP-22	1.06 ± 0.020	1.64 ± 0.033	9.62 ± 0.066
CHFSP-23	2.62 ± 0.111	1.68 ± 0.157	8.60 ± 0.251
CHFSP-24	1.15 ± 0.026	0.53 ± 0.010	7.74 ± 0.196
CHFSP-25	0.86 ± 0.014	0.80 ± 0.071	10.77 ± 0.382
CHFSP-26	0.91 ± 0.007	0.55 ± 0.003	9.12 ± 0.149
CHFSP-27	1.01 ± 0.118	1.33 ± 0.197	8.70 ± 2.202
CHFSP-28	0.61 ± 0.119	1.06 ± 0.033	5.83 ± 0.171
CHFSP-29	0.78 ± 0.007	0.91 ± 0.028	7.75 ± 0.142
Sree Bhadra	1.11 ± 0.004	1.65 ± 0.018	7.05 ± 0.236
St-14	0.75 ± 0.015	0.81 ± 0.012	9.46 ± 0.029
SEM (±)	0.05	0.03	0.21
CD 5%	0.14	0.09	0.61

3.5 Total anthocyanin content

In the present study, the anthocyanin content of sweet potato varied significantly across different genotypes, ranging from 0.062 to 0.72 mg/100 g. These results suggest a clear association between the colour of the skin and flesh of the sweet potato and its anthocyanin content. The genotype CHFSP-23, which has dark purple skin and flesh, presented the highest anthocyanin content (0.72 ± 0.005 mg/100 g) (Table 2).

3.6 Total antioxidant activity

The variation in DPPH values across different sweet potato genotypes underscores the influence of genetic factors on phenolic composition and, consequently, on antioxidant activity. The CHFSP-23 genotype, characterized by its dark purple flesh and skin, presented the highest phenolic content and, consequently, the maximum antioxidant activity (86.53 ± 0.532%). The genotype CHFSP-19 presented the lowest antioxidant activity (69.14 ± 0.108%) (Table 2).

Table 2: Variation in ascorbic acid, anthocyanin and antioxidant activity contents of sweet potato genotypes.

Genotype	Ascorbic acid (mg/100 g)	Anthocyanin (mg/100 g)	Antioxidant activity (%)
CHFSP-01	7.46 ± 0.096	0.34 ± 0.121	78.81 ± 0.240
CHFSP-02	6.36 ± 0.309	0.06 ± 0.011	72.00 ± 0.208
CHFSP-03	12.6 ± 0.177	0.62 ± 0.037	84.04 ± 0.648
CHFSP-04	18.6 ± 0.654	0.22 ± 0.033	72.95 ± 0.574
CHFSP-05	11.6 ± 0.300	0.49 ± 0.012	82.02 ± 0.469
CHFSP-06	6.96 ± 0.135	0.08 ± 0.003	72.47 ± 1.017
CHFSP-07	8.06 ± 0.392	0.21 ± 0.038	78.94 ± 0.554
CHFSP-08	6.46 ± 0.466	0.14 ± 0.006	75.12 ± 0.009
CHFSP-09	7.86 ± 0.626	0.16 ± 0.029	76.65 ± 1.453
CHFSP-10	8.26 ± 0.147	0.18 ± 0.009	79.99 ± 0.335
CHFSP-11	7.16 ± 0.162	0.37 ± 0.011	77.94 ± 0.846
CHFSP-12	7.96 ± 0.174	0.07 ± 0.009	72.34 ± 0.908
CHFSP-13	6.16 ± 0.096	0.20 ± 0.031	78.52 ± 0.168
CHFSP-14	12.6 ± 0.398	0.32 ± 0.152	80.17 ± 0.101
CHFSP-15	7.26 ± 0.057	0.23 ± 0.029	78.43 ± 0.341
CHFSP-16	7.16 ± 0.045	0.15 ± 0.025	78.03 ± 1.557
CHFSP-17	6.06 ± 0.098	0.05 ± 0.006	75.85 ± 0.685
CHFSP-18	7.36 ± 0.213	0.15 ± 0.049	77.47 ± 1.890
CHFSP -19	8.06 ± 0.216	0.08 ± 0.004	69.14 ± 0.108
CHFSP-20	5.76 ± 0.042	0.09 ± 0.008	77.46 ± 0.891
CHFSP-21	9.36 ± 0.195	0.15 ± 0.011	78.21 ± 0.643
CHFSP-22	9.86 ± 0.209	0.14 ± 0.011	76.47 ± 1.883
CHFSP-23	14.6 ± 0.459	0.72 ± 0.005	86.53 ± 0.532
CHFSP-24	7.46 ± 0.301	0.24 ± 0.058	79.16 ± 0.192
CHFSP-25	17.6 ± 0.577	0.25 ± 0.022	76.94 ± 1.214
CHFSP-26	7.26 ± 0.006	0.19 ± 0.003	75.29 ± 0.563
CHFSP-27	13.6 ± 4.919	0.13 ± 0.062	77.08 ± 3.394
CHFSP-28	6.96 ± 0.018	0.21 ± 0.040	77.47 ± 1.118
CHFSP-29	6.26 ± 0.179	0.23 ± 0.023	73.23 ± 1.308
Sree Bhadra	8.66 ± 0.508	0.23 ± 0.028	76.46 ± 0.276
St-14	15.6 ± 0.623	0.19 ± 0.002	78.79 ± 0.258
SEM (±)	0.19	0.02	0.52
CD 5%	0.55	0.07	1.46

4. Discussion

Phenols and flavonoids are the major phenolic compounds found in sweet potato (Meng *et al.,* 2019). The consumption of these substances has been scientifically demonstrated to confer various physiological benefits, including antioxidant, antibacterial, and hypoglycaemic effects, thereby mitigating the risk of developing diverse chronic ailments (Hogervorst *et al.,* 2017). These findings align with those of previous studies that compared sweet potatoes of various flesh colours (white, orange and purple) and reported that purple-fleshed sweet potatoes presented the highest phenolic content, followed by orange- and white-fleshed varieties (Teow *et al.,* 2007; Khurnpoon and Rungnoi, 2012). Additionally, phenolic chemicals may exert a direct influence on the overall antioxidative effect, further emphasizing their potential significance in promoting health and disease prevention.

In contemporary scientific discourse, there has been increasing interest in the exploration of natural substances for their capabilities

in oncological interventions. Phenolic compounds, particularly, have drawn considerable scientific focus owing to their empirically substantiated anti-neoplastic characteristics. These compounds, primarily sourced from botanical origins, have demonstrated efficacy in modulating oncogene expression and influencing signalling pathways pertinent to cancer, thereby exhibiting potential cancer-preventative effects (Shehzad *et al.,* 2020). A pivotal mechanism through which phenolic compounds exert their anticancer influence involves the modulation of tumour suppressor genes (Khan *et al.,* 2021). The pathological hallmark of cancer, characterized by uncontrolled cellular proliferation, is notably impeded by these plant-derived phenolics (Pandey and Rizvi, 2009). Furthermore, these compounds have the potential to reduce the invasive nature of cancer cells by engaging in multiple biological functions, such as initiating apoptosis (Khan *et al.,* 2021), halting the progression of the cell cycle (Niero and Machado-Santelli, 2013), and impeding various cellular mechanisms, such as the activity of metalloproteinases, the formation of new blood vessels (angiogenesis), and the movement of cells (Zhao and Hu, 2013).

Flavonoids, a group of polyphenolic compounds, are known for their significant health-promoting properties, such as antioxidant, anti-inflammatory, and anticancer activities (Ross and Kasum, 2002; Gomez *et al.,* 2009; Kumar and Pandey, 2013). The presence of these genes in various plant tissues can be influenced by numerous factors, including genetic variation among plant genotypes (Jaakola, 2013). Sweet potatoes, particularly those with orange and purple flesh, contain flavonoids such as quercetin, myricetin, luteolin, kaempferol, and apigenin (Laveriano-Santos *et al.,* 2022). These findings suggest a potential association between the flavonoid content and the pigmentation or phenotypic characteristics of these sweet potato genotypes. This association between flavonoids and pigmentation has been previously observed in numerous plant species, including apples and onions (Wu *et al.,* 2004; Khoo *et al.,* 2017). Flavonoids, specifically anthocyanins, contribute to the pigmentation of plant tissues, including the skin of fruits and vegetables (Rodriguez-Amaya and Kimura, 2004). Given the association between pigmentation and the flavonoid content observed in this study, it is plausible that the pigmentation of sweet potatoes might be directly or indirectly influenced by their flavonoid composition. Flavonoids have diverse applications, ranging from their utilization in natural colouring agents (Villela *et al.,* 2019) to their incorporation in cosmetic and dermatological formulations, including antiaging skin treatments (Aguiar *et al.,* 2019; Ullah *et al.,* 2020).

Sweet potatoes, particularly those with orange flesh, have been previously recognized as potent sources of β-carotene (Teow *et al.,* 2007). β-carotene is a specific form of carotenoid that can be converted in the human body to vitamin A, making it an essential dietary source of this micronutrient (Sommer and Vyas, 2012). This conversion has profound implications for human health, especially in regions where vitamin A deficiency is prevalent, as adequate vitamin A intake is pivotal for normal vision, immune function, and various cellular processes (West and Darnton-Hill 2001). The prominence of β-carotene in orange-fleshed sweet potato highlights its importance as a dietary source of provitamin A. Consuming that such genotypes can assist in ameliorating vitamin A deficiencies is a public health concern in many developing countries (Abong *et al.,* 2020). Carotenoids, known for their nontoxic nature, have also been acknowledged for their preventive and therapeutic roles in various pathologies (Zare *et al.,* 2021). These results emphasize the potential of certain genotypes, particularly orange-fleshed varieties, as potent dietary sources of ascorbic acid. The observed higher ascorbic acid content in orange-fleshed sweet potato aligns with the findings of previous studies (Abong *et al.,* 2020). In this study, there was significant variation in the ascorbic acid content among different genotypes of the same species. Such variations can be attributed to distinct developmental stages and tissue types, which can differentially produce and accumulate ascorbic acid (Mellidou and Kanellis, 2017). Ascorbic acid is an excellent free radical scavenger, primarily because of its ability to provide reducing equivalents and the relative stability of the resulting monodehydroascorbate radical. In addition to its role as an antioxidant, vitamin C serves as a vital cofactor for numerous enzymatic processes in both plant and human metabolism (Paciolla *et al.,* 2019).

Anthocyanins are a group of water-soluble pigments responsible for the red, blue, and purple hues observed in many fruits, vegetables, and flowers. These pigments are not only responsible for the vibrant colours but also provide health benefits due to their antioxidant properties (Khoo *et al.,* 2017). This finding supports the well-documented notion that a relatively high concentration of anthocyanins is responsible for the purple colour of various plant tissues (Jaakola, 2013). Following CHFSP-23, CHFSP-03, which has pink skin and purple flesh, presented a slightly lower but more substantial anthocyanin content (0.62 ± 0.037 mg/100 g). This finding suggests that even the presence of purple colour in only a part of the tuber, such as the flesh, can indicate a significant amount of anthocyanin content. On the other hand, the genotype CHFSP-02, characterized by its white skin and flesh, presented the lowest anthocyanin content (0.06 ± 0.011 mg/100 g) (Table 2). Compared with their purple and red counterparts, white and yellow sweet potatoes are known to contain lower levels of anthocyanins (Teow *et al.,* 2007). These findings are in line with other studies that have demonstrated that the concentration of anthocyanins in sweet potatoes is directly proportional to the intensity of their colouration (Suda *et al.,* 2003). Anthocyanins have garnered attention for their potential health-promoting effects in humans, which are primarily attributed to their capacity to scavenge free radicals and reactive species and diminish the levels of proinflammatory markers (Goncalves *et al.,* 2021).

Antioxidant activity is crucial for protecting cells from oxidative stress, reducing the risk of chronic diseases. Radical scavenging activity neutralizes harmful free radicals, thereby preventing cellular damage and maintaining overall health. In the present investigation, the relationship between phenolic content and antioxidant activity was evident among different sweet potato genotypes. A distinct trend emerged, where sweet potato genotypes with relatively high phenolic contents presented relatively high DPPH values, ranging from 69.14% to 86.53% (Table 2). These findings suggest that phenolic compounds present in these genotypes are actively involved in neutralizing free radicals, thereby showing antioxidant activity. This observation is supported by a myriad of scientific studies

emphasizing the potential of phenolic compounds as natural antioxidants because of their capacity to donate hydrogen atoms or electrons and thus neutralize free radicals (Pandey and Rizvi, 2009). Plants have served as a primary resource for both nutrition and therapeutics, whether utilized in traditional medicinal formulations or as isolated active compounds (Kasote *et al.,* 2015). The medicinal efficacy of various plants is often associated with their robust antioxidant capabilities. This antioxidant-driven therapeutic potential provides a scientific foundation for the efficacy of traditional herbal medicines, exemplified by practices in Ayurveda, which focus on disease treatment and the promotion of health and wellness (Kasote *et al.,* 2015). The results of the present investigation provide valuable insights into the antioxidant potential of different sweet potato genotypes and reinforce the pivotal role of phenolic compounds in contributing to this activity. This information can be beneficial not only from a pharmacological point of view but also for breeders and food technologists in selecting specific genotypes for targeted applications, especially in the functional food sector.

5. Conclusion

The present investigation highlights the unexplored possibilities of wild sweet potato varieties and their bioactive elements in enhancing crop genetics, even with scant information on their inherent compounds. The initial study provides an extensive analysis of twenty-nine lesser-known sweet potato varieties and two appropriate control varieties found in Northeast India, emphasizing their considerable potential benefits for human and environmental health. Remarkably, these varieties have promising antioxidant properties, making them viable candidates for meeting food requirements and positioning them as functional foods. Sweet potatoes, particularly those with purple or orange flesh, are rich in antioxidants such as phenols, flavonoids, carotenoids, ascorbic acid, and anthocyanins. These antioxidants play crucial roles in mitigating oxidative stress, reducing the risk of chronic diseases, and promoting overall health. This study also emphasized the impact of genetic variation on the contents of these bioactive compounds. The findings of this research have important implications for the agriculture, nutrition, and food industries. The present investigation provides insight into the identification and selection of sweet potato genotypes with high levels of specific bioactive compounds that can lead to the development of functional foods to meet the needs of consumers and health-conscious markets, ultimately contributing to food security and improved public health. Exploring the metabolic pathways and genetic factors that influence the content of bioactive compounds in sweet potato can aid in the development of targeted breeding strategies to create sweet potato varieties with optimized levels of antioxidants.

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Conflict of interest

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

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